Final Report
Sensitive Lakeshore Survey
Sylvan Lake (11-0304-00)
Cass County, Minnesota

June 2010

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES

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A Product of the
Intra-Lake Zoning to Protect Sensitive Lakeshore Areas Project

Application of
Minnesota's Sensitive Lakeshore Identification Manual: *A Conservation Strategy for Minnesota's Lakeshores*

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Funding Support:
Funding for this report was provided by the State Wildlife Grants Program, Game and Fish Funds, Heritage Enhancement Funds, and by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

How to cite this document:
Thompson, K., D. Perleberg, S. Loso, and K. Woizeschke. 2010. Final report on the sensitive lakeshore survey for Sylvan Lake (11-0304-00), Cass County, MN. Division of Ecological Resources, Minnesota Department of Natural Resources. 71 pp.

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Executive Summary

Aquatic plants occurred around the entire perimeter of Sylvan Lake and were particularly abundant within protected shallow areas. A total of 42 native aquatic plant taxa were recorded, including 29 submerged and free-floating taxa, four floating-leaf, and nine emergent taxa. Submerged plants occurred to a depth of at least 20 feet and were most frequent in the shore to 15 feet depth zone, where 97% of the sample sites contained vegetation. Common submerged plants included southern naiad, muskgrass, northern watermilfoil, coontail, and a variety of native pondweeds. The free-drifting plant star duckweed was also common. Emergent vegetation, including wild rice and bulrush, covered over 100 acres. Surveyors also mapped nearly ten acres of floating-leaf plant beds. Six unique aquatic plant species were documented during the surveys.

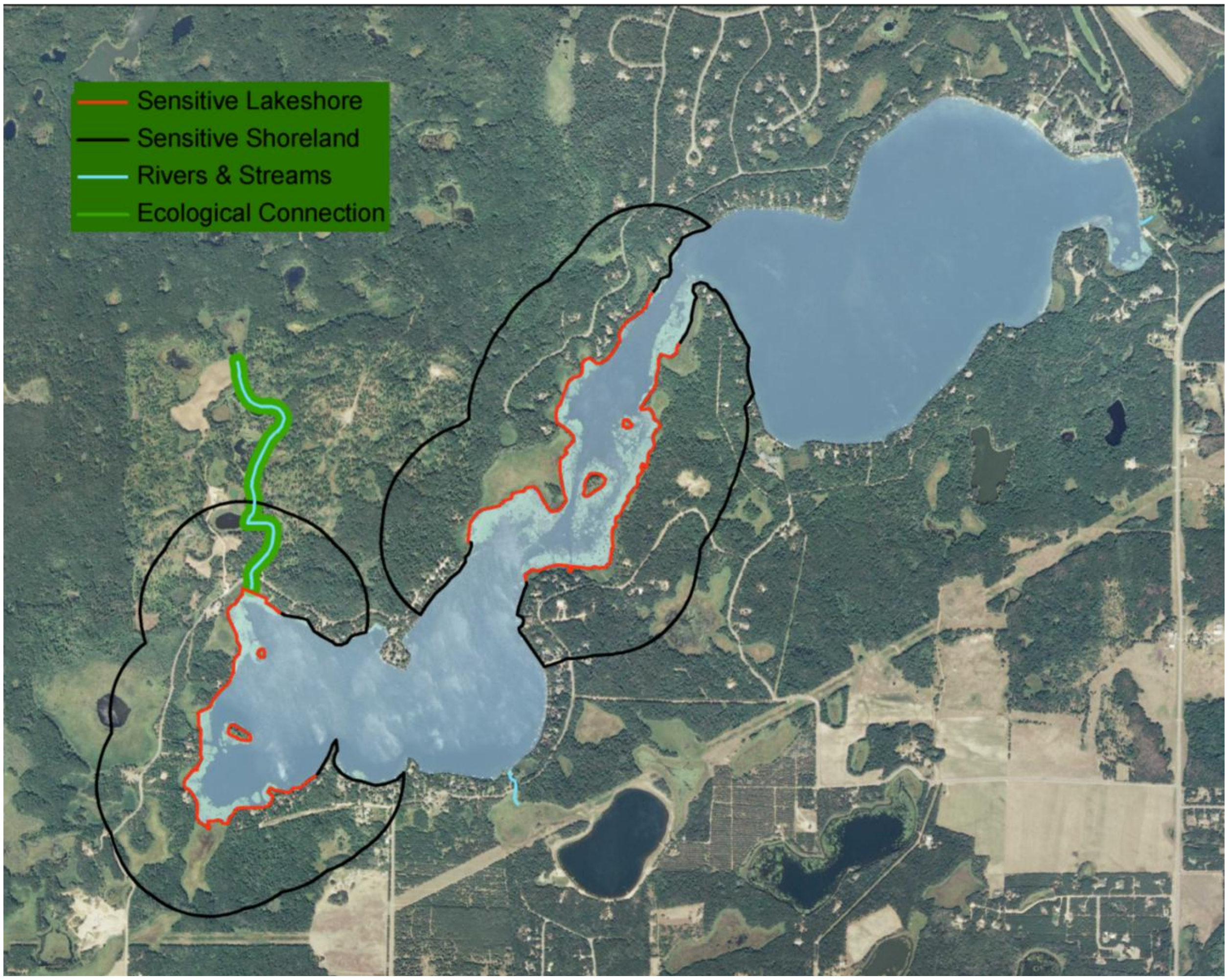
Thirteen bird species of greatest conservation need were documented on Sylvan Lake. Common loons were most abundant, and were recorded at nearly one-third of the survey stations. Bird species of greatest conservation need included aquatic-dwelling, forest-dwelling, and wetland-dwelling species. Red-winged blackbirds were the most commonly identified bird species overall. In total, surveyors recorded 68 bird species on Sylvan Lake.

No fish species of greatest conservation need were detected during the nongame fish surveys, but all three proxy species were recorded. These proxy species were detected in both the northeast and southwest basins of Sylvan Lake. Overall, twenty-five fish species were identified during the Sylvan Lake surveys, and bluegills were the most frequently recorded species. Six species previously unrecorded in the lake were documented during the surveys, bringing the total historical observed fish community to 30 species. Both mink and green frogs were recorded during Sylvan Lake frog surveys.

An ecological model based on major conservation principles was used to assess lakeshore sensitivity. The benefit of this approach is that criteria come from the science-based surveys and the value of the lakeshore is objectively assessed. Environmental decision-making is complex and often based on multiple lines of evidence. Integrating the information from these multiple lines of evidence is rarely a simple process. Here, the ecological model used 15 attributes (hydrological conditions and documented plant and animal presence) to identify sensitive areas of shoreland. A sensitivity index was calculated for each shoreland segment by summing the scores of the 15 attributes. Lakeshore segments were then clustered by sensitivity index values using established geospatial algorithms. Sensitive lakeshore areas were buffered and important ecological connections or linkages mapped. The identification of sensitive lakeshore areas by this method is an objective, repeatable and quantitative approach to the combination of multiple lines of evidence through calculation of weight of evidence. The ecological model results are lake-specific, in that the model results are intended to recognize the most probable highly sensitive lakeshores for a specific lake. Plant and animal assemblages differ naturally between lakes, and sensitivity scores should not be compared across lakes.

The ecological model identified three primary sensitive lakeshore areas to be considered for potential resource protection districting by Cass County. One ecological connection was also identified. The County may use this objective, science-based information in making decisions

about districting and reclassification of lakeshore areas. The most probable highly sensitive lakeshore areas and the recommended resource protection districts are:



Introduction

Minnesota's lakes are one of its most valuable resources. The 12,000 lakes in the state provide various industrial, commercial, and recreational opportunities. They are also home to numerous fish, wildlife, and plant species. In particular, naturally vegetated shorelines provide critical feeding, nesting, resting and breeding habitat for many species. Common loons avoid clear beaches and instead nest in sheltered areas of shallow water where nests are protected from wind and wave action. Mink frogs and green frogs are shoreline-dependent species that prefer quiet bays and protected areas with a high abundance of aquatic plants. Fish such as the least darter, longear sunfish, and pugnose shiner are strongly associated with large, near-shore stands of aquatic plants. Increasing development pressure along lakeshores may have negative impacts on these species – and Minnesota's lakeshores are being developed at a rapid rate. With this in mind, the Minnesota Department of Natural Resources developed a protocol for identifying "sensitive" areas of lakeshore. Sensitive lakeshores represent geographical areas comprised of shorelands, shorelines and the near-shore areas, defined by natural and biological features, that provide unique or critical ecological habitat. Sensitive lakeshores also include:

1. Vulnerable shoreland due to soil conditions (i.e., high proportion of hydric soils);
2. Areas vulnerable to development (e.g., wetlands, shallow bays, extensive littoral zones, etc.);
3. Nutrient susceptible areas;
4. Areas with high species richness;
5. Significant fish and wildlife habitat;
6. Critical habitat for species of greatest conservation need; and
7. Areas that provide habitat connectivity

Species of greatest conservation need are animals whose populations are rare, declining or vulnerable to decline (MN DNR 2006). They are also species whose populations are below levels desirable to ensure their long-term health and stability. Multiple species of greatest conservation need depend on lakeshore areas.

The sensitive shorelands protocol consists of three components. The first component involves field surveys to evaluate the distribution of high priority plant and animal species. Aquatic plant surveys are conducted in both submerged habitats and near-shore areas, and assess the lake-wide vegetation communities as well as describe unique plant areas. Target animal species include species of greatest conservation need as well as proxy species that represent animals with similar life history characteristics. This first component also involves the compilation of existing data such as soil type, wetland abundance, and size and shape of natural areas.

The second component involves the development of an ecological model that objectively and consistently ranks lakeshore areas for sensitive area designation. The model is based on the results of the field surveys and analysis of the additional variables. Lakeshore areas used by focal species, areas of high biodiversity, and critical and vulnerable habitats are important elements in the ecological model used to identify sensitive lakeshore areas. Because the model is based on scientific data, it provides objective, repeatable results and can be used as the basis for regulatory action.

The final component of identifying sensitive lakeshore areas is to deliver advice to local governments and other groups who could use the information to maintain high quality environmental conditions and to protect habitat for species in greatest conservation need.

This report summarizes the results of the field surveys and data analysis and describes the development of the ecological model. It also presents the ecological model delineation of Sylvan Lake sensitive lakeshore areas.

Lake Description

Sylvan Lake (DOW 11-0304-00) is located approximately two miles northeast of the city of Pillager, in Cass County, north-central Minnesota (Figure 1).

Figure 1. Location of Sylvan Lake in Cass County, Minnesota.

Sylvan Lake lies within the Crow Wing River Watershed. Much of the immediate shoreline of the lake is privately owned, and the upland is developed with residential homes, a resort, and a private youth camp. There is a public boat launch on the northeast side of the lake (Figure 2).

Sylvan Lake has a surface area of over 800 acres and about 11 miles of shoreline. The lake consists of two basins connected by a long, shallow channel. Inlets include a small tributary on the southwest basin and flow from Dade Lake in the northeast (Figure 2). A concrete dam at the southwest end of the lake controls outflow, though the water level in Sylvan Lake is often below that of the dam.

The southwest basin is shallow and has a maximum depth of 44 feet. The northeast basin is slightly deeper, with a maximum depth of 57 feet (Figure 3).

Sylvan Lake is an oligotrophic lake, with minimal nutrient enrichment. Between 2000 and 2009, the average Secchi depth (which measures water transparency) was approximately 17 feet in the southwest basin, and nearly 21 feet in the northeast basin (MPCA 2009). These readings indicate high water clarity in the lake.

Figure 2. Features of Sylvan Lake.

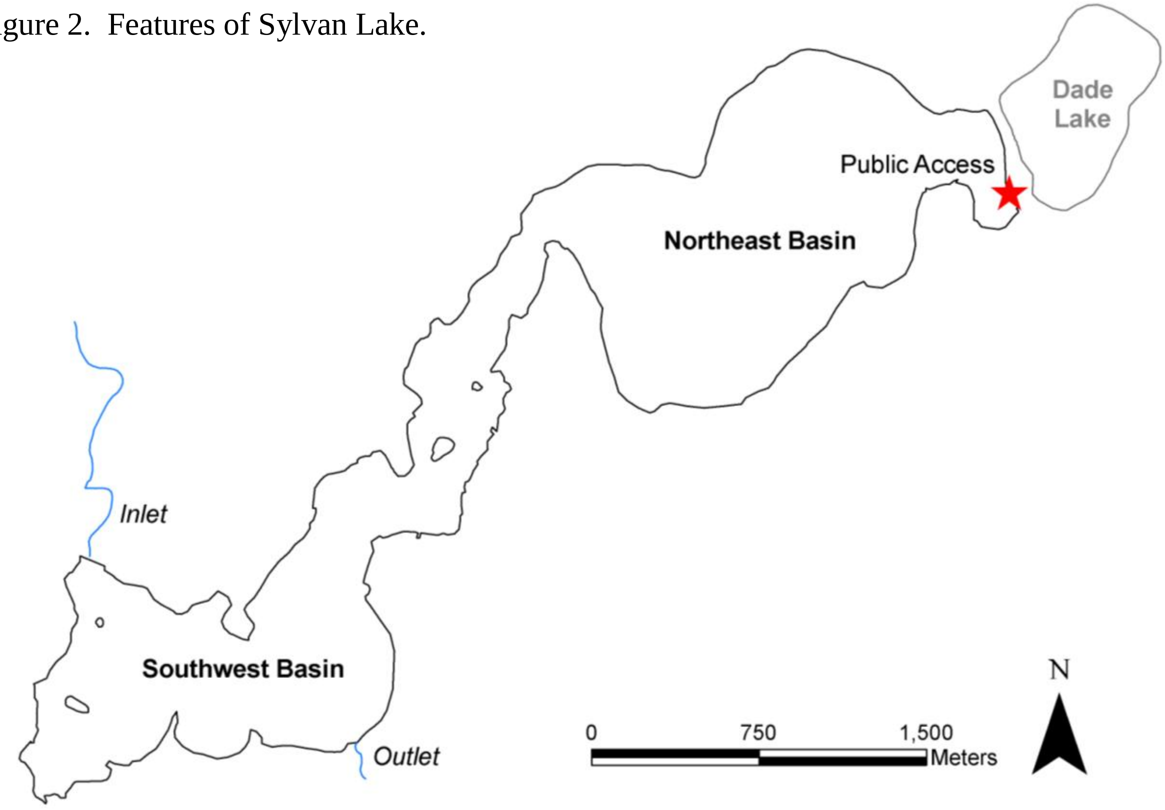
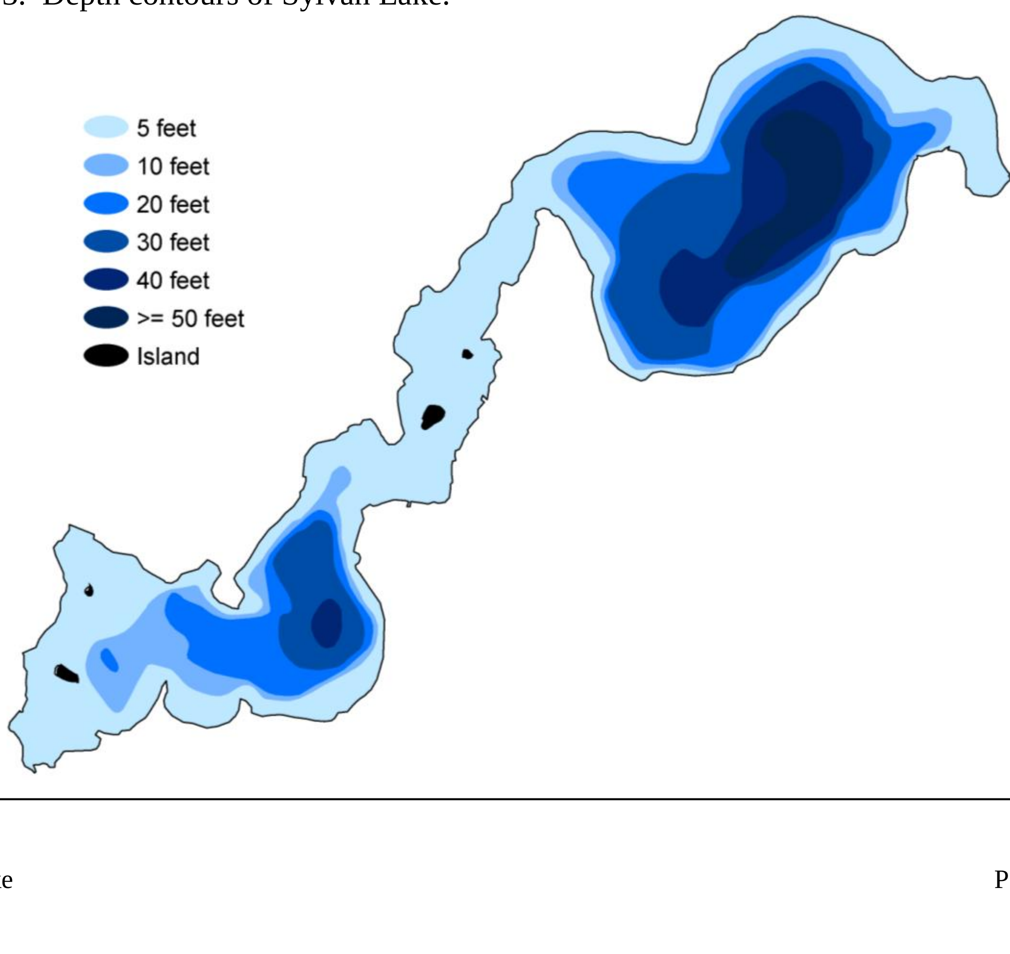


Figure 3. Depth contours of Sylvan Lake.



I. Field Surveys and Data Collection

Survey and data collection followed Minnesota's Sensitive Lakeshore Identification Manual protocol (MN DNR 2008). Resource managers gathered information on 15 different variables in order to develop the sensitive shorelands model. Sources of data included current and historical field surveys, informational databases, aerial photographs, and published literature. The variables used in this project were: wetlands, hydric soils, near-shore plant occurrence, aquatic plant richness, presence of emergent and floating-leaf plant beds, unique plant species, near-shore substrate, birds, bird species richness, loon nesting areas, frogs, fish, aquatic vertebrate species richness, rare features, and size and shape of natural areas.

Pugnose shiner photo courtesy of Konrad Schmidt

Wetlands

Objective

1. Map wetlands within the extended state-defined shoreland area (within 1320 feet of shoreline) of Sylvan Lake

Introduction

Sylan Lake wetland area

Wetlands are important habitat types that provide a variety of services to the environment, to plants and animals, and to humans. Wetland vegetation filters pollutants and fertilizers, making the water cleaner. The roots and stems of wetland plants trap sediments and silt, preventing them from entering other water bodies such as lakes. They protect shorelines against erosion by buffering the wave action and by holding soil in place. 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 or for 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.

Although the definitions of wetlands vary considerably, in general, wetlands are lands in which the soil is covered with water all year, or at least during the growing season. This prolonged presence of water is the major factor in determining the nature of soil development and the plants and animals that inhabit the area. The more technical definition includes three criteria:

1. Hydrology – the substrate is saturated with water or covered by shallow water at some time during the growing season of each year
2. Hydrophytes – at least periodically, the land supports predominantly hydrophytes (plants adapted to life in flooded or saturated soils)
3. Hydric soils – the substrate is predominantly undrained hydric soil (flooded or saturated soils) (adapted from Cowardin et al. 1979)

Methods

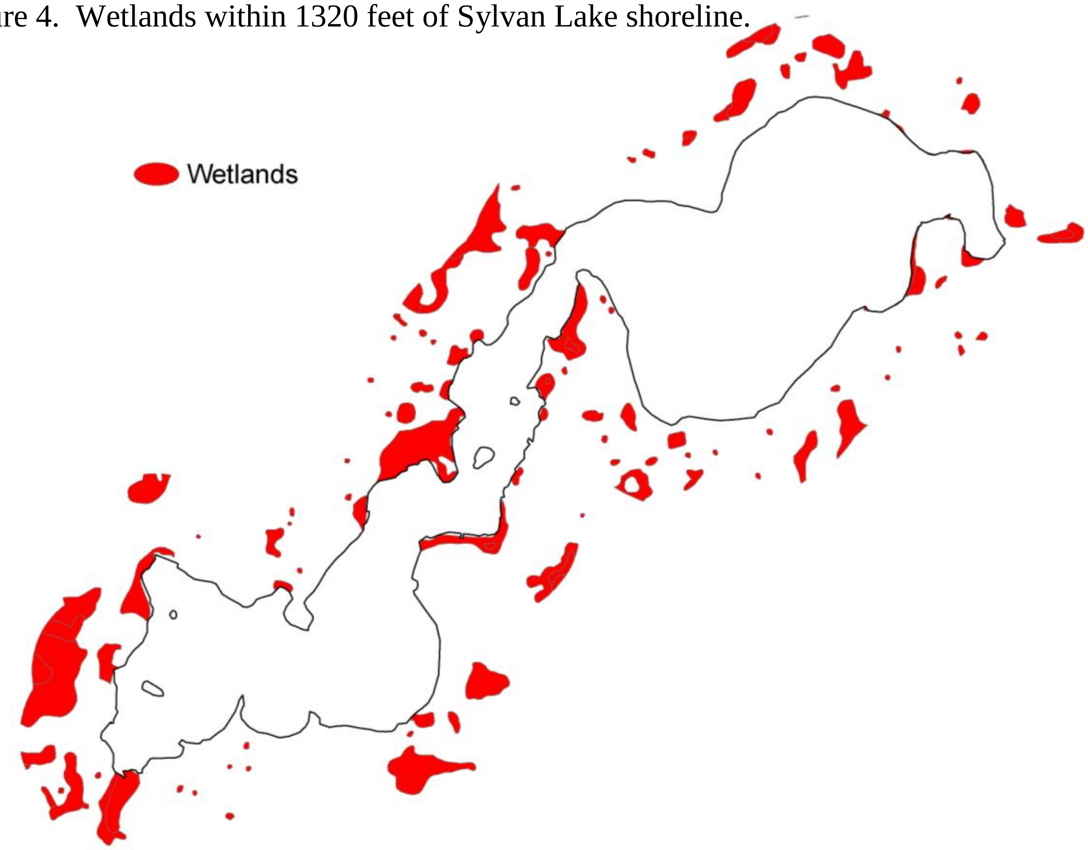
Wetland data were obtained from the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS). The NWI project was conducted between 1991 and 1994 using aerial photography from 1979 – 1988. Wetland polygons obtained from the NWI were mapped in a GIS (Geographic Information Systems) computer program. Only wetlands occurring within the extended state-defined shoreland area (i.e., within 1320 feet of the shoreline) were considered in this project. Wetlands classified as lacustrine or occurring lakeward of the Sylvan Lake ordinary high water mark were excluded from this analysis.

Results

Approximately 223 acres, or about 14% of the Sylvan Lake shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI (Figure 4). Wetlands were present along the entire lakeshore of Sylvan Lake, but were most abundant near the channel between the two basins and in the western side of the southwestern basin.

The dominant wetland types included palustrine scrub shrub (Cowardin et al. 1979) or wetland shrubland systems (MN DNR 2003), dominated by deciduous shrubs; emergent wetland (Cowardin et al. 1979) or marsh (MN DNR 2003) systems, characterized by herbaceous, emergent wetland vegetation; and forested wetlands (Cowardin et al. 1979, MN DNR 2003) with deciduous and evergreen trees. The water regime varied among wetlands and included saturated, seasonally flooded and semi-permanently flooded soils.

Figure 4. Wetlands within 1320 feet of Sylvan Lake shoreline.



Hydric Soils

Objective

1. Map hydric soils within the extended state-defined shoreland area (within 1320 feet of shoreline) of Sylvan Lake

Introduction

Hydric soils are defined as those soils formed under conditions of saturation, flooding, or ponding. The saturation of these soils combined with microbial activity causes oxygen depletion; hydric soils are characterized by anaerobic conditions during the growing season. These conditions often result in the accumulation of a thick layer of organic matter, and the reduction of iron or other elements.

Hydric soils are one of the “diagnostic environmental characteristics” that define a wetland (along with hydrology and vegetation). Identification of hydric soils may indicate the presence of wetlands, and provide managers with valuable information on where to focus conservation efforts.

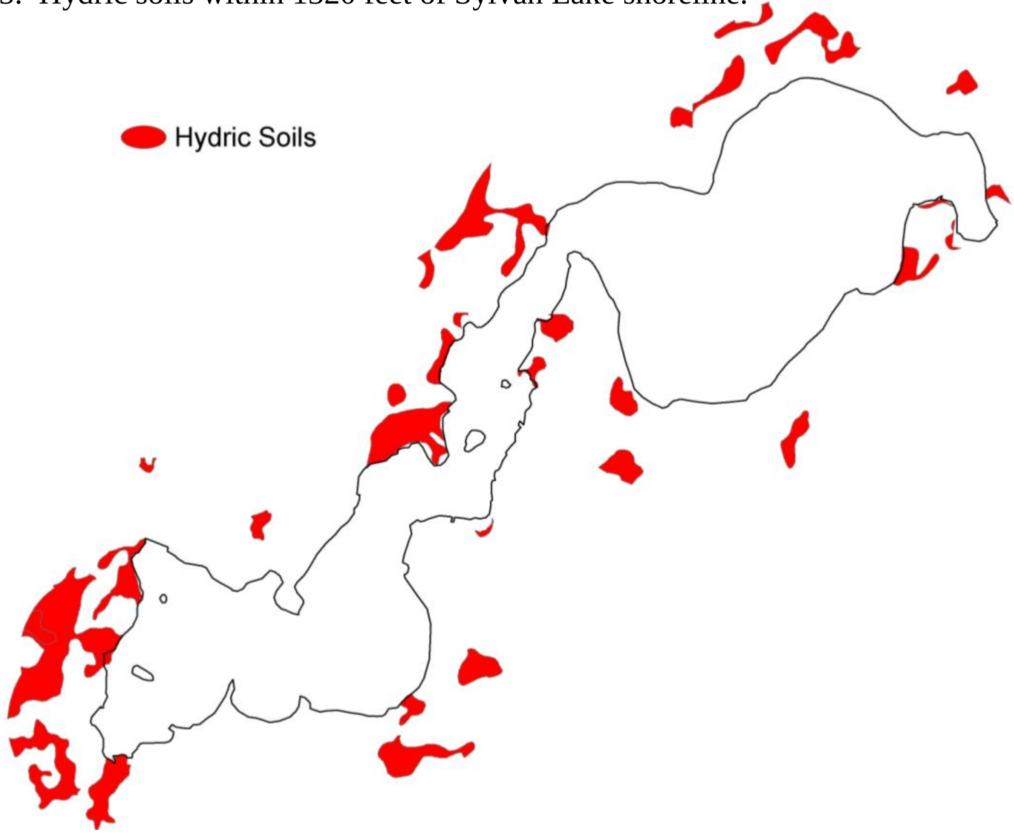
Methods

The National Cooperative Soil Survey, a joint effort of the USDA Natural Resources Conservation Service (NRCS) with other Federal agencies, State agencies, County agencies, and local participants, provided soil survey data. Polygons delineating hydric soils were mapped in a GIS computer program. Only hydric soils within 1320 feet of the shoreline were considered in this project.

Results

Hydric soils were widespread along the shoreline of Sylvan Lake (Figure 5), and encompassed nearly 181 acres within the shoreline district. Large areas of hydric soils were more common on the western shorelands of Sylvan Lake. The organic matter content of the majority of these soils was very high, and most were very poorly drained.

Figure 5. Hydric soils within 1320 feet of Sylvan Lake shoreline.



Plant Surveys

Objectives

1. Record presence and abundance of all aquatic plant taxa
2. Describe distribution of vegetation in Sylvan Lake
    a. Estimate maximum depth of plant colonization
    b. Estimate and map the near-shore occurrence of vegetation
3. Delineate and describe floating-leaf and emergent plant beds
4. Map distribution and describe habitat of unique plant species
5. Calculate and map aquatic plant taxa richness

Summary

A total of 42 native aquatic plant taxa were recorded in Sylvan Lake. These included 29 submerged and free-floating taxa, four floating-leaf, and nine emergent taxa.

Aquatic plants occurred around the entire perimeter of Sylvan Lake and were abundant within the protected shallow areas. Submerged plants occurred to a depth of at least 20 feet and were most frequent in the shore to 15 feet depth zone, where 97% of the sample sites contained vegetation. Common submerged plants included southern naiad (*Najas guadalupensis*), muskgrass (*Chara* sp.), northern watermilfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), and several other native pondweeds (*Potamogeton* spp.). The free-drifting plant star duckweed (*Lemna trisulca*) was also common.

Within the shore to five feet depth zone, 61% of the sample sites contained at least one emergent or floating-leaf plant. Wild rice (*Zizania palustris*) beds covered 102 acres. Six acres of hard-stem bulrush (*Schoenoplectus acutus*) were mapped. Floating-leaf plants, including white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*), watershield (*Brasenia schreberi*), and floating-leaf pondweed (*Potamogeton natans*), occupied about nine acres.

Unique aquatic plants documented during the surveys included four submerged plant species: lesser bladderwort (*Utricularia minor*), flat-leaved bladderwort (*U. intermedia*), humped bladderwort (*U. gibba*), water bulrush (*Schoenoplectus subterminalis*), and two emergent plant species: wiregrass-woolly sedge (*Carex lasiocarpa*) and water arum (*Calla palustris*).

Introduction

The types and amounts of aquatic vegetation that occur within a lake 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 in aquatic plant growth, whereas sheltered shallow areas may support an abundant and diverse native aquatic plant community that in turn, provides critical fish and wildlife habitat and other lake benefits.

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.

Non-native aquatic plant species have not been documented in Sylvan Lake. However, 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 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.

Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. 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. Limiting these types of activities can help protect native aquatic plant species.

Submerged plants

Submerged plants have leaves that grow below the water surface but some species also have the ability to form floating and/or emergent leaves, particularly in shallow, sheltered sites. Submerged plants may be firmly attached to the lake bottom by roots or rhizomes, or they may drift freely with the water current. This group includes flowering plants that may produce flowers above or below the water surface, as well as non-flowering plants such as large algae and mosses.

<u>Southern naiad</u> (*Najas guadalupensis*; Figure 6) has not been reported in many Minnesota lakes but 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 6. Southern naiad

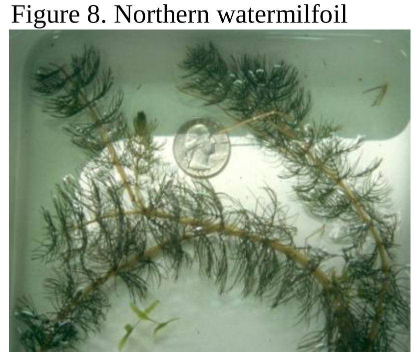
Photo by: Kerry Dressler, Univ. of Florida Center for Aquatic Plants ©1996

Muskgrass (*Chara* sp.; Figure 7) is a large algae that is common in many hard water Minnesota lakes. This plant resembles higher plants but does not form flowers or true leaves, stems and roots. Muskgrass grows entirely submerged, is often found at the deep edge of the plant zone (Arber 1920), and may form thick "carpets" on the lake bottom. These beds provide important habitat for fish spawning and nesting. Muskgrass has a brittle texture and a characteristic "musky" odor. It is adapted to a variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer.

Figure 7. Bed of muskgrass

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 8) 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 overwinters 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 and the extensive root systems help stabilize near-shore substrates.

Figure 8. Northern watermilfoil



Coontail (*Ceratophyllum demersum*; Figure 9) is the most common submerged flowering plant in Minnesota lakes. It grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is a perennial and can overwinter as a green plant under the ice before beginning new growth early in spring. Because it is only loosely rooted to the lake bottom it may drift between depth zones (Borman et al. 2001). Coontail provides important cover for young fish, including bluegills, perch, largemouth bass and northern pike. It also supports aquatic insects beneficial to both fish and waterfowl.

Figure 9. Coontail

Star duckweed (*Lemna trisulca*; Figure 10) is a free-floating species that often occurs submerged near the lake bottom but does not anchor to the substrate and can float freely with the current. Star duckweed overwinters by producing winter buds that rest on the sediment. It is a good source of food for waterfowl and provides cover for fish and invertebrates (Borman et al. 2001).

Figure 10. Star duckweed

Photo by: Robert Freckman, Univ. of WI – Stevens Point

Pondweeds (*Potamogeton* spp. and *Stuckenia* spp.) are one of the largest groups of submerged plants in Minnesota lakes. These plants are rooted perennials and their rhizomes may form mats on the lake bottom that help consolidate soil (Arber 1920). Pondweeds have opposite, entire leaves and form "cigar-shaped" flowers that emerge above the water surface. Many pondweed species overwinter as hardy rhizomes while other species produce tubers, specialized winter buds, or remain "evergreen" under the ice. Seeds and tubers of pondweeds are an important source of waterfowl food (Fassett 1957). The foliage of pondweeds is food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001). Pondweeds inhabit a wide range of aquatic sites and species vary in their water chemistry and substrate preferences and tolerance to turbidity. There are over 35 species of pondweeds in Minnesota and they vary in leaf shapes and sizes.

Figure 11. Flat-stem pondweed

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 11) is a perennial plant that is anchored to the lake bottom by underground rhizomes. It is named for its flattened, grass-like leaves. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. These pondweeds overwinter by winter buds.

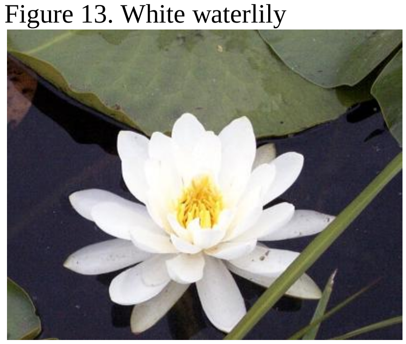
Broad-leaf pondweeds include large-leaf pondweed (*Potamogeton amplifolius*; Figure 12), white-stem pondweed (*P. praelongus*), Illinois pondweed (*P. illinoensis*), and variable pondweed (*P. gramineus*). These plants are often called "cabbage" plants by anglers. Some broad-leaf pondweeds may form floating leaves in sheltered sites while other species have only submerged leaves. Species like white-stem and large-leaf pondweed are common in many clear water Minnesota lakes but are often among the first species to decline in degraded water. White-stem pondweed is not tolerant of turbidity (Nichols 1999b) and may be negatively impacted by increased lake development.

Figure 12. Large-leaf pondweed

Floating-leaf and emergent plants

Floating-leaf and emergent aquatic plants are anchored in the lake bottom and their root systems often form extensive networks that help consolidate and stabilize bottom substrate. Beds of floating-leaf and emergent plants 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 six feet and may extend lake-ward onto mudflats and into adjacent wetlands.

Figure 13. White waterlily



White and yellow waterlilies can be found in lakes in both northern and southern Minnesota. White waterlily (*Nymphaea odorata*; Figure 13) has showy white flowers and round leaves with radiating veins. Yellow waterlily (*Nuphar variegata*; Figure 14) 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 ten feet (Nichols 1999b).

Figure 14. Yellow waterlily

Watershield (*Brasenia schreberi*) is most often found in soft-water lakes (Borman et al. 2001) in northern Minnesota. It has relatively small, floating oval leaves and small reddish flowers (Figure 15). The leaves are green on top, while the underside of the leaves and stems are reddish-purple. The leaves and stems of watershield have a slippery, gelatinous coating.

Figure 15. Watershield

Floating-leaf pondweed (*Potamogeton natans*; Figure 16) occurs in lakes throughout the state. It may co-occur with other vegetation or may be found on the deep end of bulrush beds. This plant forms very narrow submerged leaves and oval-shaped floating leaves. The fruits of floating-leaf pondweed are eaten by geese and ducks, including scaup and blue-winged teal (Borman et al. 2001).

Figure 16. Floating-leaf pondweed

Emergent aquatic plants have stems and/or leaves that extend well above the water surface. Most emergent plants are flowering plants, though their flowers may be reduced in size. Emergent plants include perennial plants as well as annual plants.

Hard-stem bulrush (*Schoenoplectus acutus*) is an emergent, perennial plant that occurs in lakes and wetlands throughout Minnesota (Ownbey and Morley 1991). Bulrush stems are round in cross section and lack showy leaves (Figure 17). Clusters of small flowers form near the tips of long, narrow stalks. This emergent may occur from shore to water depths of about six feet and its stems may extend several feet above the water surface. Bulrush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans.

Figure 17. Bulrush bed

Wild rice (*Zizania palustris*; Figure 18) is an emergent annual plant that reproduces each year from seed set in the previous fall. Wild rice is most commonly found in lakes of central and northern Minnesota. Cass County is one of five

Minnesota counties with the highest concentration of lakes supporting natural wild rice stands (MN DNR 2008b). Wild rice generally requires habitat with some water flow, such as lakes with inlets and outlets. This plant most often is found in water depths of 0.5 to three feet in soft substrates (MN DNR 2008b). Wild rice is one of the most important waterfowl foods in North America and is used by more than 17 species of wildlife listed by the Minnesota Department of Natural Resources as "species of greatest conservation need" (MN DNR 2008b). Other ecological benefits associated with wild rice stands include habitat for fish and aquatic invertebrates, shoreline protection and stabilization, and nutrient uptake. This plant also has special cultural and spiritual significance to the Ojibwe people and wild rice harvest provides important economic benefits to local economies (MN DNR 2008b).

Figure 18. Wild rice

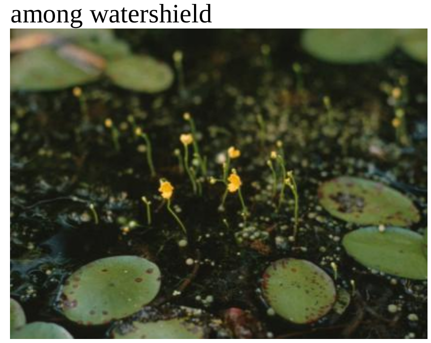
Unique aquatic plants

Unique aquatic plant species are of high conservation importance. These species may include:

- Plant species that are not listed as rare but are uncommon in the state or locally. These may include species that are proposed for rare listing.
- Plants species with high coefficient of conservatism values (C values). These values range from 0 to 10 and represent the "estimated probability that a plant is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition" (Nichols 1999a, Bourdaghs et al. 2006). Plant species with assigned C values of 9 and 10 were included as unique species.

Bladderworts (*Utricularia* spp.) are a group of submerged plants that produce roots but do not firmly anchor to the lake bottom. Greater bladderwort (*U. vulgaris)* is found in lakes and ponds throughout Minnesota but several other species are much less common. Unique bladderwort species in Sylvan Lake include <u>lesser bladderwort</u> (*U. minor*), <u>flat-leaved bladderwort</u> (*U. intermedia*), and <u>humped bladderwort</u> (*U. gibba*). These small, submerged plants are often confused as algae because of their fine stems and leaves. Bladderworts have specialized air bladders that regulate their position in the water column. They also act as "underwater Venus fly-traps" by catching and digesting small insects in the bladders. Bladderworts produce small but showy flowers (Figure 19) that emerge above the water surface. They prefer soft substrates (Nichols 1999b) but also float freely in the water column and may be found in protected areas such as waterlily beds. They are found in protected, shallow lake areas and have been documented at scattered locations throughout northern Minnesota (Ownbey and Morley 1991).

Figure 19. Bladderwort in flower among watershield



Water bulrush (*Schoenoplectus subterminalis*) is a submerged, perennial plant with fine, grass-like leaves that may form mats and float near the water surface (Figure 20). In mid to late summer its leaf tips and flower stalk may emerge above the water surface. This species once had a patchy distribution throughout North America but may now be extirpated from Illinois (Flora of North America 2007) and its conservation status is listed as critically impaired in several other states (NatureServe 2008). It is infrequently found in Wisconsin (Nichols 1999b) and Minnesota (Ownbey and Morley 1991) lakes.

Figure 20. Water bulrush

Photo by: D.W. Taylor, © 1996

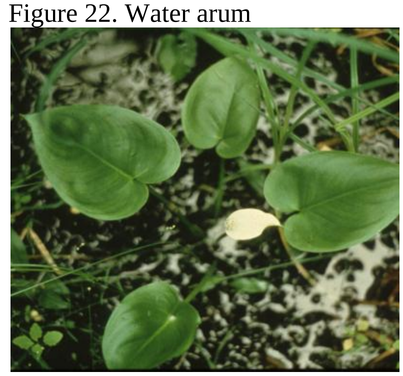
Wiregrass-woolly sedge (*Carex lasiocarpa*; Figure 21) is an emergent, perennial plant that grows in small tufts with long scaly stolons. It is purplish-red at the base and is usually smooth. The leaves have no midvein and are usually roughened near the tip. The staminate scales are light reddish-brown and erect, while the pistillate scales are purplish-brown with a green center. Woolly sedge can be found around sloughs and lake shorelines (Mohlenbrock 2005). Woolly sedge is found in northern and central Minnesota at scattered locations (Ownbey and Morley 1991).

Figure 21. Wiregrass-woolly sedge

Photo by: Emmet J. Judziewicz, ©1981

Water arum (*Calla palustris*; Figure 22) is an emergent, perennial wetland plant that may grow along marshy lakeshores as well as in wooded swamps, marshes and bogs (Nichols 1999b). The plant is recognizable by its heart-shaped leaves and the showy, white petal-like spathe. This is a species of northern latitudes and Minnesota is the southwestern limit of its range (Flora of North America 2007). Within Minnesota, water arum primarily occurs in the northeast half of the state (Ownbey and Morley 1991).

Figure 22. Water arum



Species richness

Species richness is defined as the number of species present in a community and is often used as a simple measure of biodiversity (Magurran 2004). In aquatic plant communities, species richness is influenced by many complex factors (Pip 1987) including water chemistry, transparency, habitat area and habitat diversity (Vestergaard and Sand-Jensen 2000, Rolon et al. 2008). In Minnesota, water chemistry strongly influences which plant species can potentially occur in a lake (Moyle 1945), and thus indirectly influences lakewide species richness. The trophic status of a lake further influences plant species richness, and eutrophic and hypereutrophic habitats have been associated with reduced species richness (Pip 1987). Within a region of Minnesota, lakewide aquatic plant species richness can be used as a general indicator of the lake clarity and overall health of the lake plant community. Loss of aquatic plant species has been associated with anthropogenic eutrophication (Stuckey 1971, Nicholson 1981, Niemeier and Hubert 1986) and shoreland development (Meredith 1983).

Within a lake, plant species richness generally declines with increasing water depth, as fewer species are tolerant of lower light levels available at deeper depths. Substrate, wind fetch, and other physical site characteristics also influence plant species richness within lakes.

Methods

The aquatic plant communities of Sylvan Lake were described and measured using several techniques as found in Minnesota's Sensitive Lakeshore Identification Manual (MN DNR 2008). Plant nomenclature follows MNTaxa 2009.

Grid point-intercept survey
A grid point-intercept survey was conducted in Sylvan Lake on June 16 and 17, 2008 (Perleberg and Loso 2008). A GIS computer program was used to establish aquatic plant survey points throughout the littoral (i.e., vegetated) zone of the lake to a depth of 20 feet. Points were spaced 65 meters apart and 420 sites were sampled within the shore to 20 feet depth interval. Surveyors navigated to each site using a handheld Global Positioning (GPS) unit. At each sample site, water depth and all vegetation within a one-meter squared sample area was sampled using a double-headed garden rake. All aquatic plant species present within the sample plot were recorded and frequency of occurrence was calculated for each species. Any additional species found outside the sample plots were recorded as present in the lake. Voucher specimens were collected for most species and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Emergent and floating-leaf bed delineation
Protocol for mapping plant beds were based on the procedures documented in the DNR draft Aquatic Vegetation Mapping Guidelines (MN DNR 2005). They included a combination of aerial photo delineation and interpretation, field delineation, ground-truthing and site specific surveys. Waterlily beds were delineated using 2003-2004 Farm Service Administration (FSA) true color aerial photos. Black and white aerial photos from 1999 were used to help distinguish the true shoreline from mats of perennial vegetation. In 2008, reconnaissance surveys were conducted of the largest beds to verify species composition and if needed, modify boundary lines. Field mapping focused on bulrush beds, which were difficult to see on aerial photos. Bulrush beds were mapped in 2008 using handheld GPS technology.

Searches for unique and rare species
Prior to fieldwork, surveyors obtained known locations of state and federally listed rare plants within one mile of Sylvan Lake from the Rare Features Database of the MN DNR Natural Heritage Information System. Surveyors also queried the University of Minnesota Herbarium Vascular Plant Collection database and DNR Fisheries Lake Files to determine if certain plant species had previously been documented in or near Sylvan Lake.

Surveyors searched for unique and rare plant species in 2008 during the lakewide point-intercept surveys. If unique or rare plant species were located, surveyors recorded the site location, the plant species found, associated plant species, approximate water depth and substrate type. Any new sites of rare plant species were documented and entered into the MN DNR Natural Heritage Information System.

A targeted search for rare aquatic vascular plants in Sylvan Lake was conducted by the Minnesota County Biological Survey Program on June 18, 2008 (Myhre 2008). This search focused on sites that were most likely to contain rare plant species. Botanists used professional experience to select rare species search sites and included factors such as shoreline development, substrate type, water depth, and native plant community type in their site selection. To gain access to shallow vegetated areas, searches were conducted by slowly kayaking, canoeing and/or wading through the site. A brief habitat description and a list of all plant taxa found in the search area were recorded. When necessary, plant specimens were sent to the authority in the field for identification verification and annotation. Voucher specimens were collected to document county records and some other species, and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Results

Aquatic plant species observed

A total of 42 native aquatic plant taxa were recorded in Sylvan Lake. These included 29 submerged and free-floating taxa (Table 1), four floating-leaf, and nine emergent taxa (Table 2). Several additional shoreline plants were recorded during the rare plant survey (Appendix 1).

Distribution of plants by water depth

Submerged plants were found to a water depth of 20 feet (the maximum depth sampled) and emergent and floating-leaf plants occurred in water depths of seven feet and less. The vegetated zone included about half of the lake (Figure 23) and within this area, 94% of the survey sites contained vegetation. Plant occurrence was greatest in depths from shore to 15 feet, where 97% of the sites were vegetated. In water depths of 15 to 20 feet, 76% of the sites contained plants. Scattered plant growth likely occurred beyond the 20 feet depth.

Submerged plants

Submerged plants occurred in 93% of Sylvan Lake sample sites. The plant community included leafy plants that are anchored to the lake bottom by roots as well as large algae that may resemble leafy plants but are weakly anchored to the lake bottom.

Southern naiad was the most common submerged plant in Sylvan Lake and occurred in 54% of the sample sites (Table 1). It was frequently found throughout the littoral zone. It was the most common plant in the shore to 15 feet depth zone and in depths of six to 15 feet it was found in more than 60% of the sample sites (Figure 24A).

Muskgrass was found in 23% of all sample sites (Table 1). It occurred throughout the littoral zone and was abundant at depths from shore to ten feet. Muskgrass was the dominant plant along the south shore of the north basin (Figure 24B).

Northern watermilfoil, coontail, star duckweed, and flat-stem pondweed were also common, each occurring in at least 15% of the sample sites (Table 1). These plants were generally restricted to the south basin of Sylvan Lake (Figure 24 C, D, E, F). Coontail was the dominant plant in the 16 to 20 feet depth zone.

Table 1. Submerged and free-floating aquatic plants recorded in Sylvan Lake, 2008.

Description		Common Name	Scientific Name	Frequency[a]
Algae and mosses		Muskgrass	*Chara* sp.	23
		Watermoss	Not identified to species	9
		Stonewort	*Nitella* sp.	3
Rooted plants		Southern naiad	*Najas guadalupensis*[b]	54
	Water milfoils	Northern watermilfoil	*Myriophyllum sibiricum*	21
		Whorled watermilfoil	*Myriophyllum verticillatum*	Present[e]
		Coontail	*Ceratophyllum demersum*	19
		Canada waterweed	*Elodea canadensis*	15
	Ribbon-leaf pondweeds	Flat-stem pondweed	*Potamogeton zosteriformis*	15
		Robbin's pondweed	*Potamogeton robbinsii*	5
	Broad-leaf pondweeds	Large-leaf pondweed	*Potamogeton amplifolius*	10
		Illinois pondweed	*Potamogeton illinoensis*	6
		White-stem pondweed	*Potamogeton praelongus*	5
		Variable pondweed	*Potamogeton gramineus*	<1
		Clasping-leaf pondweed	*Potamogeton richardsonii*	Present[e]
	Narrow-leaf pondweeds	Fries' pondweed[c]	*Potamogeton friesii*	3
		Straight-leaved pondweed[c]	*Potamogeton strictifolius*[e]	
		Sago pondweed	*Stuckenia pectinata*	1
		White water buttercup	*Ranunculus aquatilis*	3
		Water stargrass	*Zosterella dubia*	2
		Water marigold	*Bidens beckii*	1
		Water bulrush	*Schoenoplectus subterminalis*	1
		Wild celery	*Vallisneria americana*	Present[d]
Free-drifting		Star duckweed	*Lemna trisulca*	18
		Greater bladderwort	*Utricularia vulgaris*	6
		Lesser bladderwort	*Utricularia minor*	6
		Flat-leaved bladderwort	*Utricularia intermedia*	5
		Humped bladderwort	*Utricularia gibba*	1
		Duckweed	*Lemna* sp.	Present[e]

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations (N = 420). They represent the percent of the sample stations that contained a plant taxon.

[b]May have included some specimens of bushy pondweed (*Najas flexilis).*

[c]Some specimens of "narrow-leaved pondweeds" were positively identified as *Potamogeton friesii* (Fries' pondweed) and at least one other "look-a-like" narrow-leaf pondweed species (P. strictifolius) occurred in the lake. Therefore, all narrow-leaf pondweeds (*Potamogeton* spp.) are grouped together for frequency calculation.

Present[d] = species was found in lake but did not occur within point-intercept sample stations.

Present[e] = located only during Minnesota County Biological Survey, 18 June 2008.

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaf and emergent aquatic plants recorded in Sylvan Lake, 2008.

Description	Common Name	Scientific Name	Frequency[a]
Floating-leaf	Watershield	*Brasenia schreberi*	11
	White waterlily	*Nymphaea odorata*	11
	Yellow waterlily	*Nuphar variegata*	6
	Floating-leaf pondweed	*Potamogeton natans*	6
Emergent	Wild rice	*Zizania palustris*	12
	Hard-stem bulrush	*Schoenoplectus acutus*	1
	Soft-stem bulrush	*Schoenoplectus tabernaemontani*	Present[b]
	Spikerush	*Eleocharis* sp.	1
	Burreed	*Sparganium* sp.	<1
	Broad-leaved arrowhead	*Sagittaria latifolia*	<1
	Needle-grass	*Eleocharis acicularis*	<1
	Narrow-leaved cattail	*Typha angustifolia*	Present[b]
	Water arum	*Calla palustris*	Present[b]

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations (N = 420). They represent the percent of the sample stations that contained a plant taxon.

Present[b] = located only during Minnesota County Biological Survey, 18 June 2008.

Nomenclature follows MNTaxa 2009.

Figure 23. Aquatic plant distribution in Sylvan Lake, 2008.

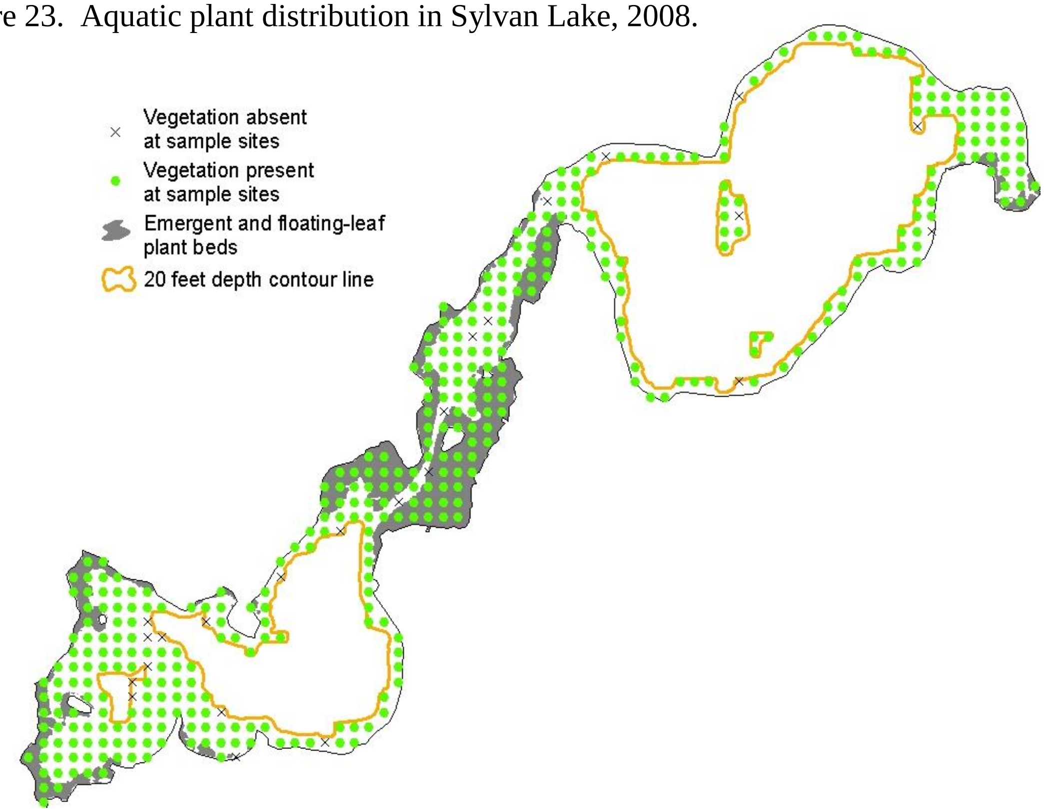
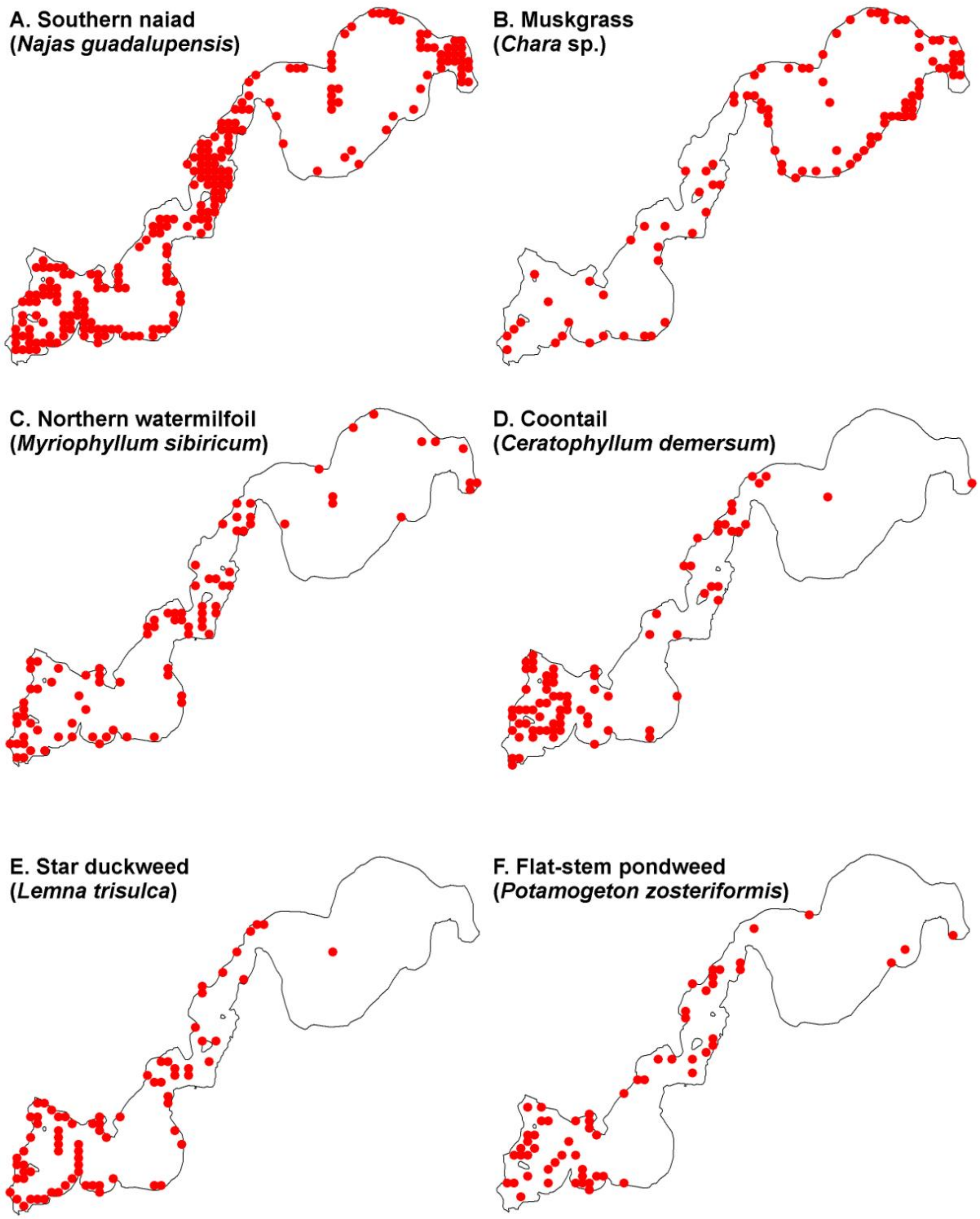


Figure 24. Distribution of common aquatic plants in Sylvan Lake, 2008.



Floating-leaf and emergent plants

About nine acres of floating-leaf plant beds were mapped and the largest beds occurred in the top of the northeast basin and along the southwest shorelines of the southwest basin (Figure 25). The most common species were white waterlily, yellow waterlily, watershield and floating-leaf pondweed. Because surveyors avoided motoring into floating-leaf plant beds, the frequency values obtained for these taxa (Table 2) were lower than the actual lakewide occurrence. Frequency values for floating-leaf taxa represent the occurrence of these taxa only within the sites that were surveyed. Waterlily beds often contained scattered bulrush and wild rice plants as well as submerged plants, and were usually associated with muck sediments.

Waterlilies in Sylvan Lake, 2008

Surveyors delineated approximately 122 acres of emergent plants and the most common taxa were wild rice, cattails and bulrush. About six acres of bulrush were mapped in Sylvan Lake and 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.

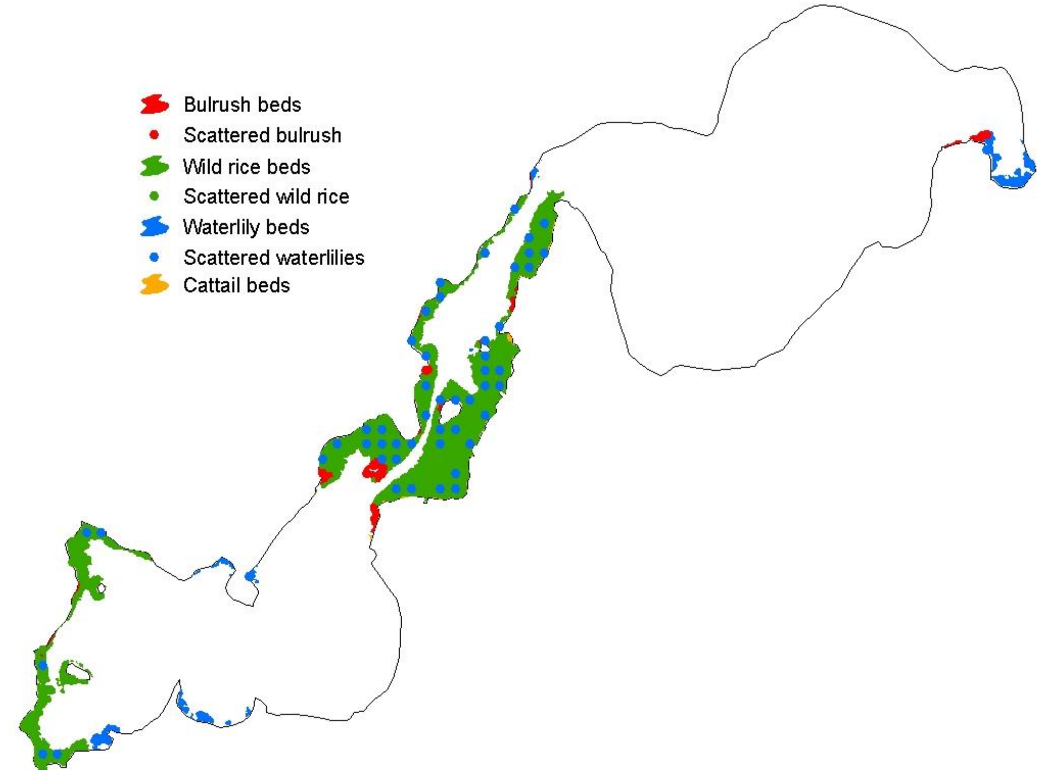
Bulrush in Sylvan Lake, 2008

About 102 acres of mixed wild rice were mapped in silt substrates. This species occurred mainly in the channel between the north and south basins of Sylvan Lake, but was also found on the southwest shores of the southern basin. About 13 acres of cattails were mapped and were located along the shore in the channel between upper and lower Sylvan.

Other emergent plants occurred at scattered locations around the lake and included broad-leaved arrowhead (*Sagittaria latifolia*), giant burreed (*Sparganium eurycarpum*), and narrow-leaved cattail (*Typha angustifolia*). Many of these emergent plants occupied the transitional zone between the lake and adjacent wetlands. Numerous additional native emergents occurred in these adjacent wetlands but this survey did not include an exhaustive wetland species inventory.

Cattails in Sylvan Lake, 2008

Figure 25. Distribution of emergent and floating-leaf plant beds in Sylvan Lake, 2008.



Unique plants

In addition to the commonly occurring plants in Sylvan Lake, six unique plant species were documented at 40 locations during the survey (Figure 26.). These plants were concentrated in the northern and southern tips of the lake and in the channel connecting the northeast and southwest lake basins. These species are not widespread in Minnesota but their presence is indicative of relatively undisturbed native plant beds in Sylvan Lake. Unique submerged aquatic plants found in Sylvan Lake included lesser bladderwort, flat-leaved bladderwort, humped bladderwort, water bulrush, wiregrass-woolly sedge, and water arum.

Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to 11 (Figure 27). Sites with the highest number of species occurred in the channel and the southern end of the lake, where a mixture of emergent, floating-leaf and submerged plants were found. 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.

Figure 26. Unique aquatic plants in Sylvan Lake, 2008.

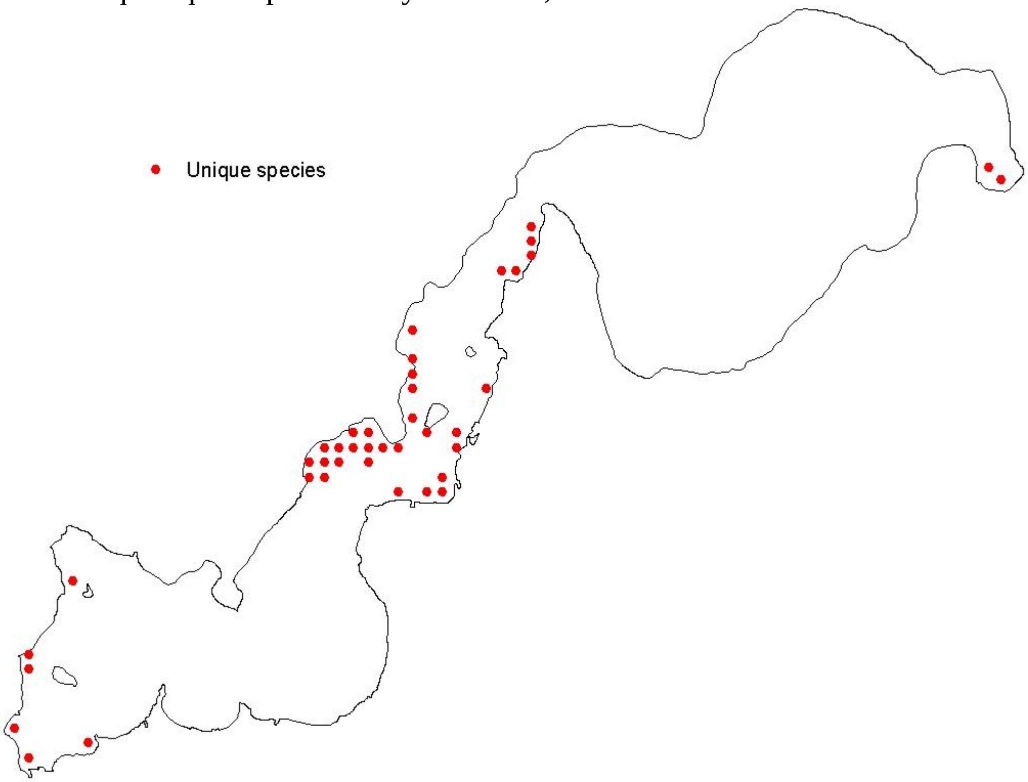
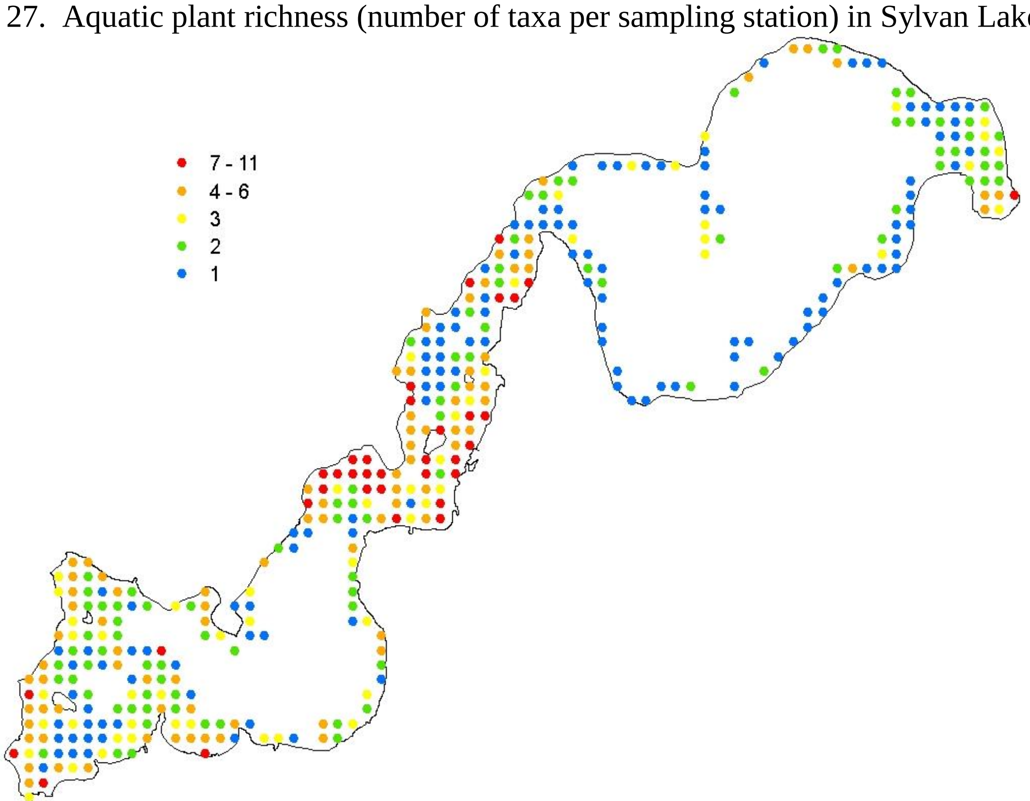


Figure 27. Aquatic plant richness (number of taxa per sampling station) in Sylvan Lake, 2008.



Near-shore Substrates

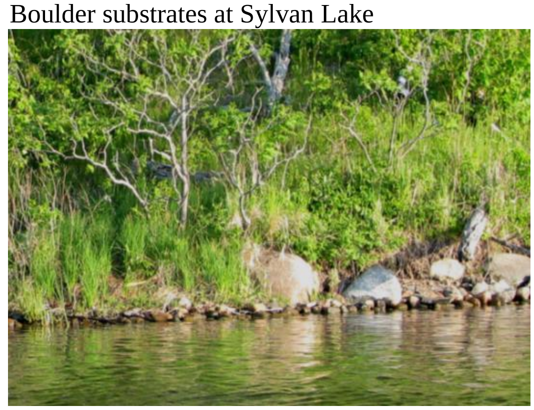
Objective

1. Describe and map the near-shore substrates of Sylvan Lake

Introduction

Substrate type can have an effect on species make-up and richness. Some fish, such as the pugnose shiner, least darter, and longear sunfish, prefer small diameter substrates, such as silt, muck, and sand. Other species, such as walleye, prefer hard bottom substrates with a larger diameter, such as gravel and rubble. A diverse substrate will also allow plants with different habitat requirements to exist within a system. For example, bulrush may occur on sand or gravel whereas yellow waterlily prefers soft substrates (Nichols 1999b).

Boulder substrates at Sylvan Lake



Methods

Near-shore substrate in Sylvan Lake was evaluated at a total of 387 sampling stations set up in the grid point-intercept aquatic plant surveys and near-shore fish surveys. Plant sample stations were 65 meters apart and occurred in a grid from shore to a depth of 20 feet; substrate was evaluated at sample stations where water depths were seven feet and less. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore fish sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 48 of these stations.

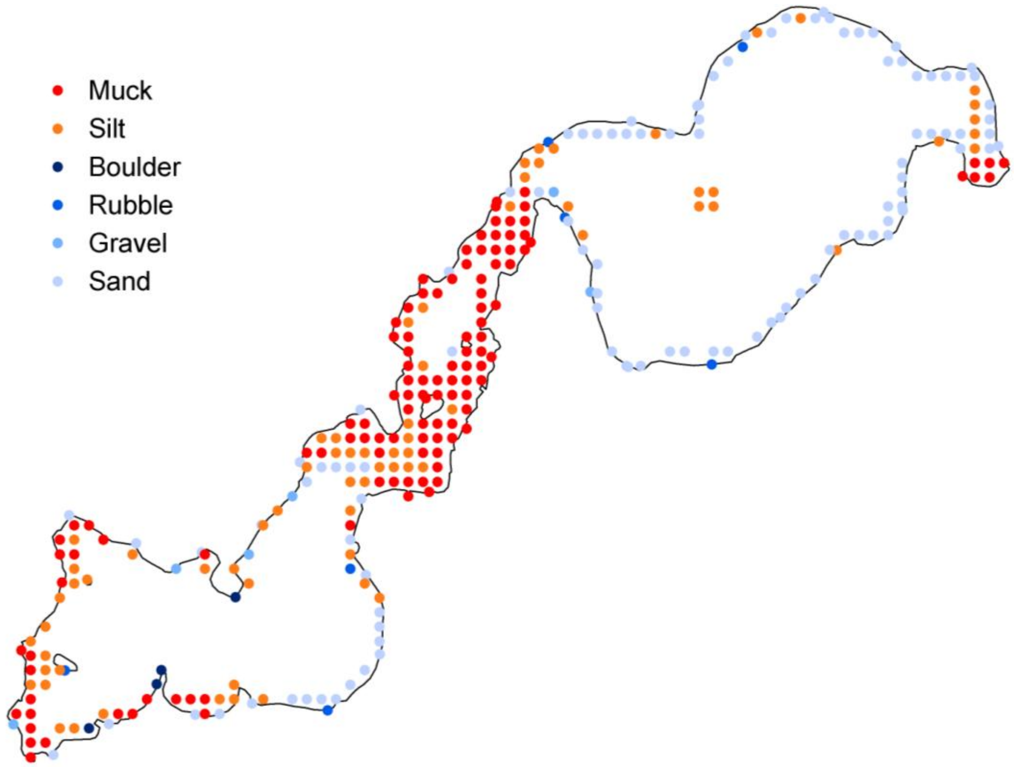
Surveyors evaluated substrate by tapping a pole into the lake bottom; soft substrate could usually be brought to the surface on the pole or sampling rake for evaluation. If this was not feasible, substrate was evaluated by visual observation. Standard lake substrate classes were based on the DNR Fisheries Survey Manual (MN DNR 1993):

Substrate Group	Type	Description
Hard Bottom	Boulder	Diameter over 10 inches
	Rubble	Diameter 3 to 10 inches
	Gravel	Diameter 1/8 to 3 inches
	Sand	Diameter less than 1/8 inch
Soft Bottom	Silt	Fine material with little grittiness
	Marl	Calcareous material
	Muck	Decomposed organic material

Results

Both hard and soft substrates were present in Sylvan Lake (Figure 28). The northeast basin was dominated by sand substrates; this substrate was also found along the eastern edge of the southwest basin. Other hard substrates, such as boulders and rubble, were found at scattered locations in both lake basins. The channel between the two basins and the western edge of the southwest basin were comprised of soft substrates, including muck and silt.

Figure 28. Distribution of Sylvan Lake near-shore substrates, 2008.



Bird Surveys

Objectives

1. Record presence of all bird species detected during point count surveys
2. Record presence of marsh birds detected with call-playback surveys
3. Document all non-survey observations of birds
4. Develop distribution maps for species of greatest conservation need

Introduction

Bird Species of Greatest Conservation Need
There are 97 bird species of greatest conservation need (SGCN) in Minnesota. Species of greatest conservation need are documented in Minnesota's State Wildlife Action Plan, Tomorrow's Habitat for the Wild and Rare (2006). Thirteen of these species were identified at Sylvan Lake.

Figure 29. American white pelican

Photo by: Carrol Henderson

American white pelicans (*Pelecanus erythrorhynchos*; Figure 29) are one of the largest birds in North America. These white waterbirds have a wingspan of nearly 10 feet, and weigh up to 30 pounds. They have black wingtips and an orange bill with a pouch. Unlike some pelicans, American white pelicans do not dive for their food, but feed while swimming. They nest in colonies on remote freshwater lakes, and depend on wetlands for many stages of their life cycle. Habitat loss is the largest known cause of nesting failure, although predation and boating disturbance can also be factors.

Figure 30. Bald eagle

Photo by: Carrol Henderson

Bald eagles (*Haliaeetus leucocephalus*; Figure 30) are an increasingly common sight in Minnesota. Once listed as an endangered species, bald eagle numbers have rebounded due to effective environmental protection laws and conservation efforts. Adult bald eagles are easily identified by the white head and tail, although these colors don't appear until birds are 4 or 5 years old. Prior to that, eagles are generally dark brown with white feathers scattered along the wings, head, tail and back. With a wingspan of up to 7 feet, bald eagles are one of the largest birds in North America. They are found in forested areas near large, open bodies of water. Although bald eagle numbers are increasing, these birds still face threats from environmental contaminants and destruction of habitat. Bald eagles are listed as a species of Special Concern in the state of Minnesota.

Common loons (*Gavia immer*; Figure 31) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. These large diving birds possess red eyes and a large, dark pointed bill that is well-adapted for catching fish. Loons spend most of their time in water, and go ashore only to mate and incubate eggs. Summer plumage is spotted black and white, while in winter the colors are gray above and white below. Loon populations are closely monitored in Minnesota; however, these birds still face threats, particularly in the form of human disturbance and lead poisoning.

Figure 31. Common loon

Photo by: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 32) are medium-sized, nondescript birds common in Eastern forests. They utilize multiple habitat types, including deciduous forests, mixed woods, and suburban areas. This bird gets its name from its call, a slurred "pee-ah-wee." Eastern wood-pewees are grayish-olive above, with a paler throat and belly and whitish wingbars. They forage throughout the canopy, often flying out from their perch to catch insects before returning to the same perch. Populations of eastern wood-pewees are declining throughout much of their range. One possible cause of the decline is the increase in white-tailed deer, which browse the canopy and decrease the lower-canopy foraging area available to the pewee.

Figure 32. Eastern wood-pewee

Photo by: J.A. Spendelow

Golden-winged warblers (*Vermivora chrysoptera*; Figure 33) are small, active, insectivorous warblers. They possess a distinctive yellow crown and yellow patch on the wings. A black mask and throat contrast with the gray and white plumage on the back and breast. They often inhabit forest edges, such as those along marshes, bogs, and fields, and are also common in alder shrub swamps. Regional declines of the golden-winged warbler are considerable. Human-caused disturbance and hybridization with increasing numbers of blue-winged warblers are correlated with the declines.

Figure 33. Golden-winged warbler

Photo by: Carrol Henderson

Least flycatchers (*Empidonax minimus*; Figure 34) are the smallest flycatchers found in Minnesota. Like many other flycatchers, they are olive to gray in color with two white wingbars and whitish underparts. They have a small bill and a prominent white eye ring. The best way to distinguish least flycatchers from other flycatchers is the call, a harsh "che-bek." These birds are often found along water edges in mature, open woods. Like many flycatchers, they catch their food by "hawking" – waiting on a branch before flying out to catch insects in the air. Least flycatchers are common throughout most of their range where habitat is suitable. However, they are sensitive to human disturbance and require large areas of forest to survive.

Figure 34. Least flycatcher

Photo by: J.A. Spendelow

Marsh wrens (*Cistothorus palustris*; Figure 35) are small, stocky wrens. Their color is brown with black and white streaks on the back and black barring on the tail. They have a dark brown or black cap and a white eye line. Marsh wrens are noisy birds, and sing almost continually during the breeding season. They often hold their tails in an upright position, in "classic" wren posture. Marsh wrens inhabit a variety of marshes. Emergent vegetation, such as cattails or bulrush, is one of the most important habitat components. While populations of marsh wrens are increasing in some areas, others are threatened by loss and degradation of wetland habitat.

Figure 35. Marsh wren

Photo by: Dave Herr

Ovenbirds (*Seiurus aurocapillus*; Figure 36) are rarely seen birds of the forest. However, their loud "teacher, teacher, teacher" song is commonly heard during the summer months. They dwell on the ground, and build a covered nest that resembles a Dutch oven. Ovenbirds are olive-brown with a boldly streaked breast. Two black stripes border an orange crown. They have a thin bill and a white eye ring. They breed in mature deciduous and mixed forests, especially those with minimal undergrowth. Ovenbird numbers appear to be stable, but the birds are vulnerable to forest fragmentation and parasitism by brown-headed cowbirds (*Molothrus ater*).

Figure 36. Ovenbird

Photo source: U.S. Fish and Wildlife Service

Figure 37. Rose-breasted grosbeak

Photo by: J.A. Spendelow

<u>Rose-breasted grosbeaks</u> (*Pheucticus ludovicianus*; Figure 37) are summer visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes, meadows and woodlands, and suburban parks and gardens. The winter range spans from southern Mexico to South America and the Caribbean. Significant regional declines in rose-breasted grosbeak populations have been noted.

Figure 38. Swamp sparrow

Photo by: Jim Stasz

The <u>swamp sparrow's</u> (*Melospiza georgiana*; Figure 38) slow trill is a familiar sound in swampy areas in the summer. Other wetlands, such as bogs and meadows, may also harbor populations of this species. Swamp sparrows eat mainly seeds and fruits, but may also be adventurous feeders, wading in the water and putting their heads underneath in order to capture aquatic insects. This rusty-colored bird has black streaks on the back and an unstreaked gray breast and neck. A reddish cap is easily visible during the breeding season. Swamp sparrows thrive in suitable habitat; however, destruction of wetlands has put this species at risk.

Figure 39. Veery

Photo by: Deanna Dawson

The <u>veery</u> (*Catharus fuscescens*; Figure 39) is one of the most easily identifiable thrushes. It has faint dark spots on a buffy breast and a reddish brown back and head. The legs are pink and the eyes are dark with an indistinct light eye ring. The veery was named after its most common call, a "vee-er" sound. Riparian areas with dense vegetation and wetlands within large forests are good places to find the veery. The veery is suffering declines throughout many parts of its range. Destruction of winter habitat and parasitism by brown-headed cowbirds are major reasons cited for the decline.

Although the wood thrush (*Hylocichla mustelina*; Figure 40) is a fairly common inhabitant of deciduous forests, it is much more often heard than seen. Its melodic, flute-like song is often heard at dawn and dusk. The wood thrush is slightly smaller than a robin in size, with a reddish to olive-brown back and wings, white underparts, and dark spots on the throat and breast. Pink legs and a white eye-ring are also identifying characteristics of the wood thrush. Despite its common status, populations of the wood thrush have declined steadily throughout nearly all of its range. Deforestation, nest predation, and brood parasitism by cowbirds have all negatively affected reproductive success of the wood thrush.

Figure 40. Wood thrush

Photo source: U.S. Fish and Wildlife Service

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 41) name describes it well. This medium-sized woodpecker exhibits a yellow underside, and feeds primarily on sap it harvests from trees. The forehead and crown are red, and the throat is also red in the male. The back and sides are striped with black and white. Deciduous forests and riparian areas along streams characterize the breeding habitat of this species. Yellow-bellied sapsuckers create a food source for many other species when they drill holes for sap, and are therefore considered an important part of the ecosystem. Populations currently appear stable, and care should be taken to ensure they remain that way.

Figure 41. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Surveyors used several techniques to collect information on bird species. Point counts were conducted at 48 stations, located 400 meters apart along the lakeshore. Surveyors listened for five minutes per station and recorded all species detected (heard or seen) within that time. Point count surveys were conducted in the early morning hours, when species were most likely to be singing. Call-playback surveys were conducted at survey stations that had appropriate habitat. At each station, surveyors played a tape that included the calls of six marsh birds (least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), American bittern (*Botaurus lentiginosus*), and pied-billed grebe (*Podilymbus podiceps*)) and listened for a response. Call-playback surveys generally took place in the early evening. Both survey techniques were dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or on the lakeshore were also recorded.

Results

During May – June 2009, 13 bird species of greatest conservation need were documented on Sylvan Lake. Common loons were most abundant; surveyors documented loons at 15 of 48 survey stations. They were found along much of the Sylvan Lake shoreline, in both the northeast and southwest lake basins (Figure 42). The American white pelican, another aquatic-dwelling species of greatest conservation need, was also documented at Sylvan Lake, but was not associated with a specific survey station.

The next three most commonly documented species of greatest conservation need, the veery, ovenbird, and yellow-bellied sapsucker, are forest-dwelling species. They were each detected at five or more survey stations. The veery was identified at stations in both basins of Sylvan Lake, whereas the majority of the ovenbird detections were in the northern part of the lake, and all yellow-bellied sapsucker detections were in the southern half of Sylvan Lake (Figure 43). The remaining forest-dwelling species of greatest conservation need (least flycatcher, eastern wood-pewee, rose-breasted grosbeak, and wood thrush) were identified at three or fewer survey stations.

Several wetland-dwelling species of greatest conservation need were also recorded at Sylvan Lake. The distribution of these species was restricted to the southern portion of the lake, where large tracts of wetland were present (Figure 44). The swamp sparrow was identified at four survey stations, and the marsh wren was documented at two stations. The golden-winged warbler was detected at one survey station along the northern edge of the southwestern basin.

The final species of greatest conservation need, the bald eagle, can be found in multiple habitat types. Although bald eagles were sighted flying over and around the Sylvan Lake shoreline several times, only once during the bird surveys were they documented perched near a survey station. This station was located on the northeastern tip of the lake, not far from the public access (Figure 45).

The vast majority of the bird species on Sylvan Lake were detected during the point count or call-playback surveys (Table 3). Several species were documented during casual observation of the lake, for a total of 68 species (Appendix 2). The red-winged blackbird, found at over 70% of the survey stations, was by far the most commonly detected species. Red-eyed vireos and song sparrows were each found at over 50% of the stations. The yellow warbler and American robin, each found at 20 or more stations, rounded out the top five most common species.

Figure 42. Distribution of aquatic habitat-dependent bird species of greatest conservation need in Sylvan Lake, May – June 2009.

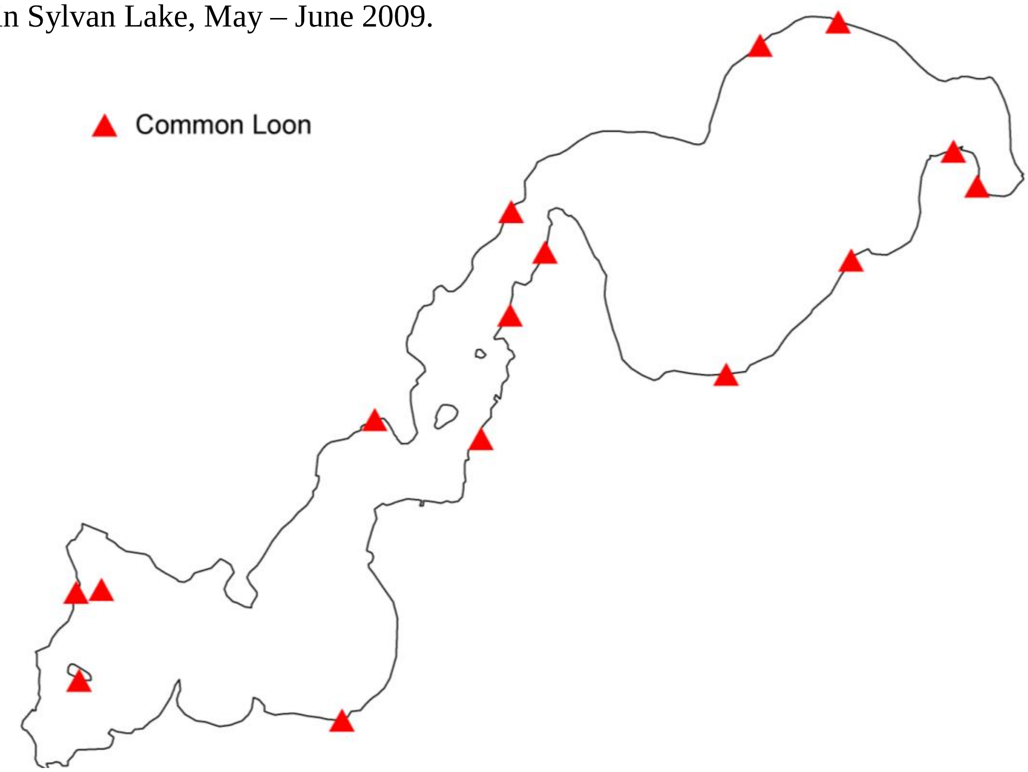


Figure 43. Distribution of forest habitat-dependent bird species of greatest conservation need in Sylvan Lake, May – June 2009.

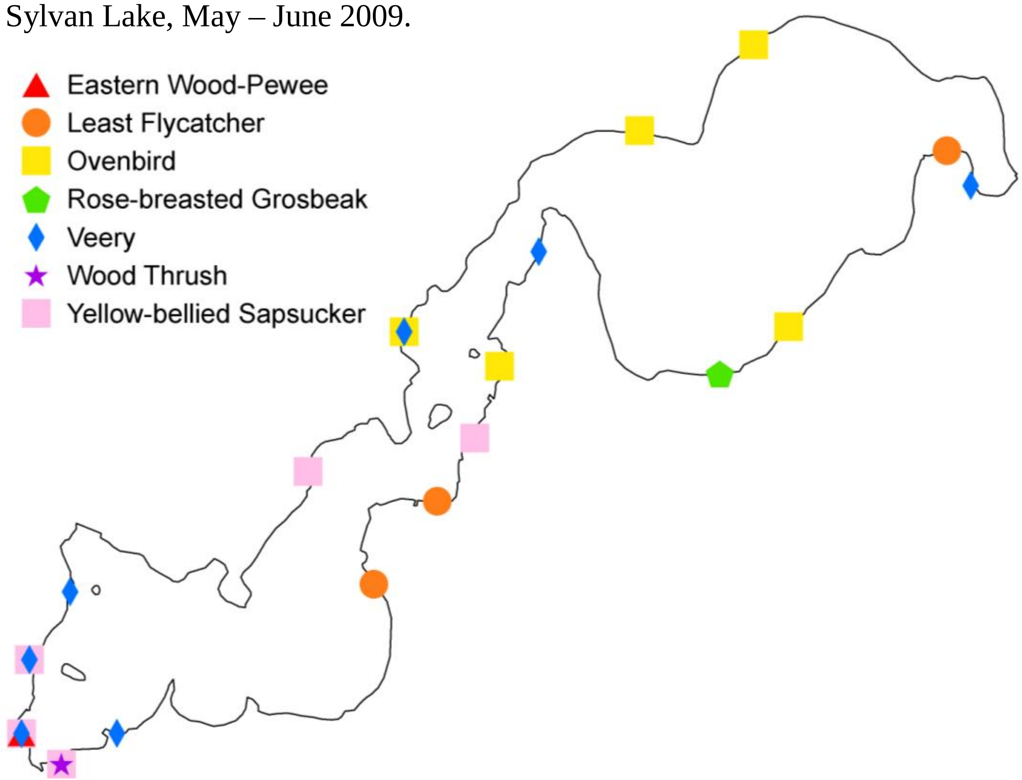


Figure 44. Distribution of wetland habitat-dependent bird species of greatest conservation need in Sylvan Lake, May – June 2009.

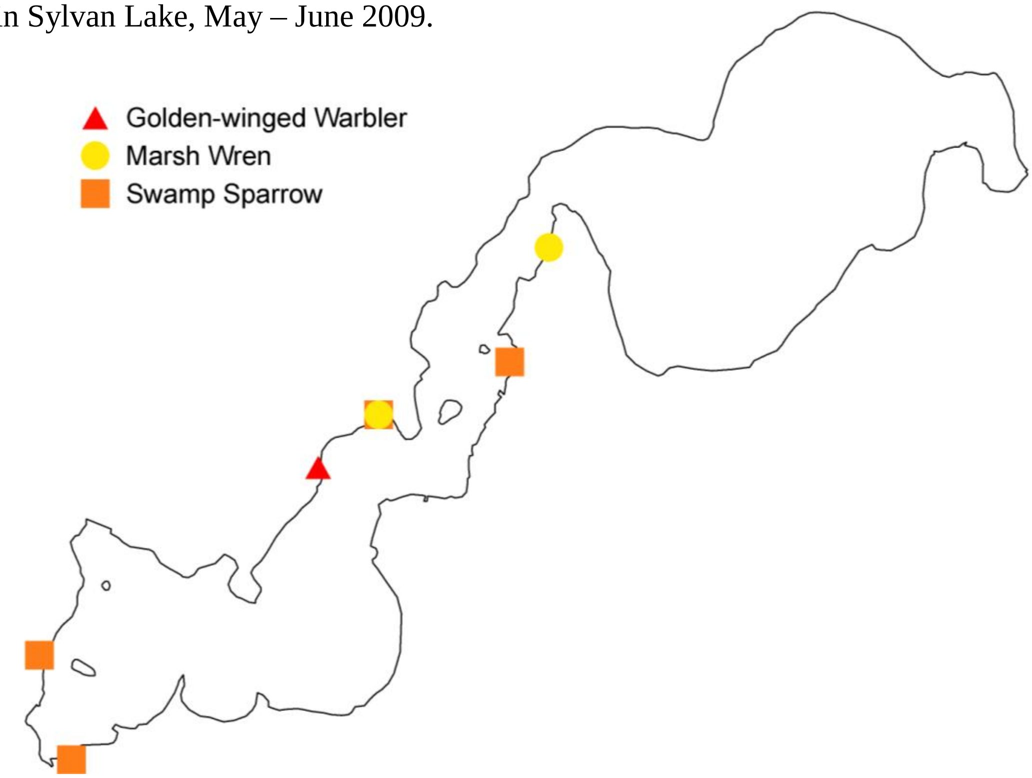


Figure 45. Distribution of bird species of greatest conservation need that occupy a variety of habitats in Sylvan Lake, May – June 2009.

Table 3. Species list and frequency of occurrence of bird species identified during Sylvan Lake surveys, May – June 2009. * denotes a species of greatest conservation need.

Description	**Common Name**	**Scientific Name**	**%**[a]
Waterfowl	Wood Duck	*Aix sponsa*	17
	Mallard	*Anas platyrhynchos*	13
	Hooded Merganser	*Lophodytes cucullatus*	2
	Common Merganser	*Mergus merganser*	2
Loons	Common Loon*	*Gavia immer*	31
Cormorants	Double-crested Cormorant	*Phalacrocorax auritus*	2
Herons/bitterns	Great Blue Heron	*Ardea herodias*	10
	Green Heron	*Butorides virescens*	17
Hawks/eagles	Osprey	*Pandion haliaetus*	4
	Bald Eagle*	*Haliaeetus leucocephalus*	2
	Cooper's Hawk	*Accipiter cooperii*	2
Rails	Sora	*Porzana carolina*	4
Sandpipers	Spotted Sandpiper	*Actitis macularia*	2
Gulls/terns	Ring-billed Gull	*Larus delawarensis*	2
	Caspian Tern	*Sterna caspia*	2
Pigeons/doves	Mourning Dove	*Zenaida macroura*	6
Hummingbirds	Ruby-throated Hummingbird	*Archilochus colubris*	2
Kingfishers	Belted Kingfisher	*Megaceryle alcyon*	10
Woodpeckers	Red-bellied Woodpecker	*Melanerpes carolinus*	13
	Yellow-bellied Sapsucker*	*Sphyrapicus varius*	10
	Downy Woodpecker	*Picoides pubescens*	2
	Hairy Woodpecker	*Picoides villosus*	4
	Northern Flicker	*Colaptes auratus*	8
	Pileated Woodpecker	*Dryocopus pileatus*	4
Flycatchers	Eastern Wood-Pewee*	*Contopus virens*	2
	Alder Flycatcher	*Empidonax alnorum*	6
	Least Flycatcher*	*Empidonax minimus*	6
	Eastern Phoebe	*Sayornis phoebe*	40
	Great Crested Flycatcher	*Myiarchus crinitus*	10
	Eastern Kingbird	*Tyrannus tyrannus*	6
Vireos	Warbling Vireo	*Vireo gilvus*	13
	Red-eyed Vireo	*Vireo olivaceus*	52
Jays/crows	Blue Jay	*Cyanocitta cristata*	33
	American Crow	*Corvus brachyrhynchos*	15

Table 3, continued.

Description	Common Name	Scientific Name	% [a]
Swallows	Purple Martin	*Progne subis*	2
	Tree Swallow	*Tachycineta bicolor*	40
	Barn Swallow	*Hirundo rustica*	21
Chickadees	Black-capped Chickadee	*Poecile atricapilla*	27
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	6
	White-breasted Nuthatch	*Sitta carolinensis*	15
Wrens	House Wren	*Troglodytes aedon*	6
	Marsh Wren*	*Cistothorus palustris*	4
Thrushes	Veery*	*Catharus fuscescens*	15
	Wood Thrush*	*Hylocichla mustelina*	2
	American Robin	*Turdus migratorius*	42
Mockingbirds	Gray Catbird	*Dumetella carolinensis*	17
Starlings	European Starling	*Sturnus vulgaris*	2
Waxwings	Cedar Waxwing	*Bombycilla cedrorum*	21
Warblers	Golden-winged Warbler*	*Vermivora chrysoptera*	2
	Yellow Warbler	*Dendroica petechia*	48
	Chestnut-sided Warbler	*Dendroica pensylvanica*	4
	Black-and-white Warbler	*Mniotilta varia*	2
	American Redstart	*Setophaga ruticilla*	4
	Ovenbird*	*Seiurus aurocapilla*	10
	Common Yellowthroat	*Geothlypis trichas*	40
Sparrows/allies	Chipping Sparrow	*Spizella passerina*	38
	Song Sparrow	*Melospiza melodia*	52
	Swamp Sparrow*	*Melospiza georgiana*	8
Cardinals/allies	Northern Cardinal	*Cardinalis cardinalis*	6
	Rose-breasted Grosbeak*	*Pheucticus ludovicianus*	2
Blackbirds	Red-winged Blackbird	*Agelaius phoeniceus*	71
	Common Grackle	*Quiscalus quiscula*	17
	Baltimore Oriole	*Icterus galbula*	31
Finches	Pine Siskin	*Spinus pinus*	2
	American Goldfinch	*Spinus tristis*	35

[a] % – Percent of surveyed sample sites in which a bird species occurred (N=48)

Bird Species Richness

Objective

1. Calculate and map bird species richness around the shoreline of Sylvan Lake

Introduction

Bird species richness is affected by a number of factors, including habitat diversity and area, habitat composition, fragmentation, competition, and presence of exotic species. Species richness is generally highest in non-fragmented habitats with a variety of vegetation types. Anthropogenic disturbance, in particular, may negatively affect bird species richness in a variety of ways. Human presence in an area may result in the loss or destruction of critical habitat. Elimination of vegetation and use of pesticides may reduce the food base for a number of bird species. Human activity in an area may also disturb breeding or nesting birds. Maintaining large areas of natural habitat will be beneficial to maintaining diversity of bird species.

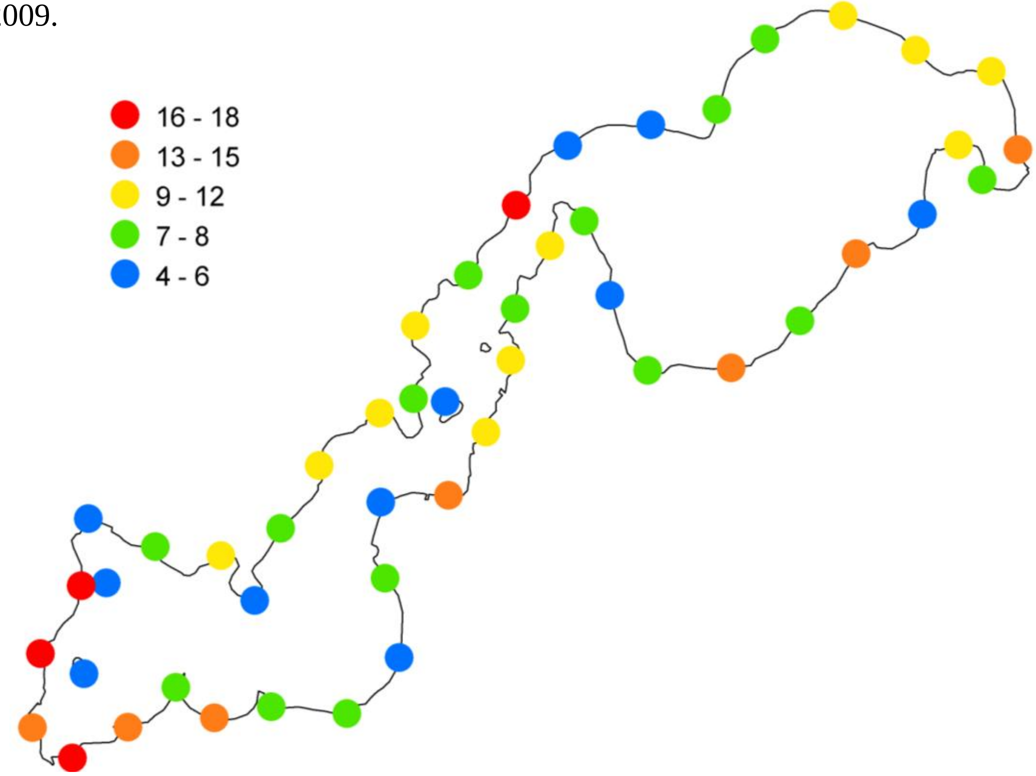
Methods

Bird species were documented during the point count and call-playback sampling surveys. At each sample station, surveyors identified and recorded the number of species found.

Results

Bird species diversity at Sylvan Lake ranged from four to 18 species at a single survey station (Figure 46). The number of species of greatest conservation need recorded at a single survey station ranged from zero to three. Over 40% of the Sylvan Lake survey stations contained 10 or more bird species. These sites were scattered along the shoreline, in both the northeast and southwest lake basins. The sites with the greatest number of species of greatest conservation need were located primarily in the southwestern corner of the southwest basin.

Figure 46. Bird species richness (number of species per sample site) in Sylvan Lake, May – June 2009.



Loon Nesting Areas

Objectives

1. Map current and historical loon nesting areas
2. Identify loon nests as natural or manmade

Introduction

Loon on nest at Sylvan Lake, 2009

The Volunteer LoonWatcher survey began in 1979 as a way for the DNR to obtain information on loon numbers and nesting success on a variety of lakes in Minnesota. Each year volunteer loon watchers observe the loons on a selected lake and fill out a report, noting information such as number of loons, number of nests, and number of chicks. Locations of loon nests, if known, are also documented in the report.

Common loons may be easily disturbed by human presence, and tend to avoid nesting where development has occurred. They prefer protected areas such as bays and islands, especially those areas with quiet shallow water and patchy emergent vegetation that provides cover. Identification of these loon nesting sites will help managers prevent degradation and destruction of these sensitive areas.

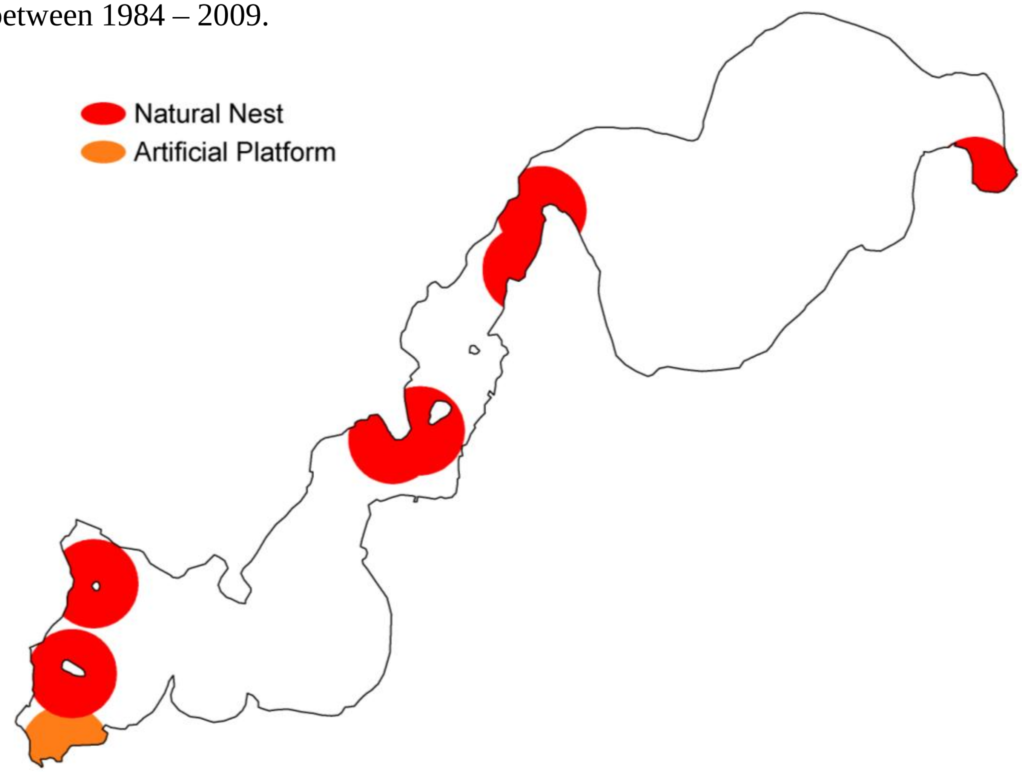
Methods

Using information from LoonWatcher reports and bird, fish, and vegetation survey crews, researchers mapped loon nesting locations in GIS. Mapped nests were buffered by 200 meters to account for locational uncertainty. Nests were identified as either natural or manmade (artificial platforms). All former and current natural nesting locations and artificial platforms used by loons were included in the maps and analysis; artificial platforms not utilized by loons were not included. Volunteers have been reporting on Sylvan Lake loons since 1984.

Results

Since 1984, eight probable loon nesting areas have been identified on Sylvan Lake (Figure 47). Nesting areas have been located within both the northeast and southwest basins, as well as in the channel connecting the two basins. Many of the nesting areas are on islands in the lake, or along protected areas of shoreline. Although several artificial platforms have been put out on Sylvan Lake, only one has been identified as actively used by nesting loons. In 2009, four active loon nesting areas were identified on the lake.

Figure 47. Location of natural loon nests and manmade loon platforms recorded on Sylvan Lake between 1984 – 2009.



Aquatic Frog Surveys

Objectives

1. Record index of abundance for all frogs and toads
2. Estimate actual abundance of green and mink frogs
3. Develop distribution maps for green and mink frogs

Introduction

Amphibians are ideal indicator species of lakeshore habitats. Although population declines may be caused by a number of factors, including predation, competition, and introduction of exotic species, amphibians are particularly prone to local extinctions resulting from human-caused alteration and fragmentation of their habitat. Removal of vegetation and woody debris, retaining wall construction, and other common landscaping practices all have been found to negatively affect amphibian populations.

Target species for the frog surveys were mink frog (*Rana septentrionalis*) and green frog (*Rana clamitans*). These frogs, which are strongly associated with larger lakes, are easily surveyed during their breeding season, which extends from May until August. During this time they establish and defend distinct territories, and inhabit vegetated areas along the lakeshore.

Figure 48. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

Mink frogs (Figure 48) are typically green in color with darker green or brown mottling. They emit an odor similar to that of a mink when handled. They inhabit quiet waters near the edges of wooded lakes, ponds, and streams, and are considered the most aquatic of the frogs found in Minnesota. Populations of mink frogs have potentially been declining recently, and the numbers of observed deformities have been increasing.

Figure 49. Green frog

Photo by: Jeff LeClere, www.herpnet.net

Green frogs (Figure 49) are medium-sized, greenish or brownish frogs with small dark spots. The belly is often brighter in color than the back. A large tympanum (eardrum) helps identify the green frog. They can be found in a variety of habitats surrounding lakes, streams, marshes, and swamps, but are strongly associated with the shallow water of lakeshores. Although green frog populations are generally stable, regional declines and local extinctions have been noted.

Methods

The aquatic frog survey methodology followed the Minnesota Frog and Toad Calling Survey (MFTCS) protocol (see Minnesota's Sensitive Lakeshore Identification Manual for additional information on how this protocol was adjusted for water routes). Frog survey points were located around the entire lake, spaced 400 meters apart. Surveys were conducted between sunset and 1:00 AM. At each station surveyors listened for up to five minutes for all frog and toad calls. An estimate of abundance and a calling index were recorded for both green and mink frogs. For other species, only calling index was recorded. If survey conditions such as rain or wind noticeably affected listening ability, the survey was terminated.

Results

Target species
Mink frogs were documented at 21 survey stations on Sylvan Lake. The vast majority of the frogs were heard within the southwest basin or within the channel connecting the two lake basins (Figure 50). Mink frogs were also heard at two survey stations near the public access. Surveyors heard green frogs at those same two stations in the northeast basin; green frogs were not detected in the channel or southwest lake basin.

Estimates of abundance for both mink frogs and green frogs ranged from one to ten calling males per survey station (Figures 51 and 52).

Other species
In addition to mink frogs and green frogs, gray treefrogs (*Hyla versicolor*) and spring peepers (*Pseudacris crucifer*) were also documented at Sylvan Lake. Frog surveyors heard gray treefrogs calling at 19 survey stations, located along the southern shoreline of the northeast basin, the channel, and the southwest basin. Index values for this species ranged from one (individual frog calls were distinct, with no overlap) to two (individual frog calls were still distinct, but overlapped). Earlier in the year, bird surveyors conducting marsh bird surveys noted the presence of spring peepers at several survey stations. Other frog or toad species that may be found near Sylvan Lake, such as wood frog (*Rana sylvatica*), chorus frog (*Pseudacris triseriata*), and American toad (*Bufo americanus*), are not strongly associated with larger lakes.

Figure 50. Distribution of green and mink frogs heard during Sylvan Lake frog surveys, July 2009.

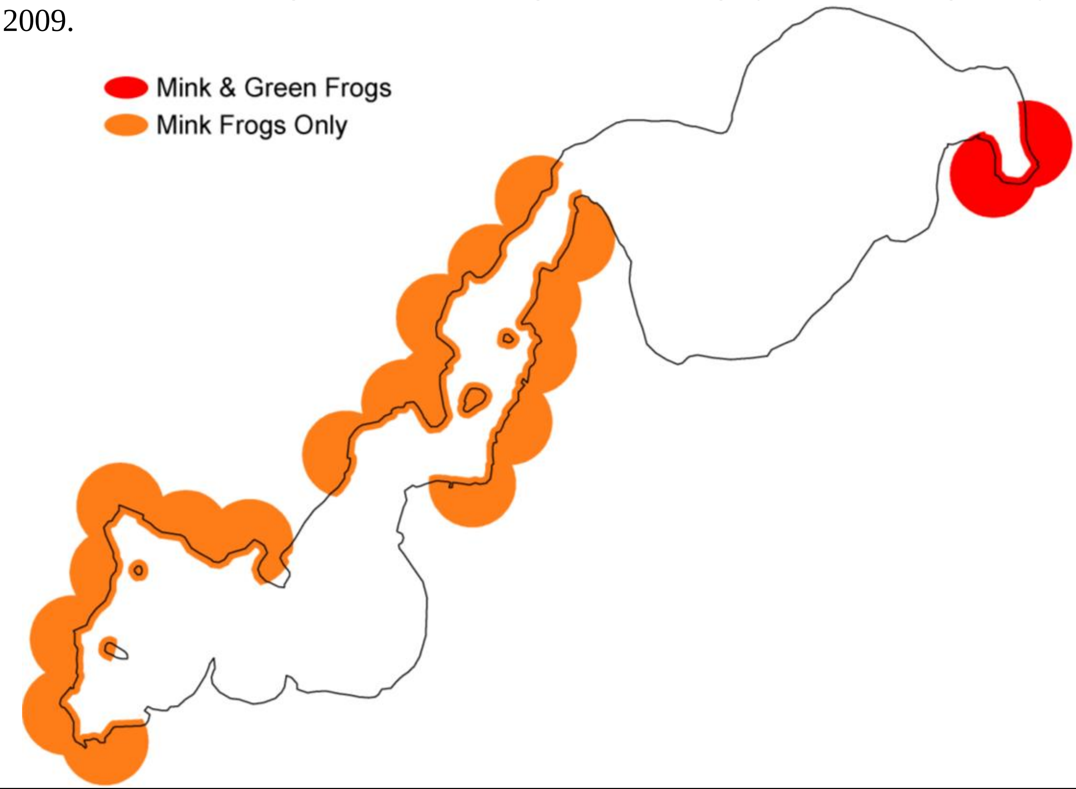


Figure 51. Abundance of mink frogs heard during Sylvan Lake frog surveys, July 2009.

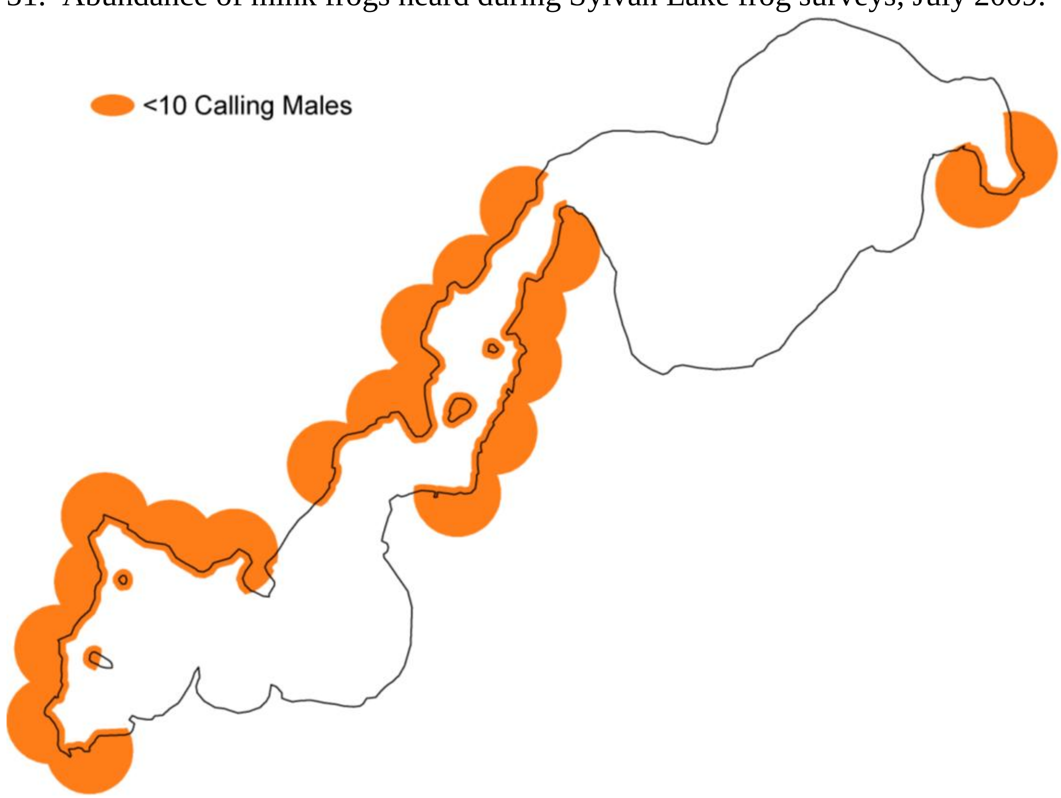
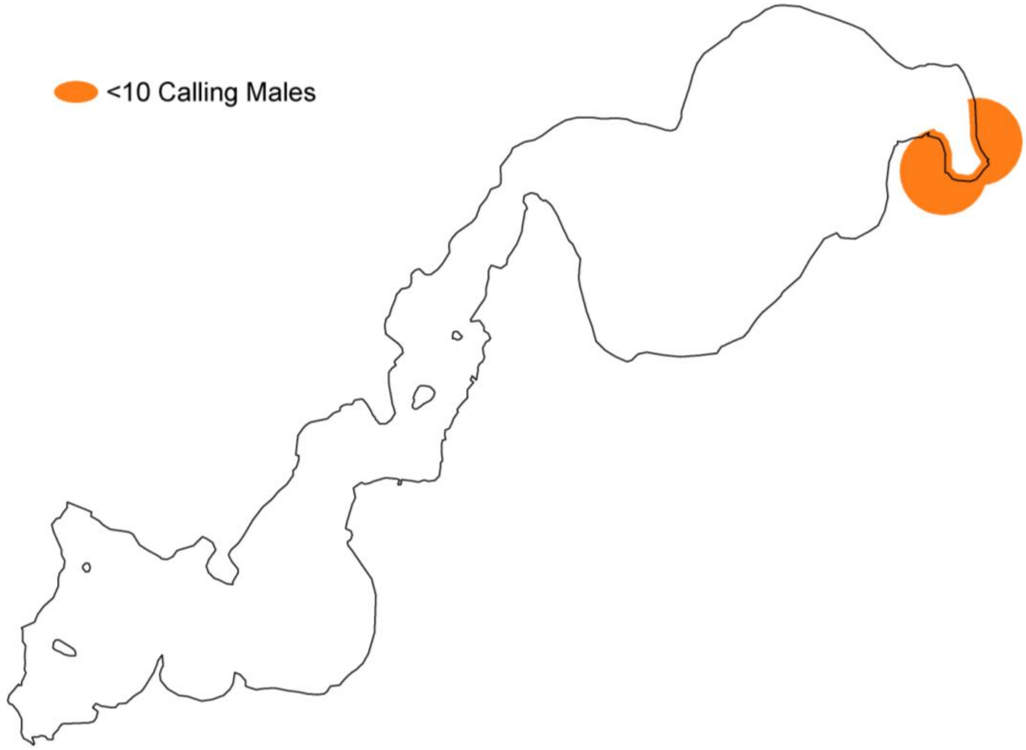


Figure 52. Abundance of green frogs heard during Sylvan Lake frog surveys, July 2009.



Nongame Fish Surveys

Objectives

1. Record presence and abundance of near-shore fish species of greatest conservation need
2. Record presence and abundance of proxy species
3. Develop distribution maps for species of greatest conservation need and proxy species
4. Identify habitat (substrate and aquatic vegetation biovolume) associated with presence of species of greatest conservation need and proxy species
5. Identify near-shore fish assemblages

Introduction

Fish Species of Greatest Conservation Need

There are 47 fish species of greatest conservation need (SGCN) within the state of Minnesota. Of these 47 species, three are near-shore species found within Cass County. The pugnose shiner and least darter are listed as species of Special Concern in the state of Minnesota. The longear sunfish exhibits a spotty distribution, and is listed as threatened in Wisconsin.

Pugnose shiners (*Notropis anogenus*; Figure 53) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess large eyes and a distinctively upturned mouth that gives them a "pugnose" appearance. They are secretive minnows, and are found often in schools of 15 to 35 individuals. Pugnose minnows inhabit clear lakes and low-gradient streams and are extremely intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 53. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (*Etheostoma microperca*; Figure 54) are Minnesota's smallest fish, averaging only 25 – 38 mm in length. They are olive-brown in color with scattered dark brown spots and markings and four dark bars radiating from the eye. Males possess an extremely long pectoral fin. Least darters are found in clear, shallow areas of low-gradient streams or lakes. Extensive beds of muskgrass (*Chara* spp.) are a preferred habitat feature. Removal of vegetation, riparian area modification, and poor water quality all pose threats to the least darter.

Figure 54. Least darter

Photo by: Konrad Schmidt

Longear sunfish (*Lepomis megalotis*; Figure 55) are a deep-bodied fish reaching a length of 71 – 94 mm. These colorful fish have a belly that is orange-red, and the sides are speckled with turquoise. Adults have an elongated opercular "ear flap" that is trimmed in white. Like the other species of greatest conservation need, the longear sunfish prefers clear, shallow, vegetated areas and is intolerant of turbidity.

Figure 55. Longear sunfish

Photo by: Konrad Schmidt

Proxy species

Proxy species have similar life history characteristics and occupy habitat similar to species of greatest conservation need; they represent indicator species for those SGCN.

Blackchin shiners (*Notropis heterodon*; Figure 56) are small (50 – 75 mm) fish with a bronze-colored back and silver sides and belly. A dark lateral band extends through the chin. Like the species of greatest conservation need, the blackchin shiner inhabits clear water with abundant submerged aquatic vegetation; it also prefers a clean sand or gravel substrate. This species cannot tolerate turbidity or loss of aquatic vegetation.

Figure 56. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (*Notropis heterolepis*; Figure 57) are similar in size and coloration to blackchin shiners. However, the dark lateral line does not extend through the lips or chin. Scales on the back are outlined in a dark color, giving them a crosshatch appearance. Blacknose shiners are sensitive to turbidity and pollution, and their range has contracted since the beginning of the century. Habitat includes clean, well-oxygenated lakes and streams with plentiful vegetation and low turbidity and pollution.

Figure 57. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 58) are slender fish with slightly flattened heads. The mouth, which opens dorsally, is an adaptation for surface feeding. Dark vertical bars are present along the sides. Size ranges from about 50 – 100 mm. Calm, clear, shallow water with abundant aquatic vegetation and a sandy or gravely substrate is preferred by the killifish.

Figure 58. Banded killifish

Photo by: Konrad Schmidt

Methods

Fish surveys were conducted using Minnesota's Sensitive Lakeshore Survey Protocol. Fish survey stations were located 400 meters apart, and were the same stations used for surveying birds and aquatic frogs. At each station, fish were sampled using three different methods: trapnetting, shoreline seining, and electrofishing. At several locations, excessive vegetation, depth, or soft substrate prevented surveyors from using seines or trapnets. However, electrofishing samples were still collected, from a boat if necessary. All species captured using the different sampling methods were identified and counted. Target fish species included near-shore species of greatest conservation concern (pugnose shiner, least darter, and longear sunfish) and proxy species (blackchin shiner, blacknose shiner, and banded killifish). These species are associated with large, near-shore stands of aquatic grasses and macrophytes. They are intolerant to disturbance, and have been extirpated from lakes where extensive watershed and lakeshore development has occurred.

In addition to the fish data, habitat data were collected at each sampling station. Substrate data were recorded using standard near-shore classes. Aquatic vegetation biovolume was also estimated at each station; this represented the volume (percent) of a sampling area that contained submerged aquatic vegetation.

Results

Twenty-five fish species were identified during the Sylvan Lake surveys (Table 4). Bluegills were found most frequently; surveyors recorded this species at 100% of the survey stations. Largemouth bass and yellow bullheads were also widespread, and were each detected at over 75% of the survey sites. Emerald shiners, northern redbelly dace, tadpole madtom, walleye, central mudminnow, and burbot were each recorded at five or fewer survey stations. Mimic shiners were documented in the greatest numbers; over 4000 individuals were recorded at 13 survey stations. Bluntnose minnows and bluegills each also numbered over 1000.

Six fish species previously unrecorded in Sylvan Lake were documented during the surveys. These species were blackchin shiner, central mudminnow, emerald shiner, Iowa darter, mimic shiner, and tadpole madtom. With the documentation of these species, the observed historical fish community in Sylvan Lake totals 30 species.

No fish species of greatest conservation need were detected during the surveys, but all three proxy species were recorded (Figure 59). Banded killifish were found at 14 survey stations, while blackchin shiners and blacknose shiners were documented at six and seven stations, respectively. All three species occurred within both the northeast and southwest lake basins. Surveyors counted fewer than 50 individuals of any of these proxy species. Proxy species generally occurred at survey stations with a sand substrate. Aquatic vegetation biovolume was slightly higher at sites where proxy species were present than at sites where they were not.

The presence of several of the target fish species at Sylvan Lake may indicate minimal disturbance along several sections of shoreline. However, because these species are declining or vulnerable across much of their range, continued monitoring and maintenance of these shoreline habitats is necessary to ensure continued existence of these populations. Limiting macrophyte removal, pesticide and herbicide use, and modification of the riparian zone will help maintain good water quality and a healthy aquatic plant community.

Figure 59. Distribution of fish proxy species documented during Sylvan Lake nongame fish surveys, July – August 2008.

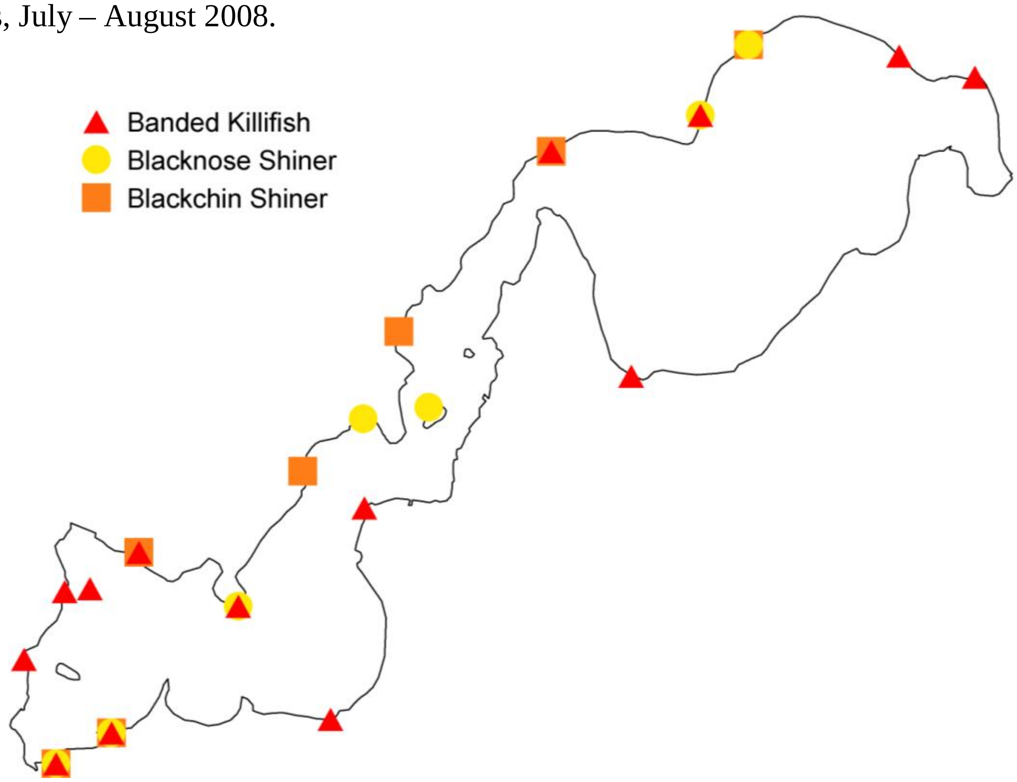


Table 4. Abundance and frequency of fish species identified during Sylvan Lake fish surveys, July – August 2008.

Description	Common Name	Scientific Name	# [a]	% [b]
Bowfins	Bowfin	*Amia calva*	10	19
Minnows/carps	Emerald shiner	*Notropis atherinoides*	12	2
	Blackchin shiner	*Notropis heterodon*	33	13
	Blacknose shiner	*Notropis heterolepis*	30	15
	Spottail shiner	*Notropis hudsonius*	382	27
	Mimic shiner	*Notropis volucellus*	~4300	27
	Northern redbelly dace	*Phoxinus eos*	12	4
	Bluntnose minnow	*Pimephales notatus*	~1000	63
Suckers	White sucker	*Catostomus commersonii*	76	13
North American catfishes	Black bullhead	*Ameiurus melas*	2	4
	Yellow bullhead	*Ameiurus natalis*	204	81
	Tadpole madtom	*Noturus gyrinus*	3	4
Pikes	Northern pike	*Esox lucius*	16	23
Mudminnows	Central mudminnow	*Umbra limi*	6	8
Burbots	Burbot	*Lota lota*	9	10
Killifishes	Banded killifish	*Fundulus diaphanus*	48	29
Sunfishes	Rock bass	*Ambloplites rupestris*	51	50
	Pumpkinseed	*Lepomis gibbosus*	52	52
	Bluegill	*Lepomis macrochirus*	~2200	100
	Largemouth bass	*Micropterus salmoides*	271	90
	Black crappie	*Pomoxis nigromaculatus*	74	63
Perches	Iowa darter	*Etheostoma exile*	154	58
	Johnny darter	*Etheostoma nigrum*	40	27
	Yellow perch	*Perca flavescens*	125	60
	Walleye	*Sander vitreus*	4	6

[a] # – Total number of individuals found. Numbers above 1000 were rounded to the nearest 100.

[b] % – Percent of surveyed sample sites in which a species occurred (N=48).

Aquatic Vertebrate Richness

Objective

1. Calculate and map aquatic vertebrate richness around the shoreline of Sylvan Lake

Introduction

A variety of factors may influence aquatic vertebrate richness, including habitat diversity, water chemistry, flow regime, competition, and predation. High aquatic vertebrate richness indicates a healthy lakeshore community with diverse habitat, good water quality, varied flow regimes, and a sustainable level of competition and predation. A diverse aquatic vertebrate community will also help support diversity at higher trophic levels.

Methods

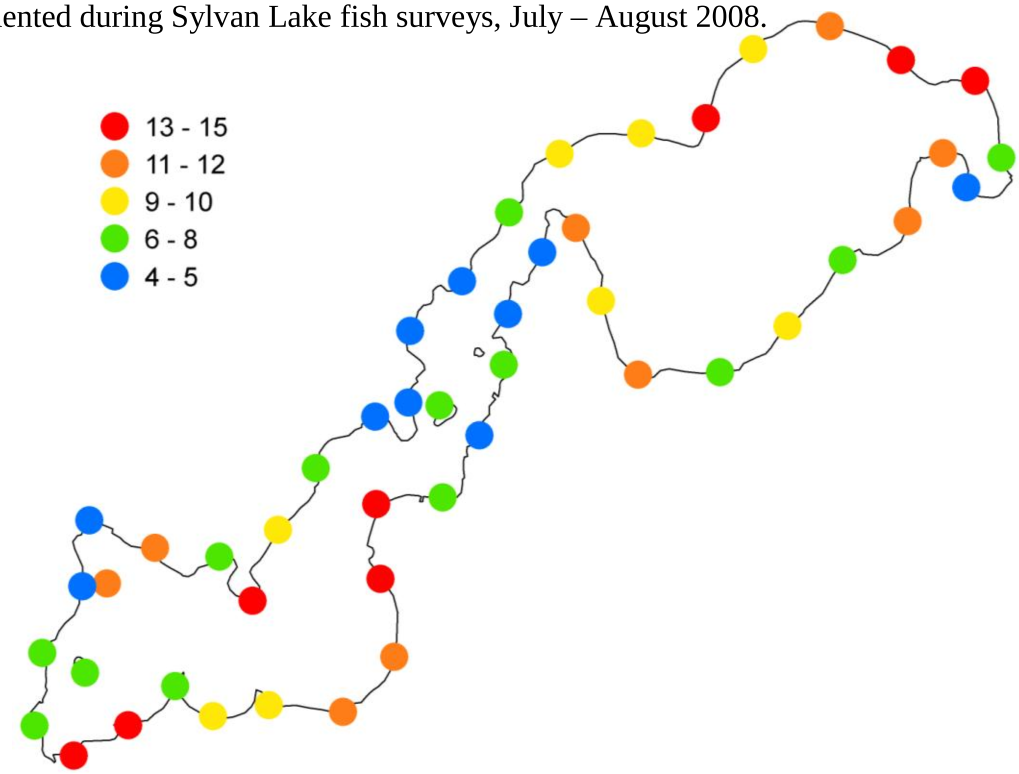
Aquatic vertebrate species were documented during the nongame fish sampling surveys. All aquatic vertebrates, including fish, frogs, and turtles, captured during trapnetting, seining, and electrofishing surveys were identified to the species level. Young-of-year animals that could not be identified to the species level and hybrids were not used in the analysis.

Results

Aquatic vertebrate richness at Sylvan Lake ranged between four and 15 species (Figure 60). Twenty-one of the 48 sites had 10 or more species recorded, whereas only 10 sites contained five or fewer species. Aquatic vertebrate richness was generally highest within the northeast and southwest basins. Survey stations in the channel connecting the two basins tended to have slightly lower species richness.

In addition to fish, painted turtles, snapping turtles, and muskrat were recorded during the fish surveys. Hybrid sunfish were also identified during the surveys, but were not used in the analyses.

Figure 60. Aquatic vertebrate species richness (number of species per survey station) documented during Sylvan Lake fish surveys, July – August 2008.



Other Rare Features

Objective

1. Map rare features occurring within the extended state-defined shoreland area (within 1320 feet of shoreline) of Sylvan Lake

Introduction

The Minnesota Natural Heritage Information System provides information on Minnesota's rare animals, plants, native plant communities, and other features. The Rare Features Database includes information from both historical records and current field surveys. All Federally and State-listed endangered and threatened species and state species of special concern are tracked by the Natural Heritage program. The program also gathers information on animal aggregations, geologic features, and rare plants with no legal status.

Methods

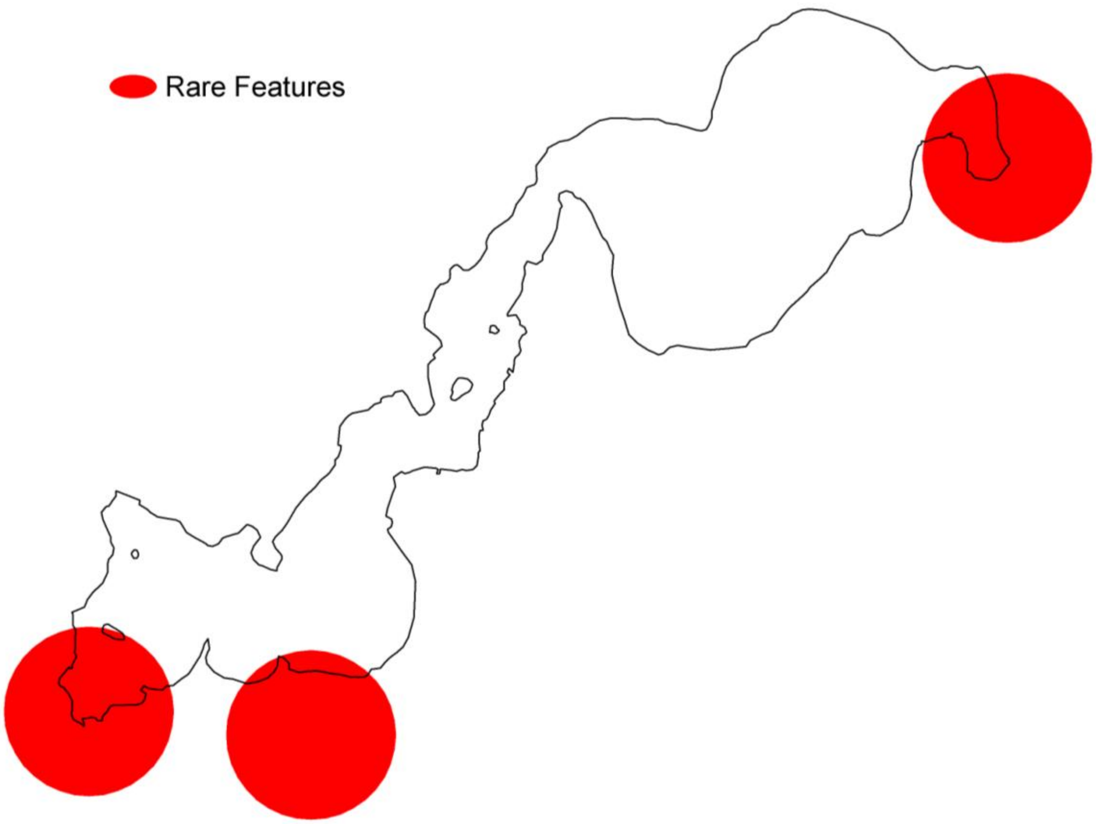
Researchers obtained locations of rare features from the Rare Features Database. Only "listed" plant and animal species (Federal or State endangered, threatened, or special concern) were considered in this project; non-listed unique plant species were included in the "Unique Plant Species" section of this report. Rare features within 1320 feet of the shoreline were mapped using GIS. Varying buffer sizes around rare feature locations represent locational uncertainty and do not indicate the size of the area occupied by a rare feature.

Results

Three rare features were identified at Sylvan Lake (Figure 61). These features represent three locations of a reptile species of Threatened status. The publication of exact descriptive and locational information is prohibited in order to help protect this rare species.

Although specific management recommendations will vary depending on the rare features present at Sylvan Lake, practices that maintain good water quality and the integrity of the shoreline will be beneficial to all species involved.

Figure 61. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Sylvan Lake shoreline.



Copyright 2009 State of Minnesota, Department of Natural Resources. Rare features data have been provided by the Division of Ecological Resources, Minnesota Department of Natural Resources (MNDNR) and were current as of November 24, 2009. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Bay Delineation

Objective

1. Determine whether areas of the lake are in isolated bays, non-isolated bays, or not within bays

Introduction

Bays are defined as bodies of water partially enclosed by land. They often offer some degree of protection from the wind and waves to those species living within them. These protected areas provide habitat for a number of aquatic plant species, and bays are frequently characterized by abundant vegetation. These areas of calm water and plentiful vegetation, in turn, provide habitat for a number of fish and wildlife species. Protecting these areas will be beneficial to a variety of plant and animal species.

Methods

Bays were delineated using lake maps and aerial photos. Obvious bays (e.g., significant indentations of shoreline, bodies of water set off from main body or enclosed by land) were mapped based on inspection of lake maps. Additional bays were identified using aerial photos. Underwater shoals or reefs that offset a body of water from the main body were visible only in these photographs. Non-isolated bays were open to the main water body by a wide mouth. Isolated bays had a narrower connection to the main water body, or were offshoots of non-isolated bays.

Results

No bays were delineated in Sylvan Lake.

II. Ecological Model Development

The second component of the sensitive lakeshore area protocol involved the development of an ecological model. The model scored lakeshore areas based on calculations of sensitivity. The model incorporated results of the field surveys and analysis of additional data, so included information on plant and animal communities as well as hydrological conditions.

In order to develop a continuous sensitivity score along the shoreline, the ecological model used a moving analysis window that included both shoreland and near-shore areas. Resource managers developed a system to score each of the 15 variables. These scores were based on each variable's presence or abundance in relation to the analysis window (Table 5). Each analysis window was assigned a score, which was equal to the highest score present within a window. On occasion, point data were buffered by a set distance and converted to polygons to account for locational uncertainty before inclusion in the model.

Scores for each of the layers were summed (Figure 62). This map represents an index of sensitivity; those points with higher total scores are highly sensitive, whereas points with lower total scores have lower sensitivity.

Once the total score index was developed for the shoreline, clusters of points along the shoreline with similar values were identified using GIS (Figure 63). The clusters with high values (i.e., areas of highly sensitive shoreline) were buffered by ¼ mile. These buffered areas were defined as most likely highly sensitive lakeshore areas. These areas will be forwarded to the local government for potential designation as resource protection areas (Figure 64).

Table 5. Criteria for assigning scores to analysis windows for each variable.

Variable	Score	Criteria
Wetlands	3	> 25% of analysis window is in wetlands
	2	12.5 – 25% is in wetlands
	1	< 12.5% is in wetlands
	0	No wetlands present
Hydric Soils	3	> 25% of analysis window is hydric soils
	2	12.5 – 25% hydric soils
	1	< 12.5% hydric soils
	0	No hydric soils present
Near-shore Plant Occurrence	3	Frequency of occurrence is > 75% (> 75% of points within analysis window contained vegetation)
	2	Frequency of occurrence is 25 – 75%
	1	Frequency of occurrence < 25%
	0	No vegetation present

Table 5, continued.

Variable	Score	Criteria
Aquatic Plant Richness	3	Total number of plant taxa per analysis window > 10
	2	Total number of plant taxa 5 – 10
	1	Total number of plant taxa 1 – 4
	0	No vegetation present
Presence of Emergent and Floating-leaf Plant Beds	3	Emergent and/or floating-leaf plant stands occupy > 25% of the aquatic portion of the analysis window
	2	Stands occupy 5 – 25%
	1	Stands present but occupy less than 5%
	0	No emergent or floating-leaf plant beds present
Unique or Rare Plant Species	3	Presence of 2 or more unique or rare plant species within analysis window
	2	Presence of 1 unique plant species
	0	No unique plant species present
Near-shore Substrate	3	Frequency of occurrence is > 50% soft substrate (i.e., > 50% of points within analysis window consisted of soft substrate)
	2	Frequency of occurrence is 25 – 50% soft substrate
	1	Frequency of occurrence < 25% soft substrate
	0	No soft substrate present
Birds	3	Presence of 3 or more SGCN within analysis window
	2	Presence of 2 SGCN
	1	Presence of 1 SGCN
	0	No SGCN present
Bird Richness	3	Total number of bird species within analysis window > 25
	2	Total number of bird species 11 – 25
	1	Total number of bird species 1 – 10
	0	No bird species observed
Loon Nesting Areas	3	Presence of natural loon nest within analysis window
	2	Presence of loon nest on artificial platform
	0	No loon nesting observed
Frogs	3	Presence of both mink and green frogs within analysis window
	2	Presence of mink or green frogs
	0	Neither mink nor green frogs present

Table 5, continued.

Variable	**Score**	**Criteria**
Fish	3	Presence of one or more SGCN within analysis window
	2	Presence of one or more proxy species
	0	Neither SGCN nor proxies present
Aquatic Vertebrate Richness	3	Total number of aquatic vertebrate species within analysis window > 10
	2	Total number of aquatic vertebrate species 5 – 10
	1	Total number of aquatic vertebrate species 1 – 4
	0	No aquatic vertebrate species observed
Rare Features	3	Presence of multiple Natural Heritage features within analysis window
	2	Presence of a Natural Heritage feature
	0	No Natural Heritage feature present
Bays	3	Protected or isolated bay within analysis window
	2	Non-protected or non-isolated bay
	0	Not a distinctive bay

Figure 62. Total score layer created by summing scores of all 15 variables. Highest total scores represent most sensitive areas of shoreline.

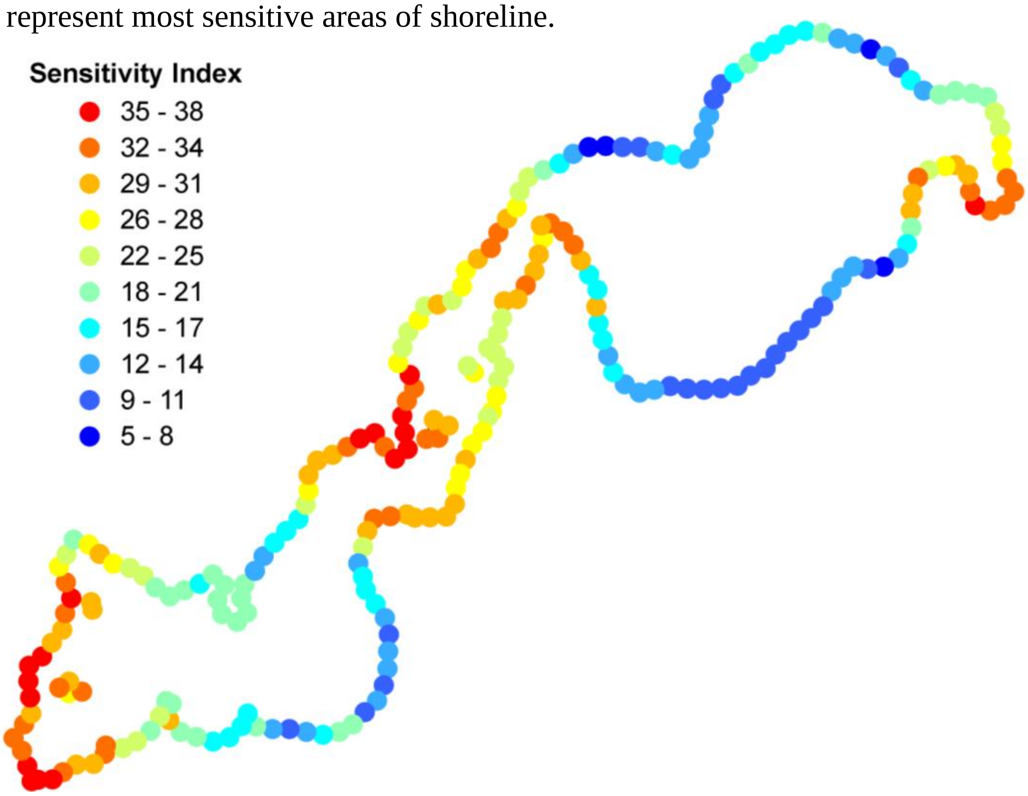


Figure 63. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland).

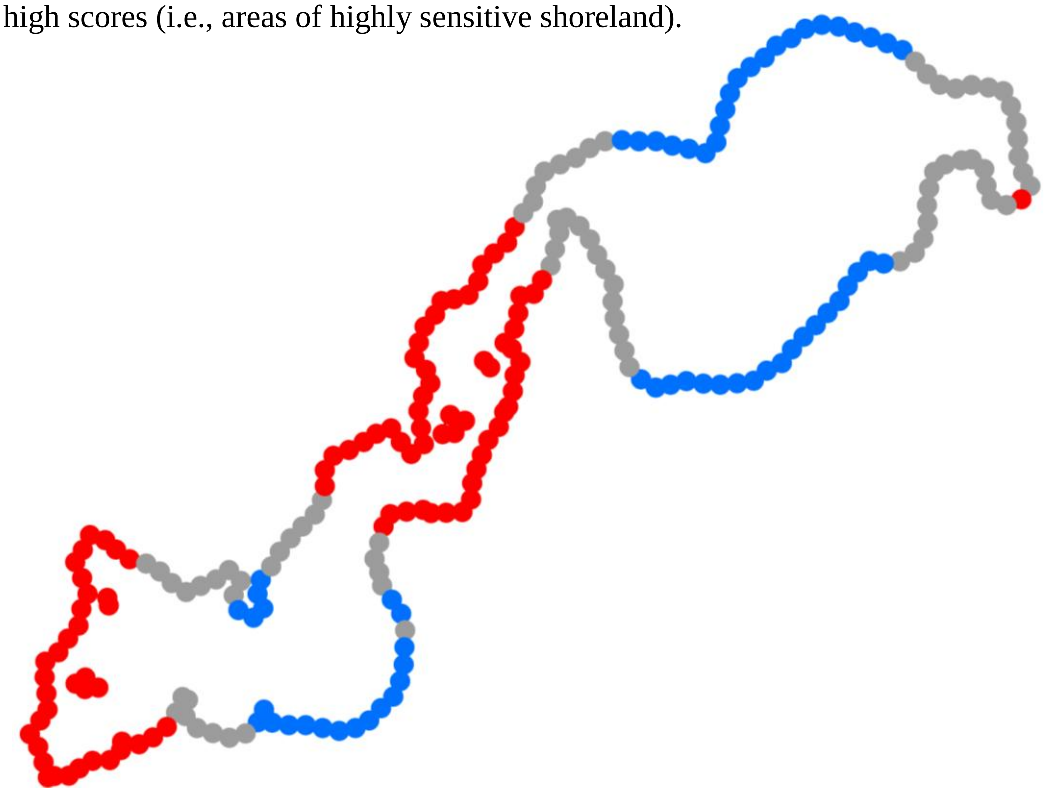
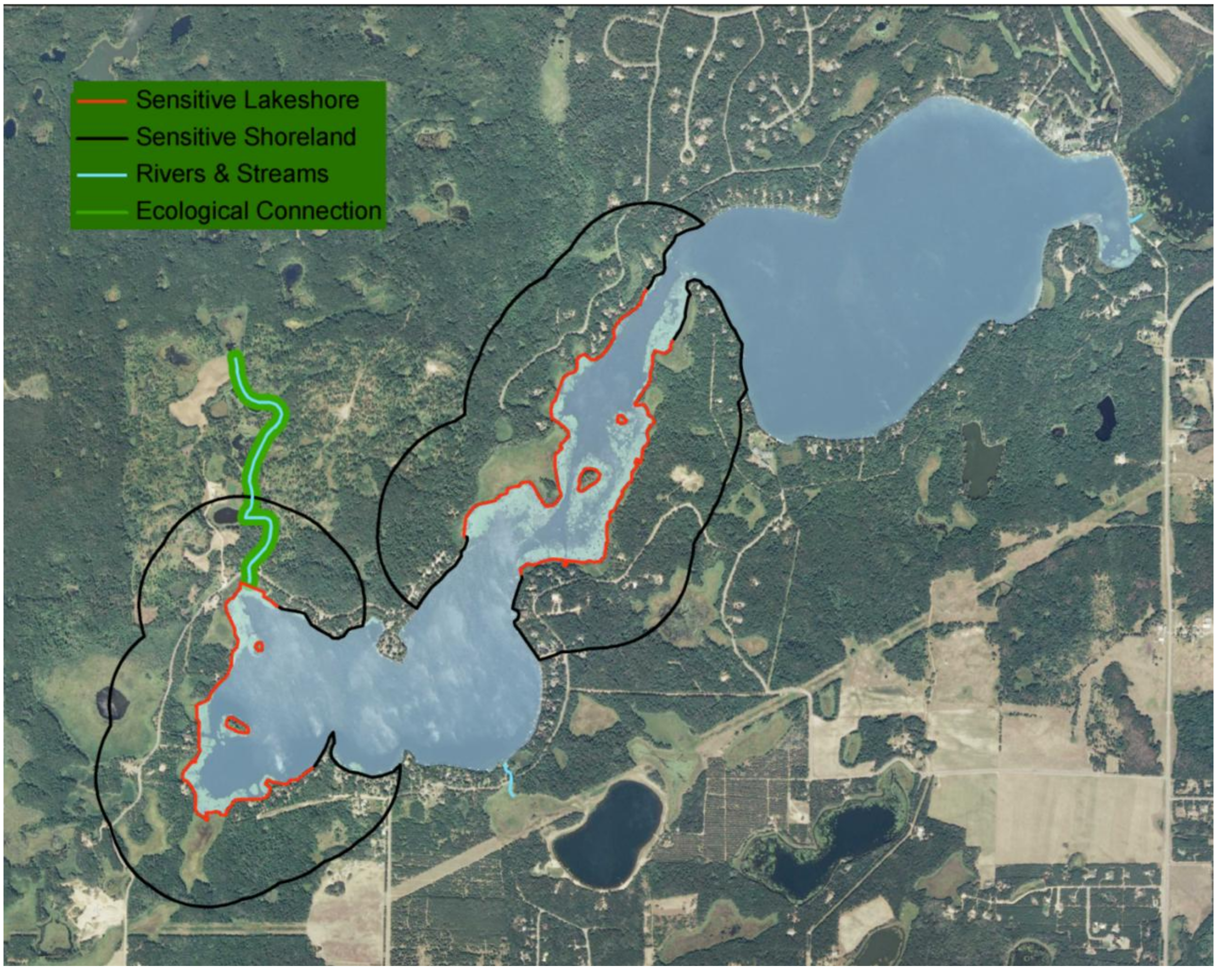


Figure 64. The sensitive lakeshore areas identified by the ecological model.



Habitat Connectivity
In addition to the sensitive shorelands identified through the GIS model, surveyors considered adjacent river shorelines that provide connectivity to and from the lake shorelands. Aquatic habitat connectivity allows for the movement of organisms within a watershed. Organisms can move between existing habitats, colonize new areas, or recolonize former habitat in the wake of local extinctions. The inlet of Sylvan Lake was identified as an important ecological connection. Depending on the existing shoreline classification of this river, the County may use the ecological connection recommendation to consider reclassifying to a more protective river class.

Other Areas of Ecological Significance
There are additional aquatic areas of ecological significance in Sylvan Lake that contain important aquatic plant communities but these sites are not necessarily associated with priority shoreland features. Identifying these sites is important, although exact delineation of their boundaries can be difficult because they occur in the water and may be patchy in distribution.

In Sylvan Lake, sites containing a high diversity of native submerged plants are considered sites of ecological significance. These include broad underwater zones that contain numerous types of submerged plants. Not only do these species-rich sites provide a diverse habitat mix for fish and wildlife, but they may also help mitigate the potentially harmful impacts if invasive plants occur in the lake.

Other sites of ecological significance are emergent and floating-leaf plant beds that may occur outside of the sensitive shoreland districts. Often, these sites are too small to warrant inclusion as part of a shoreline protection district, but their small size is a defining feature that adds to their importance within the lake. Emergent and floating-leaf plant beds continue to be fragmented as shorelines are developed. Protecting remaining areas of these plant communities and preventing further fragmentation is important.

One of the primary threats to these sites is the direct destruction of plant beds through aquatic plant management and recreational boating activities. Planning efforts, such as the development of a Lake Vegetation Management Plan, can be used to set specific management practices within these types of sites.

Sensitive Lakeshore

As the field surveys documented, the channel connecting the northeast and soutwest basins of Sylvan Lake, as well as the southwest lake shoreline supported a great diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such as emergent and floating-leaf vegetation, was also present in high quantities in these areas. The ecological model displays these areas both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby may have significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. The inlet of Sylvan Lake is also an important part of the lake ecosystem. It provides habitat connectivity between Sylvan Lake and nearby habitat. It allows movement of animals from various populations, increasing diversity. Habitat connectivity also allows animals with different vegetation requirements during different life stages to access those habitats. Protection of both the shoreline itself and the habitat surrounding the shoreline will be the most effective way to preserve the plant and animal communities in and around Sylvan Lake, and the value of the lake itself.

References

Arber, A. 1920. Water plants: A study of aquatic angiosperms. Cambridge University Press. 436 pp.

Borman, S., R. Korth and J. Temte. 2001. Through the looking glass: A field guide to aquatic plants. The Wisconsin Lakes Partnership, Stevens Point, Wisconsin. 248 pp.

Bourdaghs, M., C.A. Johnston, and R.R. Regal. 2006. Properties and performance of the floristic quality index in Great Lakes coastal wetlands. Wetlands 26(3):718–735.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131 pp.

Fassett, N.C. 1957. A manual of aquatic plants. The University of Wisconsin Press. 405 pp.

Flora of North America Editorial Committee, eds. 2007. Flora of North America North of Mexico. 12+ vols. New York and Oxford.
http://www.minnesotawaters.org

Magurran, A.E. 2004. Measuring biological diversity. Blackwell Science, Oxford.

Meredith, T.C. 1983. The effects of shorezone development on the nature of adjacent aquatic plant communities in Lac St. Louis, Quebec. Lake and Reservoir Management Proceedings. 3rd Annual Nalms Conference. North American Lake Management Society. October 1983. Washington, D.C. pp.527-530.

Minnesota Department of Natural Resources. 1993. Lake Survey Manual. Section of Fisheries, St. Paul.

Minnesota Department of Natural Resources. 2003. Field guide to the native plant communities of Minnesota: The Laurentian Mixed Forest province. Ecological Land Classification Program, Minnesota Biological Survey, and Natural Heritage and Nongame Research Program, St. Paul.

Minnesota Department of Natural Resources. 2005. Aquatic vegetation mapping guidelines. Working version, May 2005. Section of Fisheries, St. Paul.

Minnesota Department of Natural Resources. 2006. Tomorrow's habitat for the wild and rare: An action plan for Minnesota wildlife, comprehensive wildlife conservation strategy. Division of Ecological Services, Minnesota Department of Natural Resources.

Minnesota Department of Natural Resources. 2008. Minnesota's sensitive lakeshore identification manual: A conservation strategy for Minnesota lakeshores (version 1). Division of Ecological Resources, Minnesota Department of Natural Resources.

Minnesota Department of Natural Resources. 2008b. 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/fish_wildlife/legislativereports/20080215_wildricestudy.pdf

Minnesota Pollution Control Agency. 2009. Clean lake monitoring program. Minnesota Pollution Control Agency, St. Paul. http://www.pca.state.mn.us/water/clmp.html

MNTaxa. 2009. Minnesota state checklist of vascular plants. Division of Ecological Resources, Minnesota Department of Natural Resources, St. Paul.

Mohlenbrock, R.H. 2005. Cyperaceae sedges. Aquatic and standing water plants of the central Midwest. 272 pp.

Moyle, J.B. 1945. Some chemical factors influencing the distribution of aquatic plants in Minnesota. American Midland Naturalist 34:402-420.

Myhre, K. 2008. Plant survey of Sylvan Lake (11-0304-00), Cass County, Minnesota, June 18, 2008. Division of Ecological Resources, Minnesota Department of Natural Resources. Minnesota County Biological Survey Program. Unpublished data.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer

Nichols, S.A. 1999a. Floristic quality assessment of Wisconsin lake plant communities with example applications. Lake and Reservoir Management 15(2):133–141.

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

Nicholson, S.A. 1981. Changes in submersed macrophytes in Chautaqua Lake, 1937-1975. Freshwater Biology 11:523-530.

Niemeier, P.E. and W.A. Hubert. 1986. The 85-year history of the aquatic macrophyte species composition in a eutrophic prairie lake (United States). Aquatic Botany 25:83-89.

Ownbey, G.B. and T. Morley. 1991. Vascular plants of Minnesota: A checklist and atlas. University of Minnesota Press, Minneapolis. 307 pp.

Perleberg, D. and S. Loso. 2008. Aquatic vegetation of Sylvan Lake (DOW 11-0304-00), Cass County, Minnesota, 2008. Division of Ecological Resources, Minnesota Department of Natural Resources, Brainerd. 20 pp.

Pip, E. 1987. Species richness of aquatic macrophyte communities of Central Canada. Hydrobiological Bulletin 21(2):159-165.

Rolon, A.S., T. Lacerda, L. Maltchik, and D.L. Guadagnin. 2008. Influence of area, habitat and water chemistry on richness and composition of macrophyte assemblages in southern Brazilian wetlands. Journal of Vegetation Science 19:221-228.

Stuckey, R.L. 1971. Changes of vascular aquatic flowering plants during 70 years in Put-in-Bay Harbor, Lake Erie, Ohio. The Ohio Journal of Science 71:321-342.

Vestergaard, O. and K. Sand-Jensen. 2000. Aquatic macrophyte richness in Danish lakes in relation to alkalinity, transparency, and lake area. Canadian Journal of Fisheries and Aquatic Sciences 57:2022-2031.

Appendix 1. Shoreline emergent aquatic plants recorded in Sylvan Lake, June 18, 2008 (K. Myhre, MN DNR Minnesota County Biological Survey).

Description	Common Name	Scientific Name
Shoreline Emergent	Two-stamened sedge	*Carex diandra*
	Wiregrass-woolly sedge	*Carex lasiocarpa* var. *americana*
	Blue flag iris	*Iris versicolor*
	Purple loosestrife	*Lythrum salicaria*
	Marsh cinquefoil	*Potentilla palustris*
	Water dock	*Rumex* sp.
	Northern marsh fern	*Thelypteris palustris*
	Marsh St. John's wort	*Triadenum fraseri*
Shoreline Shrubs	Speckled alder	*Alnus incana* ssp. *rugosa*
	Bog birch	*Betula pumila*

Nomenclature follows MNTaxa 2009.

Appendix 2. Bird species list. Includes all species within Sylvan Lake and shoreland recorded during surveys and casual observation, May – June 2009.

Common Name	**Scientific Name**
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Common Loon	*Gavia immer*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Cooper's Hawk	*Accipiter cooperii*
Sora	*Porzana carolina*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Hydroprogne caspia*
Mourning Dove	*Zenaida macroura*
Barred Owl	*Strix varia*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapilla*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*

Appendix 2, continued.

Common Name	Scientific Name
Veery	*Catharus fuscescens*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
European Starling	*Sturnus vulgaris*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Baltimore Oriole	*Icterus galbula*
Pine Siskin	*Spinus pinus*
American Goldfinch	*Spinus tristis*