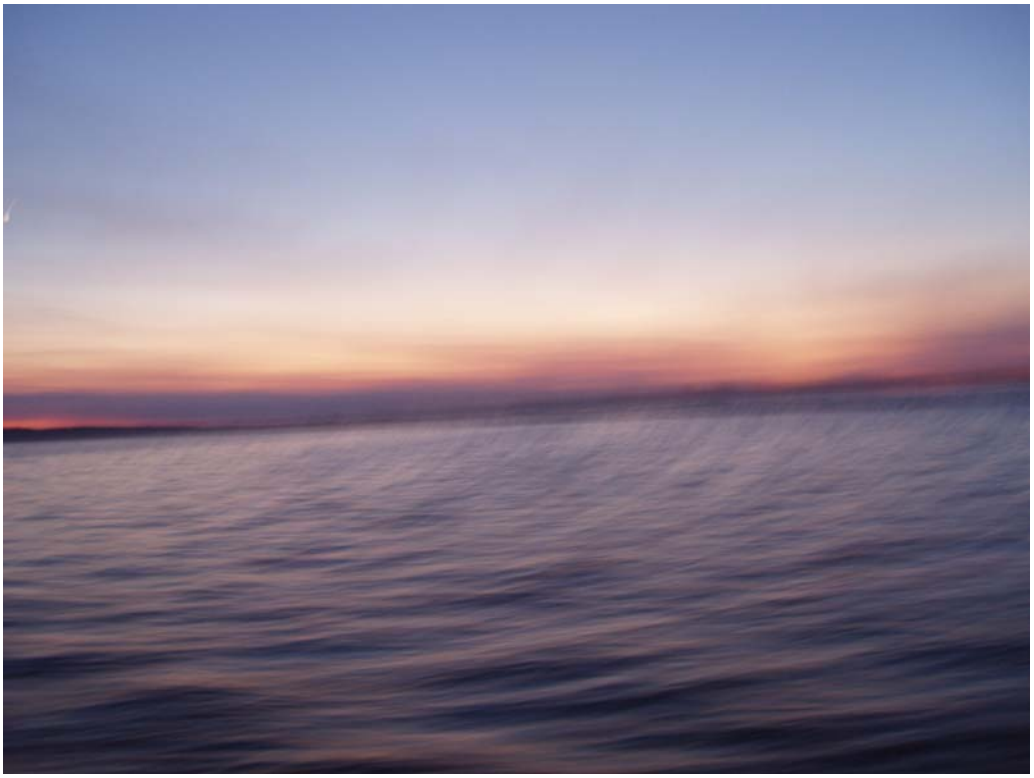
Final Report
Sensitive Lakeshore Survey
Ten Mile Lake (11-0413)
Cass County, Minnesota

July 2008



STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES

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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Executive Summary

Plant surveys revealed a rich, diverse plant community. A total of 48 native aquatic plant taxa were recorded, making Ten Mile Lake among the richest lake plant communities in the state. Eleven plant species previously undocumented in this lake were collected for this survey. Plants occurred around the entire perimeter of Ten Mile Lake but were more concentrated within the bays where 84 percent of the survey sites contained vegetation compared to 54 percent of the sites in the main basin. Submerged plants occurred to a depth of 29 feet and included rooted flowering plants and large algae. Approximately 90 acres of bulrush and 50 acres of waterlilies occurred within the bays and along protected shorelines. Unique plant species included both emergent and submerged plants. Seven of these species were documented for the first time in Ten Mile Lake.

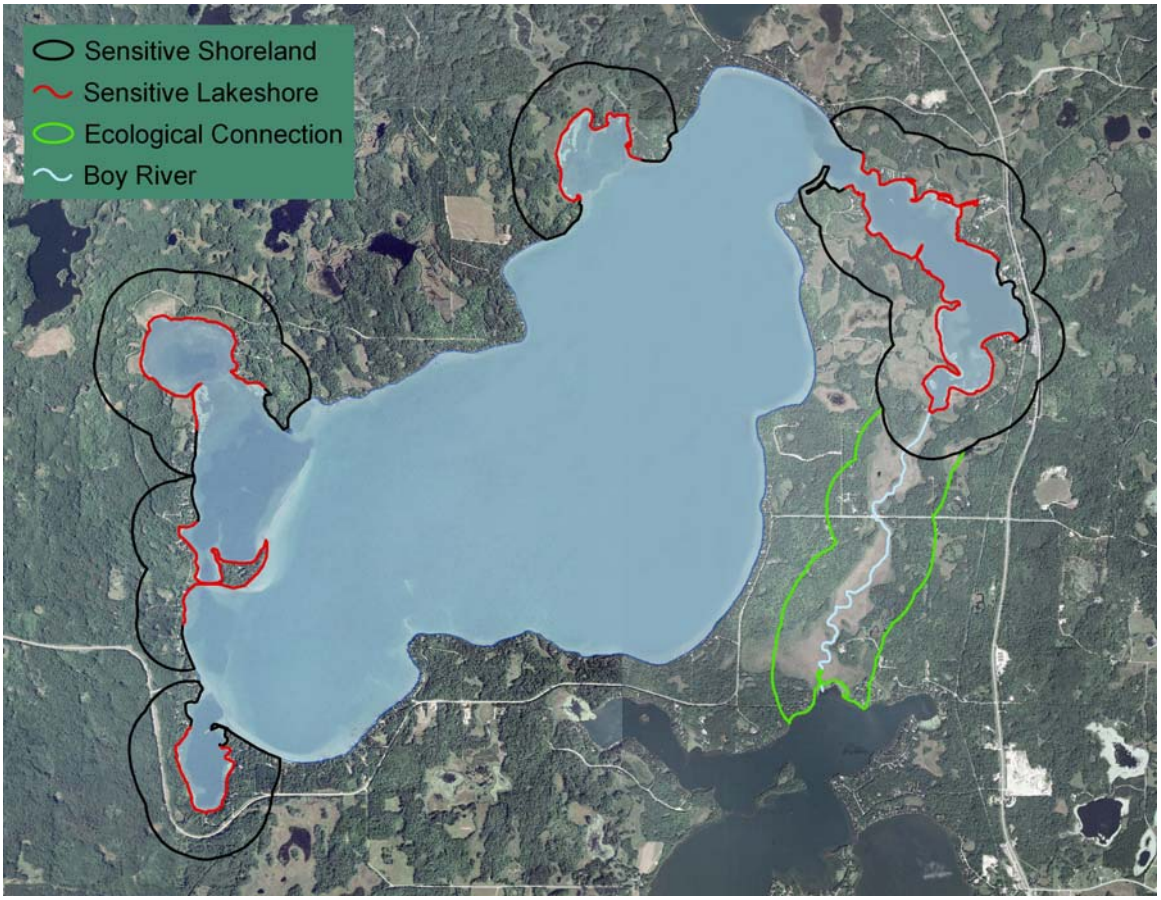
Five fish species previously undocumented in the lake were collected for this survey, bringing the total historical observed fish community to 38 species. The new species recorded included blackchin shiner, pugnose shiner, brook stickleback, least darter, and longear sunfish. Both mink and green frogs were observed, with the vast majority found in the sheltered bays.

Surveyors documented 82 species of birds, including 17 species of greatest conservation need. Red-eyed vireos were the most abundant bird species overall, whereas the veery was the most commonly detected species of greatest conservation need. Although distribution of several species was restricted to the bays, others were found along the shoreline of the main basin as well.

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. Lakeshores were then clustered by sensitivity index values using established geospatial algorithms. These areas were buffered and important ecological connections or linkages mapped. The identification of sensitive lakeshore 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. While model results for shoreland segments can be compared across lakes, plant and animal assemblages differ naturally between lakes, and sensitivity scores should not be compared across lakes.

The ecological model identified five primary sensitive lakeshore areas to be considered for potential resource protection districts by Cass County. 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 Ten Mile Lake sensitive lakeshore areas.

Lake Description

Ten Mile Lake (DOW 11-0413-00) is located between the cities of Hackensack and Walker, in Cass County, north-central Minnesota (Figure 1). The lake is named "Ten Mile" because it is located ten miles south of a historical trading post on Leech Lake.

Figure 1. Location of Ten Mile Lake in Cass County, Minnesota.

Ten Mile Lake is the headwaters of the Boy River, which flows south from Ten Mile Lake and then east and north through a chain of 15 or 16 lakes before emptying into the east side of Leech Lake.

Ten Mile Lake has a surface area of 4,669 acres, making it one of the larger lakes in the state and the seventh largest in Cass County. It is also one of the deepest lakes in Minnesota, with a maximum depth of 208 feet and a mean depth of 53 feet (Hodgson and Heiskary 1991). About 30 percent of the lake is less than 15 feet in depth and shallow areas include the bays and near-shore sites (Figure 2).

The shoreline of Ten Mile Lake is primarily forested but also heavily developed with residential homes. There are several bays and a public boat launch on the southwest shore (Figure 3).

I. Field Surveys and Data Collection

Survey and data collection followed Minnesota's Sensitive Lakeshore Area 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.

Figure 2. Depth contours of Ten Mile Lake.

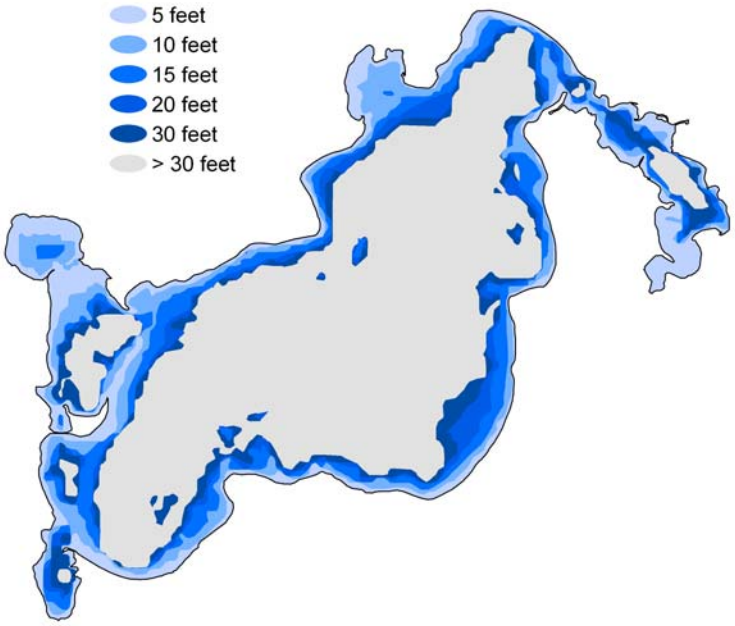
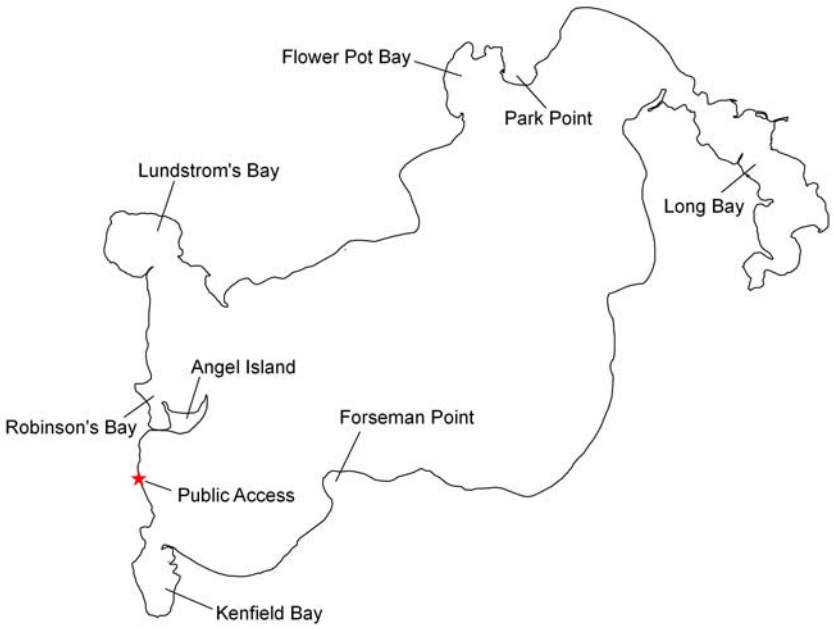


Figure 3. Features of Ten Mile Lake.



Wetlands

Objectives

1. Map wetlands within the state-defined shoreland area of Ten Mile Lake

Summary

Wetlands were distributed along the majority of the Ten Mile Lake shoreline.

Introduction

Ten Mile Lake wetland – sedge mat with scattered shrubs

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 non-soil and 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)

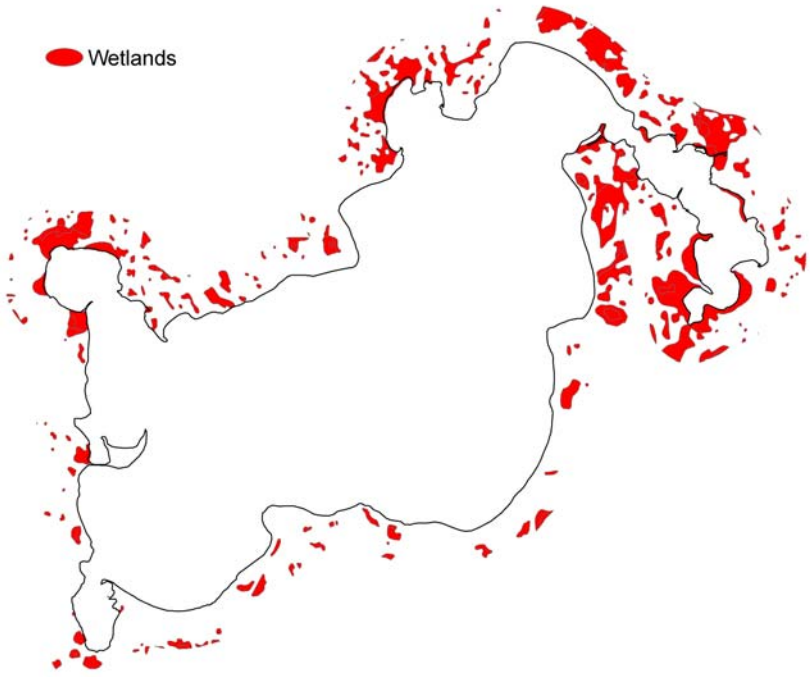
Methods

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 1320 feet of the shoreline were considered in this project. Wetlands classified as lacustrine and occurring lakeward of the Ten Mile Lake ordinary high water mark were excluded from this analysis.

Results

Approximately 650 acres, or about 20 percent of the Ten Mile Lake shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI. Wetlands were present along the entire lakeshore of Ten Mile Lake, but were most abundant near the northern bays, including Lundstrom's Bay, Flower Pot Bay, and Long Bay (Figure 4). The dominant wetland types included emergent wetland (Cowardin et al. 1979) or marsh (MN DNR 2003) systems, characterized by herbaceous, emergent wetland vegetation; palustrine scrub shrub (Cowardin et al. 1979) or wetland shrubland systems (MN DNR 2003), dominated by deciduous or evergreen shrubs; 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. Distribution of wetlands within 1320 feet of Ten Mile Lake shoreline.



Hydric Soils

Objectives

1. Map hydric soils within the state-defined shoreland area of Ten Mile Lake

Summary

Hydric soils were present along much of the shoreline of Ten Mile 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.

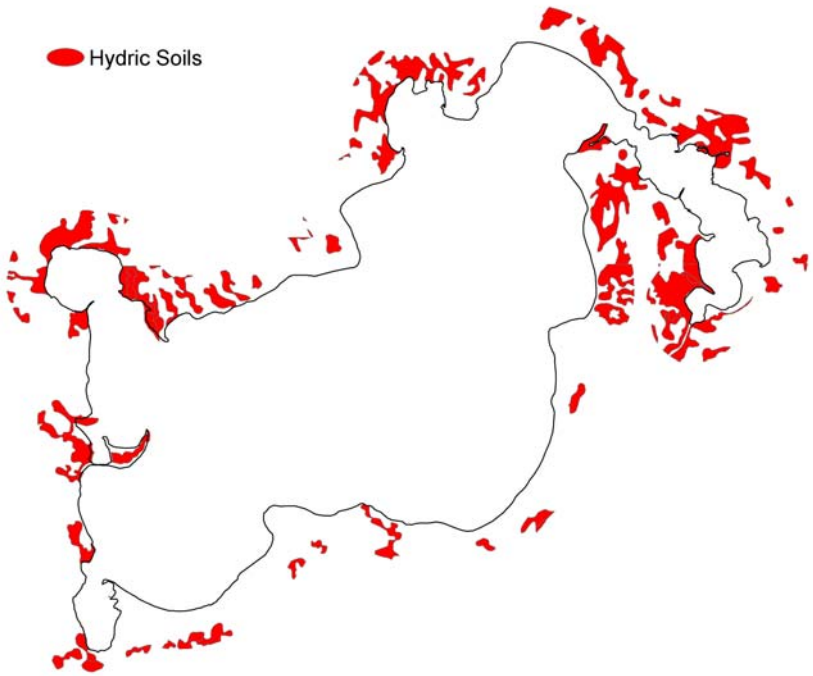
Methods

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 Ten Mile Lake (Figure 5). Specific hydric soil types varied widely, from muck to loam to peat. Hydric soils appeared to be more common near bays and less common along the exposed segments of the main basin shoreline.

Figure 5. Distribution of hydric soils within 1320 feet of Ten Mile Lake shoreline.



Plant Surveys

Objectives

1. Describe distribution of vegetation in Ten Mile Lake
   a. Estimate maximum depth of plant colonization
   b. Estimate plant occurrence in bays versus main lake
   c. Estimate and map the near-shore occurrence of vegetation
2. Record presence and abundance of all plant species
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

Plants occurred around the entire perimeter of Ten Mile Lake but were more abundant within the bays, where 84% of the survey sites contained vegetation compared to 54% of the sites in the main basin. Plant species richness was also highest within the bays. Submerged plants occurred to a depth of 29 feet and included rooted flowering plants and large algae.

Rooted submerged plants were most common in depths less than six feet whereas large algae were common to a depth of 25 feet. Muskgrass (*Chara* sp.) was the most common submerged plant in Ten Mile Lake and was found in 45% of the survey sites. The most common flowering submerged plants included flat-stem pondweed (*Potamogeton zosteriformis*), Canada waterweed (*Elodea canadensis*), bushy pondweed (*Najas flexilis*), northern watermilfoil (*Myriophyllum sibiricum*), Robbins' pondweed (*Potamogeton robbinsii*), white-stem pondweed (*Potamogeton praelongus*) and a narrow-leaf pondweed (*Potamogeton* spp.). The lakewide frequency of occurrence for these species ranged from four to seven percent.

Surveyors documented approximately 90 acres of bulrush beds and approximately 50 acres of waterlily beds on Ten Mile Lake. A total of eight unique plants were identified at 36 locations along the Ten Mile Lake shoreland zone. Unique emergent plants included water arum (*Calla palustris*), three-way sedge, (*Dulichium arundinaceum)* and wire-grass sedges (*Carex oligosperma* and *Carex lasiocarpa*). Unique submerged plants included water bulrush (*Scirpus subterminalis*), humped bladderwort (*Utricularia gibba*), flat-leaf bladderwort (*U. intermedia*), and lesser bladderwort (*U. minor*). Seven of these species were documented for the first time in Ten Mile Lake.

A total of 48 native aquatic plant taxa were recorded at Ten Mile Lake, making it among the richest lake plant communities in the state.

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, depth, substrate and wave activity. Deep or wind-swept areas are often lacking in aquatic plant growth, whereas sheltered shallow areas can 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 taxa, introductions of non-native plant or animal taxa, and human activities in and around the lake.

Non-native aquatic plant species have not been documented in Ten Mile Lake but if they invade the lake, they may directly or indirectly impact the native plant community. Non-native plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that 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 - algae

A wide variety of native plant species were found within Ten Mile Lake. The most common submerged plant taxa were large algae: muskgrass (*Chara* sp.) and stonewort (*Nitella* sp.).

Muskgrass (Figure 6) is a macroscopic, or large, algae that is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important habitat for fish spawning and nesting.

Figure 6. Bed of muskgrass

Stonewort (Figure 7) is also a large algae but lacks the brittle texture and musky odor of muskgrass. Instead, it is odorless and soft to the touch. It is often found in deeper water than muskgrass. Stonewort has smooth, forked branches and grows to several feet in length. Stonewort is an important food source for waterfowl, especially ducks. It also provides habitat for invertebrate communities that serve as a food source for a variety of fish.

Figure 7. Stonewort

Submerged plants – flowering plants

Several types of flowering submerged plants occurred in Ten Mile Lake, including Canada waterweed (*Elodea canadensis*), northern watermilfoil (*Myriophyllum sibiricum*), several pondweed species (*Potamogeton* spp.*)* and bushy pondweed (*Najas flexilis*).

Canada waterweed (Figure 8) is a rooted, perennial submerged species that is widespread throughout Minnesota and is adapted to a variety of conditions. It is tolerant of low light and prefers soft substrates. This species can overwinter as an evergreen plant and spreads primarily by fragments. The branching stems of this plant can form thick underwater plant beds that are valuable habitat for a variety of fish and invertebrates.

Figure 8. Canada waterweed

Photo by: Vic Ramey, U. of Florida

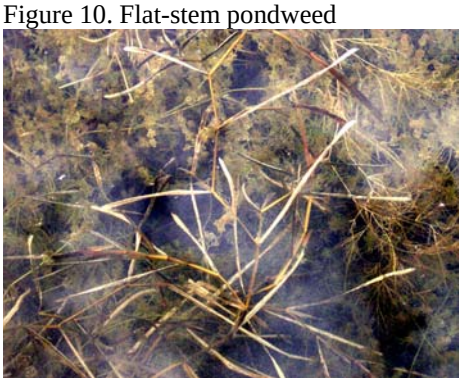
Northern watermilfoil (Figure 9) is a rooted, perennial submerged plant with finely dissected leaves. It may reach the water surface, particularly in depths less than ten feet and its flower stalk extends above the water surface. It spreads primarily by stem fragments and overwinters by hardy rootstalks 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 9. Northern watermilfoil

Pondweeds (*Potamogeton* spp.) are the largest group of submerged plants in Minnesota and most are named for their unique leaf structure. The fruits of pondweeds are a favorite duck food and the leaves provide food and shelter for fish.

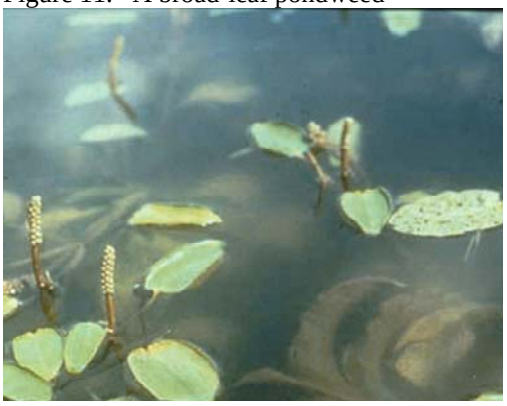
Narrow-leaf pondweeds include flat-stem pondweed (*Potamogeton zosteriformis*) (Figure 10) and Robbins' pondweed (*Potamogeton robbinsii*). These plants have flattened, grass-like leaves. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. These pondweeds are anchored to the lake bottom by rhizomes and overwinter by winter buds.

Figure 10. Flat-stem pondweed



Broad-leaf pondweeds include large-leaf pondweed (*Potamogeton amplifolius*), variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, white-stem pondweed (*P. praelongus*), and clasping-leaf pondweed (*P. richardsonii*). These rooted, perennial plants with wide leaves are often called "cabbage" plants by anglers. They often grow in patches or beds, and have spiked seed heads that grow above the water during the summer. These plants are primarily submerged but many will form floating leaves in shallower water (Figure 11). Broad-leaf pondweeds provide habitat for several fish species, including muskie, northern pike, largemouth bass, and bluegills. Walleye also frequently use broad-leaf pondweeds for cover.

Figure 11. A broad-leaf pondweed



Bushy pondweed (Figure 12) is unusual because it is one of the few annual submerged species in Minnesota and must re-establish every year from seed. This common species grows entirely below the water surface. It has long, waving stems in deep water, but is dense and bushy in shallow water. It is often confused with muskgrass, but does not possess a musky odor. The seeds and foliage of this plant are an important duck food and beds of this plant provide good fish cover.

Figure 12. Bushy pondweed

Emergent and floating-leaf plant beds

Information on the spatial distribution of emergent and floating-leaf plants within Ten Mile Lake is important. Emergent aquatic plants, such as bulrush, offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. Waterlily beds provide similar benefits and also provide shade for fish and frogs. The root systems of emergent and floating-leaf plants act to stabilize the lake bottom and beds of these plants help buffer the shoreline from wave action.

Waterlilies include several types of rooted plants with leaves that float on the water surface. 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). Waterlilies are perennial and have extensive rhizome systems that overwinter on the lake bottom.

Hardstem bulrush (*Scirpus acutus*) (Figure 15) is a perennial emergent that may occur from shore to water depths of about six feet and its stems may extend several feet above the water surface.

Figure 13. White waterlily

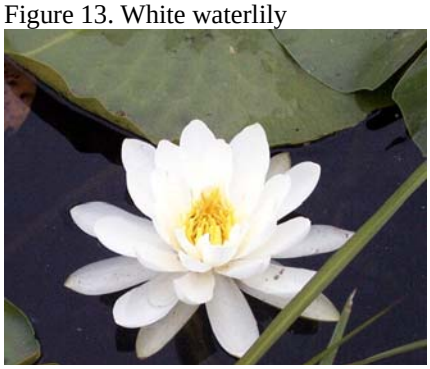


Figure 14. Yellow waterlily

Figure 15. Bulrush bed on Ten Mile Lake, 2006.

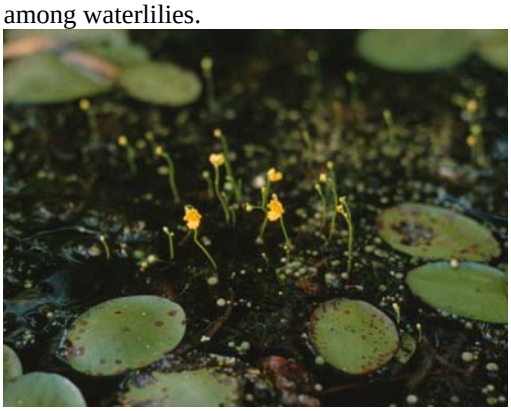
Unique aquatic plants

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

- Rare (endangered, threatened, special concern) plant species
- 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.

Unique bladderwort species include humped bladderwort (*Utricularia gibba*) (Figure 16), lesser bladderwort (*U. minor*) and flat-leaved bladderwort (*U. intermedia*). These small, submerged plants are often confused as algae because of their fine stems and leaves. 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. 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 yellow flowers that emerge above the water surface. They are found in protected, shallow lake areas and have been documented at scattered locations throughout northern Minnesota (Ownbey and Morley 1991).

Figure 16. Humped bladderwort in flower among waterlilies.



Water bulrush (*Scirpus subterminalis*) (Figure 17) is a submerged, perennial plant with fine, grass-like leaves that may form mats and float near the water surface. 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 2007). It is infrequently found in Wisconsin (Nichols 1999b) and Minnesota (Ownbey and Morley 1991) lakes.

Figure 17. Water bulrush

Photo by: D.W. Taylor. Copyright 1996.

Figure 18. Water arum

Water arum (*Calla palustris*) (Figure 18) 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 19. Three-way sedge

Photo by: A. Murray. Copyright 2003
U. of Florida, Center for Aquatic Plants

Three-way sedge (*Dulichium arundinaceum*) (Figure 19) is an emergent, perennial plant that grows along soft bottom lakeshores and in marshes. This plant does not produce a showy flower but can be identified by its unique three-ranked leaf arrangement that resembles a three-armed airplane propeller from above (Newmaster et al. 1997). Three-way sedge is found along shores of lower alkalinity lakes (Nichols 1999b) throughout central and northern Minnesota (Ownbey and Morley 1991).

Figure 20. Wiregrass sedge

Wiregrass sedges (*Carex lasiocarpa* and *Carex oligosperma*) (Figure 20) are emergent, perennial plants. As their name implies, they are grass-like in appearance but with long, fine leaves that resemble wire. These plants have extensive rhizome systems that form the framework of floating fen mats (Newmaster et al. 1997). Wiregrass sedges are common in boreal wetlands (Flora of North America 2007) and occur in northeastern Minnesota wetlands (Ownbey and Morley 1991).

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 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 hypertrophic 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 (Nichols 1981, Stuckey 1971, Niemeier and Hubert 1986) and shoreland development (Meredith 1983).

Within a lake, plant species richness generally declines with increasing water depth because 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 Ten Mile Lake were described and measured using several techniques as found in Minnesota's Sensitive Lakeshore Area Identification Manual (MN DNR 2008).

Grid point-intercept survey
A grid point-intercept survey was conducted on Ten Mile Lake between June 12 and June 22, 2006 (Perleberg 2006). Aquatic plant survey points were established throughout the littoral (i.e., vegetated) zone of the lake to a depth of 30 feet. Points were spaced 75 meters apart and 1,465 sites were sampled.

Near-shore in-lake vegetation survey plots
Eleven near-shore, in-lake survey plots were sampled in August, 2007. Plots were selected based on the presence of nongame fish. Each plot measured 15 meters along the shoreline and 16 meters lakeward; 30 sites were samples within each plot. Surveyors recorded plant species present, water depth, substrate and presence of woody debris.

Shoreline vegetation survey plots
Surveyors inventoried shoreland plants at 46 sites in July and August 2006 and at 11 sites in August 2007. Shoreline vegetation plots were placed systematically in 2006 and adjacent to in-lake vegetation plots in 2007. Plots measured one meter landward by 15 meters along shore. Surveyors sampled at the vegetated zone of the land-water interface. and recorded all plant taxa within the shoreline plot.

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.

Field mapping focused on extensive bulrush beds, which were difficult to see on aerial photos. In 2003, MN DNR Fisheries staff mapped extensive bulrush habitat in Ten Mile Lake using Global Positioning System (GPS) technology. In 2006, reconnaissance surveys of the largest beds were conducted to verify species composition and if needed, modify boundary lines.

Searches for unique and rare species
Surveyors obtained known locations of state and federally listed rare plants within one mile of Ten Mile 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 to determine if certain plant species had previously been documented in or near Ten Mile Lake.

Surveyors searched for unique plant species in June and August 2006 during the lakewide point-intercept and nongame surveys, and in July and August 2007 during the near-shore vegetation surveys. At each unique plant location, surveyors recorded the unique plant species found, the location, associated plant species, approximate water depth and substrate type. For plant species that had not previously been recorded in the lake, surveyors collected a voucher specimen.

Results

Distribution of plants by water depth
Plants were found to a maximum depth of 29 feet in Ten Mile Lake and 63% of all sample sites contained vegetation. Plant occurrence was greatest in depths of 11 to 20 feet, where vegetation was found in 75% of the sample sites. Rooted plants occurred at all depths to 29 feet but were most common in depths less than six feet, where they were found in 48% of the sample sites. Large algae were also present at all depths to 29 feet and were more frequent than rooted plants. In water depths from shore to 25 feet, large algae occurred in nearly half of all sample sites.

The greatest number of plant taxa was found in shallow water, from shore to a depth of five feet. Emergent plants were restricted to water depths of seven feet and less, and floating-leaved plants were most common to a depth of five feet. Free-floating duckweeds were only found in protected bays and occurred in depths less than six feet. Submerged rooted plants were found to a maximum depth of 29 feet but only three taxa occurred in depths greater than 20 feet. Non-rooted submerged plants (primarily large algae) were found at all depths to 29 feet.

Distribution of plants in main basin versus bays
Plants occurred around the entire perimeter of Ten Mile Lake but were concentrated within the bays. Of the plant taxa found, 36 occurred in the bays and only 22 were found in the main basin. Within the main basin, plants were found in 54% of the sample sites. However, most of these sites contained only non-rooted plants (large algae or watermoss) and rooted plants occurred in only 11% of the sites. Areas of the main basin that did contain rooted plants were relatively protected shorelines such as the shore north of the

public access, the shore north of Batcheller Point, and the shore south of Forseman Point. Aquatic plants were abundant within all bays and 84% of the sample sites in the bays were vegetated. Extensive bulrush and waterlily beds were present in Lundstrom's Bay and Flower Pot Bay and a diverse mix of submerged plants occurred in all bays.

Aquatic plant species observed

A total of 48 native aquatic plant taxa were recorded in Ten Mile Lake, including 13 emergent, six floating-leaved, one free-floating and 28 submerged plants (Table 1). Submerged plants included two types of large algae, an aquatic moss, an aquatic fern, and numerous flowering plants. An additional 36 wetland emergent plants were also recorded (Table 1).

Table 1. Aquatic plants recorded in Ten Mile Lake 2006 – 2007.

Frequency values are provided for taxa that were observed within point-intercept survey sample stations.
Present = present in lake but not found at point-intercept sample stations.
*This species was confirmed in the lake but there may have been at least one additional taxon present within this genus that could not be identified to the species level at each individual sample site.
[#] This species is non-native, escaped from cultivation.

Description				Common Name	Scientific name	Frequency of occurrence (N=1465)		
						Bays	Main basin	Lake wide
Submerged	Non-flowering plants		Algae	Muskgrass	*Chara* sp.	67	37	45
				Stonewort	*Nitella* sp.	2	14	11
				Watermoss	*Not identified to genus*	2	<1	1
				Quillwort	*Isoetes* sp.	0	<1	<1
	Flowering plants	Perennial	Pondweeds	Canada waterweed	*Elodea canadensis*	15	3	7
				Whorled watermilfoil	*Myriophyllum verticillatum*		Present	
				Northern watermilfoil	*Myriophyllum sibiricum*	12	3	6
				Flat-stem pondweed	*Potamogeton zosteriformis*	15	3	6
				Robbins' pondweed	*Potamogeton robbinsii*	10	1	4
				White-stem pondweed	*Potamogeton praelongus*	9	2	4
				Narrow-leaf pondweed	*Potamogeton* sp.	9	2	4
				Large-leaf pondweed	*Potamogeton amplifolius*	4	<1	1
				Illinois pondweed	*Potamogeton illinoensis*	4	1	1
				Clasping-leaf pondweed	*Potamogeton richardsonii*	2	0	<1
				Variable pondweed	*Potamogeton gramineus*	1	<1	2
				Fries' pondweed	*Potamogeton friesii**	1	<1	<1
				Sago pondweed	*Stuckenia pectinata*	1	<1	<1
				Coontail	*Ceratophyllum demersum*	6	2	3
				Water marigold	*Megalodonta beckii*	1	<1	<1
				White water buttercup	*Ranunculus aquatilis*	1	0	<1
				Greater bladderwort	*Utricularia vulgaris*	2	0	<1
				Flat-leaved bladderwort	*Utricularia intermedia*	1	0	<1
				Lesser bladderwort	*Utricularia minor*		Present	
				Humped bladderwort	*Utricularia gibba*		Present	
				Wild celery	*Vallisneria americana*	<1	<1	<1
				Water stargrass	*Heteranthera dubia*	1	<1	<1
				Water bulrush	*Scirpus subterminalis*	1	0	<1
		Annual		Bushy pondweed	*Najas flexilis*	14	<1	4
Free-floating				Greater duckweed	*Spirodela polyrhiza*	<1	0	<1
Floating-leaf				Floating-leaf pondweed	*Potamogeton natans*	10	0	3
				White waterlily	*Nymphaea odorata*	7	0	2
				Yellow waterlily	*Nuphar variegata*	6	0	2
				Watershield	*Brasenia schreberi*	2	0	1
				Floating-leaf burreed	*Sparganium fluctuans*	<1	<1	<1
				Floating-leaf smartweed	*Polygonum amphibium*		Present	

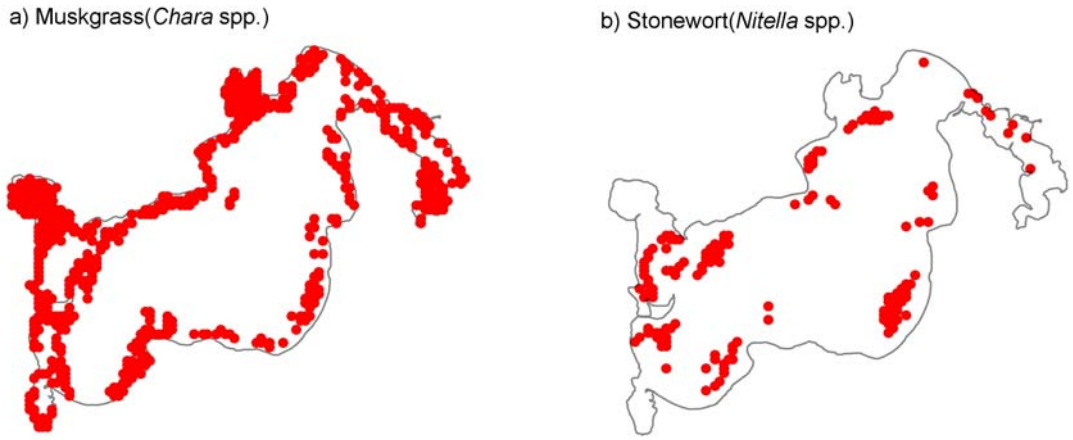
Table 1 (continued). Aquatic plants recorded in Ten Mile Lake 2006-2007.

Description	Common name	Scientific name	Frequency of occurrence		
			Bays	Main basin	Lake wide
In-lake Emergent	Hardstem bulrush	*Scirpus acutus**	7	1	3
	Wild rice	*Zizania palustris*	3	0	1
	Spikerush	*Eleocharis* sp.	<1	0	<1
	Giant burreed	*Sparganium eurycarpum**	<1	0	<1
	American burreed	*Sparganium americanum**		Present	
	Giant arrowhead	*Sagittaria latifolia**	<1	0	<1
	Arum-leaf arrowhead	*Sagittaria cuneata*		Present	
	Sessile-fruited arrowhead	*Sagittaria rigida*		Present	
	Needlegrass	*Eleocharis cf. acicularis*		Present	
	Three-way sedge	*Dulichium arundinaceum*		Present	
	Juncus	*Juncus* sp.		Present	
	Narrow-leaf cattail	*Typha cf. angustifolia*		Present	
	Broad-leaf cattail	*Typha latifolia*		Present	
Wetland Grasses and Sedges	Canada bluejoint grass	*Calamagrostis canadensis*		Present	
	Water sedge	*Carex aquatilis*		Present	
	Bottlebrush sedge	*Carex comosa*		Present	
	Lake sedge	*Carex hystricina*		Present	
	Lake sedge	*Carex lacustris*		Present	
	Wiregrass sedge	*Carex lasiocarpa*		Present	
	Wiregrass sedge	*Carex oligosperma*		Present	
	Giant cane	*Phragmites australis*		Present	
Wetland Emergent Forbs	Aster	*Aster* spp.		Present	
	Swamp milkweed	*Asclepias incarnata*		Present	
	Water arum	*Calla palustris*		Present	
	Marsh marigold	*Caltha palustris*		Present	
	Marsh bellflower	*Campanula aparinoides*		Present	
	Bulbiferous water hemlock	*Cicuta bulbifera*		Present	
	Giant water hemlock	*Cicuta maculata*		Present	
	Willow herb	*Epilobium* cf. *ciliatum*		Present	
	Swamp horsetail	*Equisetum palustre*		Present	
	Joe-Pye weed	*Eupatorium* sp.		Present	
	Bedstraw	*Galium* sp.		Present	
	Bottle gentian	*Gentiana andrewsii*		Present	
	Jewelweed	*Impatiens capensis*		Present	
	Blue flag iris	*Iris versicolor*		Present	
	Water horehound	*Lycopus uniflorus*		Present	
	Moneywort	*Lysimachia nummularia*[#]		Present	
	Tufted loosestrife	*Lysimachia thyrsiflora*		Present	
	Loesel's twayblade orchid	*Liparis loeselii*		Present	
	Wild mint	*Mentha arvensis*		Present	
	Forget-me-nots	*Myosotis scorpiodes*[#]		Present	
	Clearweed	*Pilea pumila*		Present	
	Water pepper	*Polygonum hydropiper*		Present	
	Swamp five-finger	*Potentilla palustris*		Present	
	Water dock	*Rumex* sp.		Present	
	Marsh skullcap	*Scutellaria galericulata*		Present	
	Marsh fern	*Thelypteris palustris*		Present	
	St. John's wort	*Triadenum fraseri*		Present	
	Stinging nettle	*Urtica dioica*		Present	

Submerged plants – algae

In Ten Mile Lake, muskgrass was the most frequently documented submerged plant. It occurred in 45% of all survey sites and was found around the entire lake (Figure 21a). Within the bays, muskgrass was found in 67% of the survey sites, compared to 37% of the sites in the main basin. Muskgrass occurred to a maximum depth of 28 feet but was most common in depths from shore to 15 feet where it occurred in 56% of the sites. In depths greater than 20 feet, muskgrass was found in only five percent of the sample sites. Stonewort was the only plant that was more abundant in the main basin (where it occurred in 14% of the sample sites) than in the bays (where it occurred in only two percent of the sample sites (Figure 21b). In Ten Mile Lake it occurred in 11% of the sample sites and was found on the deep edge of muskgrass beds. Stonewort was found in depths of seven to 30 feet and was the only plant found beyond 28 feet deep.

Figure 21. Distribution of large algae in Ten Mile Lake, 2006 – 2007.



Submerged plants – flowering plants

The most common flowering submerged plants were Canada waterweed, northern watermilfoil, and several pondweed species. Canada waterweed occurred from shore to a depth of 22 feet. It was found in seven percent of all sample sites and was most common within the bays where it occurred in 15% of the sites (Figure 22a). Canada waterweed was one of the few flowering plants found at offshore sites in the main basin of Ten Mile Lake. Northern watermilfoil was found in six percent of all the Ten Mile Lake sample sites, 12% of the bay sites and in three percent of the main basin sites (Figure 22b). It occurred to a depth of 20 feet but was more common in depths of 15 feet and less.

Narrow-leaf pondweeds found in Ten Mile Lake included flat-stem pondweed and Robbins' pondweed. Flat-stem pondweed was found in six percent of the sites surveyed (Figure 22c) and Robbins' pondweed occurred in four percent (Figure 22d). Both species were most common within the bays, where they were found in 15% and 10% of the sample sites, respectively. These species were found to a depth of 20 feet and often co-occurred with Canada waterweed, northern watermilfoil and other pondweeds. White-stem pondweed was the most abundant broad-leaf pondweed in Ten Mile Lake and was found in four percent of all sample sites (Figure 22e). Broad-leaf pondweeds

were more common in depths of 15 feet and less, and were generally found within sheltered bays.

In Ten Mile Lake, bushy pondweed was found to a depth of 12 feet. It was mainly restricted to the bays where it occurred in 14% of the sites; in the main lake, it was found in less than one percent of the sites (Figure 22f).

Figure 22. Distribution of common flowering plants in Ten Mile Lake, 2006 – 2007.

a) Canada waterweed (*Elodea canadensis*)

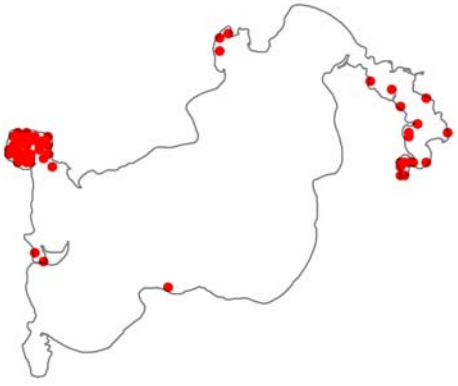
b) Northern watermilfoil (*Myriophyllum sibiricum*)

c) Flat-stem pondweed (*Potamogeton zosteriformis*)

d) Robbins' pondweed (*Potamogeton robbinsii*)

e) Broad-leaf pondweeds (*Potamogeton praelongus, P. amplifolius, P. illinoensis, P. gramineus*)

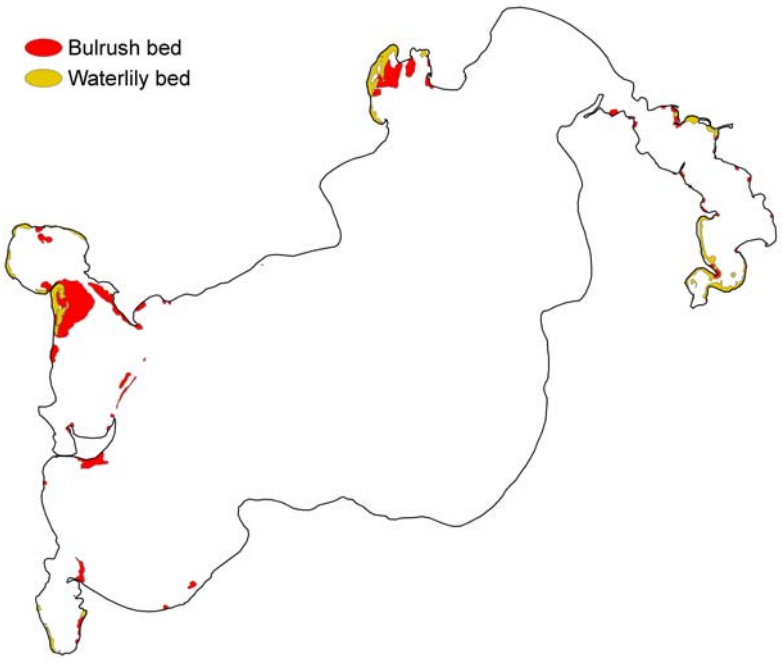
f) Bushy pondweed (*Najas flexilis*)



Emergent and floating-leaf bed delineation
Surveyors mapped approximately 90 acres of emergent vegetation and the most common plant within these beds was bulrush (Figure 23). The largest bulrush beds occurred at the south end of Lundstrom's Bay and in Flower Pot Bay. Submerged vegetation was often found within these bulrush beds. Bulrush was usually found in sand and silt sediments and occurred to a maximum depth of seven feet. Other emergent plants found included arrowhead (*Sagittaria* spp.), burreed (*Sparganium* sp.) spikerush (*Eleocharis* sp.) and wild rice (*Zizania palustris*). Wild rice was found in Lundstrom's Bay, Flower Pot Bay and Long Bay.

Surveyors also mapped approximately 50 acres of floating-leaf plant beds (Figure 23). Floating-leaf pondweed (*Potamogeton natans*), white waterlily and yellow waterlily were the most common species. Waterlily beds often contained scattered bulrush plants as well as submerged plants, and were typically associated with muck sediments.

Figure 21. Distribution of emergent and floating-leaf plant beds, 2006.



Unique plants
Unique plants were located at 36 locations (Figure 24). All of the unique plant occurrences were within delineated bays. A total of eight unique species were located in the lake and the maximum number of unique plants found at a site was four.

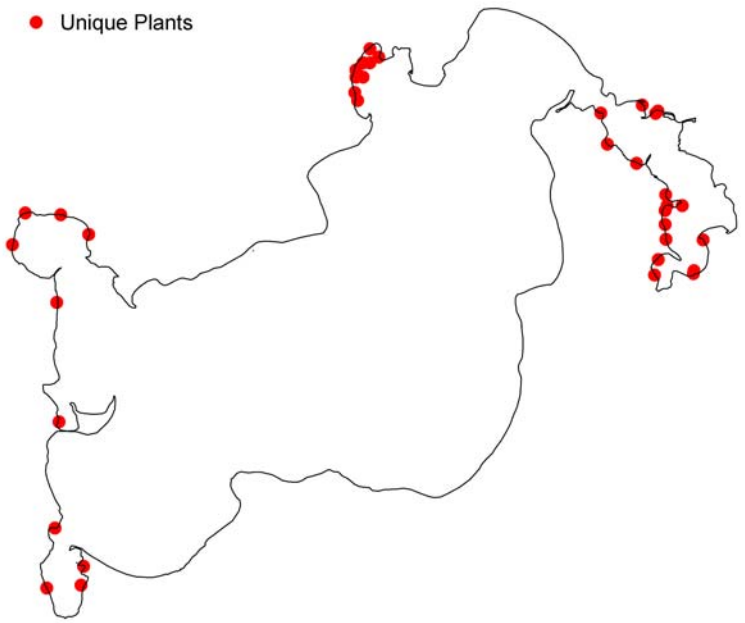
The unique emergent plants occurred in or adjacent to dense sedge mats of the wetland shores and included areas of each delineated bay. These sites were characterized by soft

substrates and hydric soils with water depths up to several inches. Associated plant species include a mixture of sedges often dominated by water sedge (*Carex aquatilis*) with other sedges (*Carex comosa*, *C. hystricina*, *C. lacustris*). Scattered shrubs such as bog birch (*Betula pumila*) and alder (*Alnus incana*) occurred within the sedge marshes. Lakeward, the plant community included a variety of aquatic emergents such as burreed, arrowhead and wild rice.

Wiregrass sedges were the most frequently found unique plants and occurred at 17 of the 36 unique plant sites. Water arum was found at 16 sites and often occurred within openings of sedge mats and at the wetland-water interface. Three-way sedge was found at one site along shore.

The unique submerged plants were found within shallow, quiet backwaters of Long Bay and Flower Pot Bay. These sites ranged in water depth from a few inches to four feet and had soft substrates. These sites had a mean plant species richness of six species per meter square. Associated species included watershield (*Brasenia schreberi*), white waterlily, yellow waterlily, floating-leaf pondweed, wild rice, northern watermilfoil, greater bladderwort (*Utricularia vulgaris*) and muskgrass. At least one unique bladderwort species was found at ten sites and water bulrush occurred at five sites.

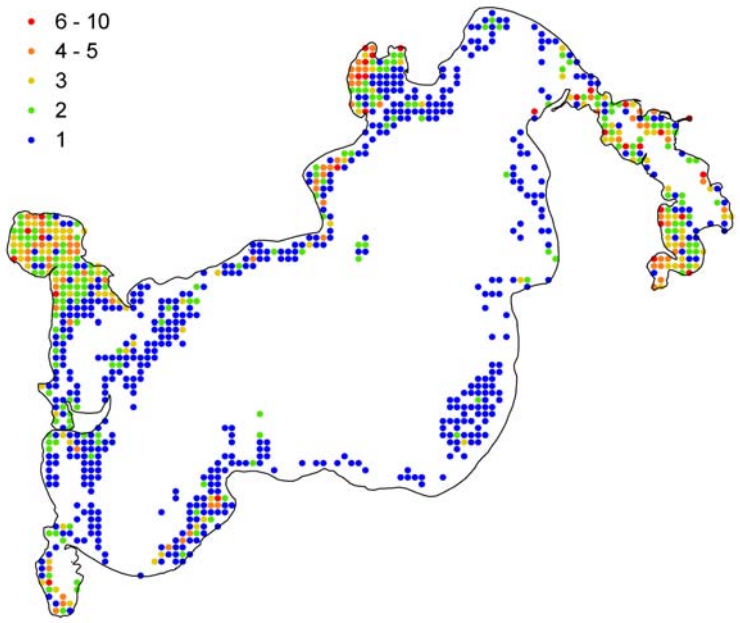
Figure 24. Distribution of unique and rare plants, 2006 – 2007.



Species richness

Plants occurred around the entire perimeter of Ten Mile Lake but species richness was highest within the bays (Figure 25). The number of different plant taxa found at each survey site ranged from zero to 10. Less than 4% of the sample sites contained 5 or more species. In the main basin, the mean number of plant taxa per site was less than one. The bays contained the greatest number of taxa and several areas contained between six and ten species per square meter. Species richness was also highest in shallow water, from shore to a depth of five feet.

Figure 25. Aquatic plant taxa richness (number of taxa per sample site) at sampling sites, 2006 – 2007.



Near-shore Substrates

Objectives

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

Summary

Near-shore substrate included boulders, rubble, gravel, sand, silt, marl, and muck. The bays were characterized by soft bottom substrates, whereas the main basin was dominated by hard bottom substrates.

Introduction

Natural sand beach on Ten Mile Lake

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 that range from soft to hard, such as silt, muck, and gravel. 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, gravel or marl while yellow waterlily prefers soft substrates (Nichols 1999b).

Methods

Near-shore substrate in Ten Mile Lake was evaluated at a total of 602 sampling stations set up in the grid point-intercept aquatic plant and near-shore fish and vegetation surveys. Plant point-intercept sample stations were 75 meters apart and occurred in a grid from shore to a depth of 20 feet. Surveyors described substrate at 489 of these sites that occurred within the shore to the six foot water depth. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore fish sample stations and near-shore vegetation sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 67 of these stations. Near-shore vegetation sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 46 of these stations.

Substrate was evaluated by visual observation of the lake bottom. If this method was not feasible, surveyors evaluated substrate by tapping a pole into the lake bottom; soft

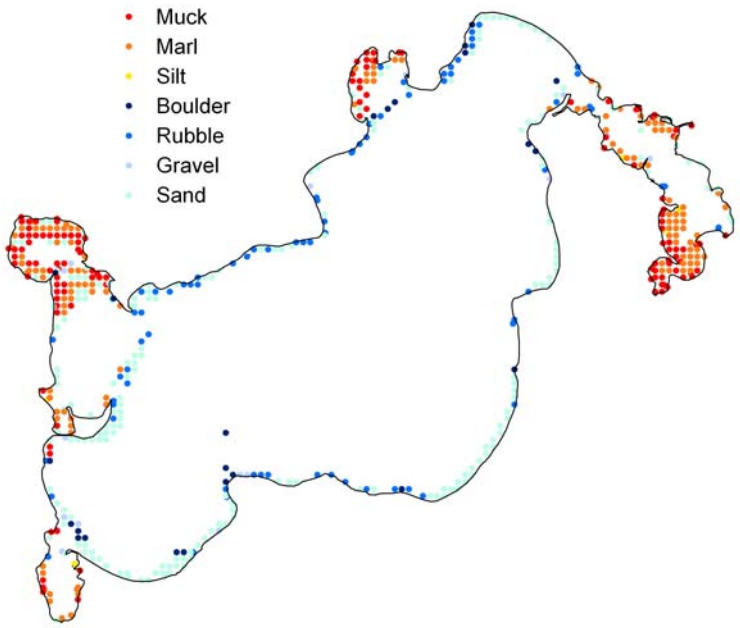
substrate could usually be brought to the surface on the pole or sampling rake for evaluation. Standard lake substrate classes were based on the DNR Lake Survey Manual (MN DNR 1993):

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

Substrate type varied somewhat between the main basin and the bays. The main basin was characterized by hard bottom substrates, and included sand, gravel, rubble and boulders (Figure 26). A sand-gravel reef occurred on the south side of Angel Island and extended north from the island. Boulders occurred across the entrances to Flower Pot Bay and Kenfield Bay and were also found along Forseman Point and the shoreline north of Park Point. Natural sand beaches occurred along shores of the main basin. Substrates within the bays were mainly muck, silt and marl. Overall, the dominant near-shore substrate type was sand, which comprised nearly 40% of the sampling sites.

Figure 26. Distribution of near-shore substrates around Ten Mile Lake, June 2006.



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
5. Estimate abundance of species of greatest conservation need and common species

Summary

Bird surveys of Ten Mile Lake were conducted between May 17 and July 1, 2007. Surveyors documented 82 different species of birds, including 17 species of greatest conservation need. Red-eyed vireos (*Vireo olivaceus*) were the most commonly detected bird species overall, whereas the veery (*Catharus fuscescens*) was the most frequently detected species of greatest conservation need. Although distribution of several species was restricted to the bays, others were found along the shoreline of the main basin as well. Maximum species diversity was 21 species at one survey point.

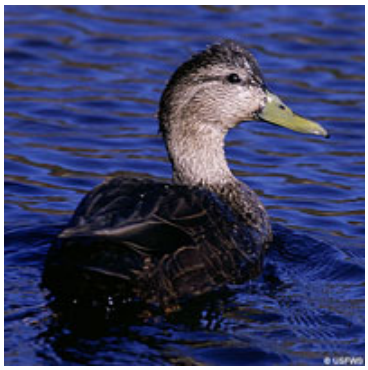
Introduction

Bird Species of Greatest Conservation Need

There are 97 bird species of greatest conservation need (SGCN) in Minnesota. SGCNs are documented in Minnesota's State Wildlife Action Plan, Tomorrow's Habitat for the Wild and Rare (2006). Seventeen of these species were identified at Ten Mile Lake.

American black ducks (*Anas rubripes*; Figure 27) are large dabbling ducks. The body is dark brown, rather than black, with a lighter brown head and neck and red or orange legs. Male and female black ducks are similar in plumage. They breed in a variety of habitats, from beaver ponds to sedge meadows. Populations have declined across their range, including in Minnesota, over the past 50 years. The decline is attributed mainly to the presence of mallards (*Anas platyrhynchos*), which readily hybridize with American black ducks and may outcompete them for breeding spots.

Figure 27. American black duck



Source: U.S. Fish and Wildlife Service

American white pelicans (*Pelecanus erythrorhynchos*; Figure 28) are large, white waterbirds weighing up to 30 pounds. They have black wingtips and an orange bill with a pouch. 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 28. American white pelican

Photo by: Carrol Henderson

Bald eagles (*Haliaeetus leucocephalus*; Figure 29) 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 8 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.

Figure 29. Bald eagle

Common loons (*Gavia immer*; Figure 30) 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. This large diving bird possesses red eyes and a large, dark pointed bill that is well-adapted for catching fish. 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 30. Common loon

Common nighthawks (*Chordeiles minor*; Figure 31) are most often seen in the air, exhibiting an erratic flight pattern as they forage for insects. They are cryptically colored with brown, gray, and white mottling. A white bar is visible across the wing when the bird is in flight. Originally found in open, rural areas, the nighthawk has adapted to urban settings and will even nest on gravel rooftops. Despite their adaptability, nighthawks have declined in some areas. Predation and a decreased insect food base due to the use of pesticides may be factors in this decline.

Figure 31. Common nighthawk

Photo by: Carrol Henderson

Common terns (*Sterna hirundo*; Figure 32) are the most widespread terns in North America. In the breeding season common terns have a solid black cap with gray back and underparts. The gray wings have dark edges. The rump is white, and the legs and bill are orange-red in color. Common terns nest in colonies, in wetland habitat such as marshes. Populations of common terns declined in the 1970s, likely due to poisoning by pesticides. Habitat loss, nest predation, and disturbance by humans may also negatively affect common terns.

Figure 32. Common tern

Photo by: Carrol Henderson

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. They are often found along water edges in mature, open woods. 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

Northern rough-winged swallows (*Stelgidopteryx serripennis*; Figure 35) are small, fairly common songbirds. They are brown on the head and back with a pale brown throat and white belly. The outer wing feathers, or primaries, have "hooks" on the edge, giving them a rough feel. These swallows are insectivorous and feed in the air, often over water. They will nest either singly or colonially near rocky or exposed banks of clay or sand. Open habitat is preferred for breeding. Northern rough-winged swallows are fairly adaptable and are even increasing in parts of their range. One rough-winged swallow nesting site was found on Ten Mile Lake.

Figure 35. Northern rough-winged swallow

Photo by: Dave Herr

Ovenbirds (*Seiurus aurocapillus*; Figure 36) are easily heard, but difficult to see, birds of the forest. 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

Source: U.S. Fish and Wildlife Service

Red-shouldered hawks (*Buteo lineatus*; Figure 37) are large hawks with broad wings and long tails. The upper part of the wing is rusty in color, and the back and tail are streaked with black. Reddish bars are present on the belly. Red-shouldered hawks are found in mixed decidouous-conifer woods with an open understory or riparian areas. Populations are projected to decline in the future because of the loss of large stands of mature hardwoods. Nesting birds are also sensitive to human disturbance.

Figure 37. Red-shouldered hawk

Photo by: Charles Mills

Rose-breasted grosbeaks (*Pheucticus ludovicianus*; Figure 38) 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 and meadows and woodlands, and suburban parks and gardens. Significant regional declines in rose-breasted grosbeak populations have been noted.

Figure 38. Rose-breasted grosbeak

Photo by: J.A. Spendelow

The swamp sparrow's (*Melospiza georgiana*; Figure 39) 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. 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. Swamp sparrow

Photo by: Jim Stasz

The veery (*Catharus fuscescens*; Figure 40) 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.

Figure 40. Veery

Photo by: Deanna Dawson

Virginia rails (*Rallus limicola*; Figure 41) are a rarely seen, ground-dwelling marsh bird. They have a rusty-colored breast and belly, brown-streaked back, and black and white barring on the flanks. The bill is reddish and slightly curved. The Virginia rail rarely flies, and spends most of its time walking through dense vegetation in freshwater marshes. Population information is limited, but several reports have indicated declines in some areas. The only sighting of this secretive bird on Ten Mile Lake was in Flower Pot Bay.

Figure 41. Virginia rail

Photo by: David Arbour

White-throated sparrows (*Zonotrichia albicollis*; Figure 42) are common in Minnesota during their spring and fall migrations. They are recognizable by the white patch on the throat and their characteristic "Old Sam Peabody Peabody Peabody" song. The head is striped with black and tan or white, and has a yellow spot above the eye. The chest is gray and the back is streaked with brown and black. They inhabit coniferous or mixed forests, and prefer areas with multiple openings and abundant low-growing vegetation. Although white-throated sparrows are widespread, they are declining over portions of their breeding range. Research into this decline will be important for the future of this species.

Figure 42. White-throated sparrow

Photo by: Dave Herr

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 43) 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 43. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Surveyors used several techniques to collect information on bird species. Point counts were conducted at 97 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 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

Surveyors identified 17 species of greatest conservation need at Ten Mile Lake. Common loons were the most abundant; surveyors documented 20 loons at 9 different stations. The veery was found at the greatest number of locations, with surveyors identifying this species at 14 stations. Bald eagles, least flycatchers, ovenbirds, rose-breasted grosbeaks, and swamp sparrows were all documented at 5 or more survey stations. The other species of greatest conservation need found at Ten Mile Lake were: American black duck, American white pelican, common nighthawk, common tern, golden-winged warbler, red-shouldered hawk, rough-winged swallow, Virginia rail, white-throated sparrow, and yellow-bellied sapsucker. With the exception of the Virginia rail, which was documented during a call-playback survey, and the American white pelican, red-shouldered hawk and yellow-bellied sapsucker, which were recorded when casually observing the lake, all species of greatest conservation need were identified during point count surveys.

Species of greatest conservation need were distributed around a variety of areas of the shoreline. Those species that were mainly aquatic in nature were found along both the western and northeastern shorelines (Figure 44), whereas forest habitat species were located at survey stations along the southern shoreline as well (Figure 45). Those species

that depend on marsh habitat were found in a number of different bays (Figure 46), as were bald eagles and a rough-winged swallow nest (Figure 47).

Surveyors recorded 67 bird species during the point count and call-playback surveys at Ten Mile Lake (Table 2). Fifteen additional species were recorded through casual observation, for a total of 82 species (Appendix 1). Red-eyed vireos were the most common species overall, and were found at more than 60% of the survey sites. American crows were second in abundance, and were identified at 56 of the 97 stations. Song sparrows, chipping sparrows, and red-winged blackbirds rounded out the top five most common species.

Figure 44. Distribution of aquatic habitat-dependent bird species of greatest conservation need, May – July 2007.

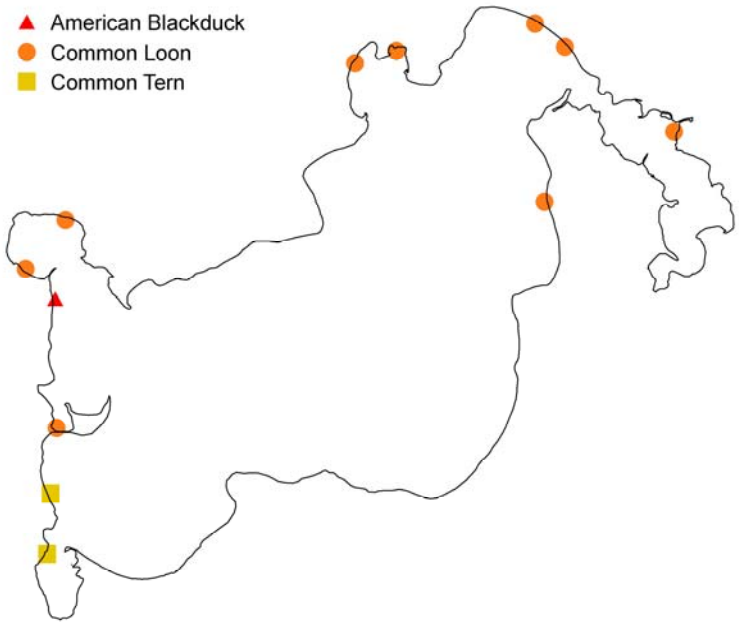


Figure 45. Distribution of forest habitat-dependent bird species of greatest conservation need, May – July 2007.

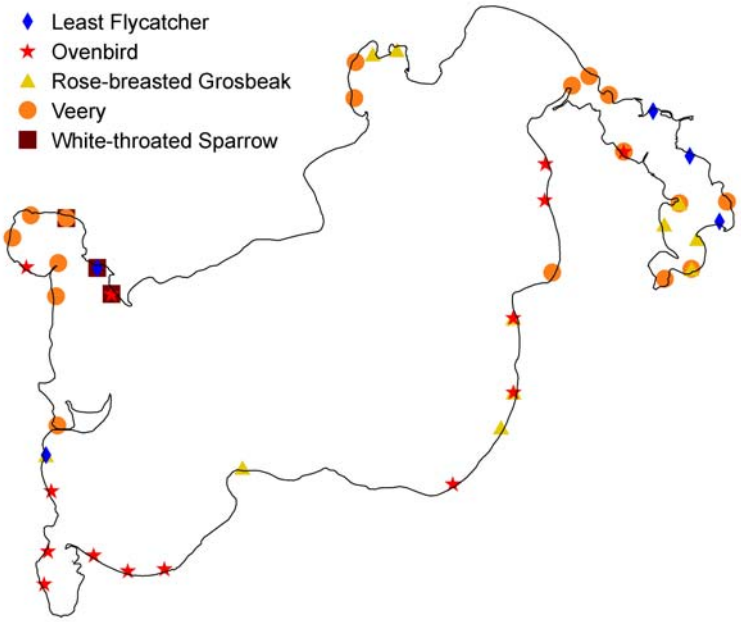


Figure 46. Distribution of wetland habitat-dependent bird species of greatest conservation need, May – July 2007.

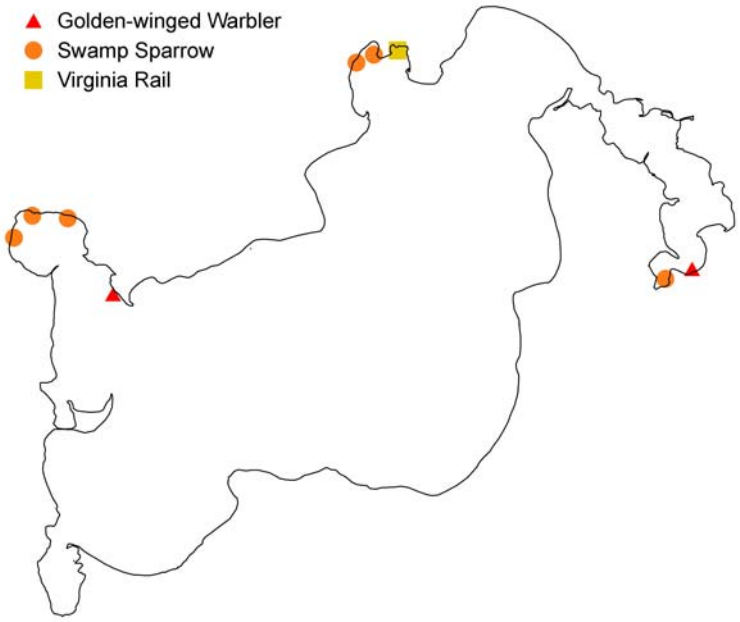


Figure 47. Distribution of bird species of greatest conservation need that occupy a variety of habitats, May – July 2007.

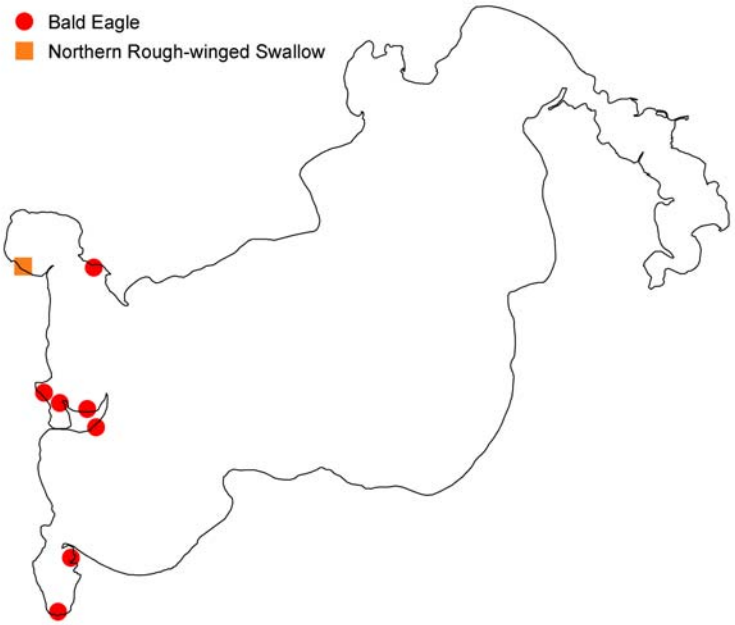


Table 2. Species list and frequency of occurrence of bird species identified during surveys, May – July 2007. * denotes a species of greatest conservation need.
[a] % – the percent of surveyed sample sites in which a bird species occurred

Family	Description	Common Name	Scientific Name	[a] %
Accipitridae	Hawks	Bald eagle*	*Haliaeetus leucocephalus*	7
		Broad-winged hawk	*Buteo platypterus*	1
Alcedinidae	Kingfishers	Belted kingfisher	*Megaceryle alcyon*	5
Anatidae	Waterfowl	American black duck*	*Anas rubripes*	1
		Canada goose	*Branta canadensis*	3
		Common goldeneye	*Bucephala clangula*	8
		Common merganser	*Mergus merganser*	7
		Mallard	*Anas platyrhynchos*	11
		Wood duck	*Aix sponsa*	1
Ardeidae	Herons/bitterns	Great blue heron	*Ardea herodias*	6
		Green heron	*Butorides virescens*	6
Bombycillidae	Waxwings	Cedar waxwing	*Bombycilla cedrorum*	2
Caprimulgidae	Goatsuckers	Common nighthawk*	*Chordeiles minor*	1
Cardinalidae	Grosbeaks/buntings	Rose-breasted grosbeak*	*Pheucticus ludovicianus*	12
Corvidae	Jays/crows	American crow	*Corvus brachyrhynchos*	58
		Blue jay	*Cyanocitta cristata*	30
Emberizidae	Warblers/sparrows	Chipping sparrow	*Spizella passerina*	39
		Song sparrow	*Melospiza melodia*	41
		Swamp sparrow*	*Melospiza georgiana*	7
		White-throated sparrow*	*Zonotrichia albicollis*	3
Falconidae	Falcons	Merlin	*Falco columbarius*	1
Fringillidae	Finches	American goldfinch	*Carduelis tristis*	15
		Pine siskin	*Carduelis pinus*	2
Gaviidae	Loons	Common loon*	*Gavia immer*	9
Hirundinidae	Swallows	Barn swallow	*Hirundo rustica*	16
		Purple martin	*Progne subis*	1
		Rough-winged swallow*	*Stelgidopteryx serripennis*	1
		Tree swallow	*Tachycineta bicolor*	25
Icteridae	Blackbirds/orioles	Baltimore oriole	*Icterus galbula*	15
		Brown-headed cowbird	*Molothrus ater*	1
		Common grackle	*Quiscalus quiscula*	26
		Red-winged blackbird	*Agelaius phoeniceus*	36
Laridae	Gulls/terns	Common tern*	*Sterna hirundo*	2
		Ring-billed gull	*Larus delawarensis*	2
Mimidae	Mockingbirds/thrashers	Gray catbird	*Dumetella carolinensis*	8
Paridae	Chickadees/titmice	Black-capped chickadee	*Poecile atricapilla*	9

Table 2, cont.

Family	Description	Common Name	Scientific Name	%
Parulidae	Warblers	American redstart	*Setophaga ruticilla*	16
		Black-and-white warbler	*Mniotilta varia*	11
		Black-throated green	*Dendroica virens*	1
		Common yellowthroat	*Geothlypis trichas*	13
		Chestnut-sided warbler	*Dendroica pensylvanica*	19
		Golden-winged warbler*	*Vermivora chrysoptera*	2
		Nashville warbler	*Vermivora ruficapilla*	1
		Ovenbird*	*Seiurus aurocapilla*	14
		Yellow warbler	*Dendroica petechia*	31
Picidae	Woodpeckers	Downy woodpecker	*Picoides pubescens*	1
		Hairy woodpecker	*Picoides villosus*	5
		Pileated woodpecker	*Dryocopus pileatus*	3
		Red-bellied woodpecker	*Melanerpes carolinus*	8
		Northern flicker	*Colaptes auratus*	3
Rallidae	Rails	Virginia rail*	*Rallus limicola*	1
Scolopacidae	Sandpipers/phalaropes	Spotted sandpiper	*Actitis macularius*	5
Sittidae	Nuthatches	Red-breasted nuthatch	*Sitta canadensis*	5
		White-breasted nuthatch	*Sitta carolinensis*	8
Strigidae	Typical owls	Barred owl	*Strix varia*	2
Thraupidae	Tanagers	Scarlet tanager	*Piranga olivacea*	2
Trochilidae	Hummingbirds	Ruby-throated hummingbird	*Archilochus colubris*	1
Troglodytidae	Wrens	House wren	*Troglodytes aedon*	4
Turdidae	Thrushes	American robin	*Turdus migratorius*	23
		Veery*	*Catharus fuscescens*	19
Tyrannidae	Flycatchers	Alder flycatcher	*Empidonax alnorum*	4
		Eastern kingbird	*Tyrannus tyrannus*	5
		Eastern phoebe	*Sayornis phoebe*	21
		Great crested flycatcher	*Myiarchus crinitus*	2
		Least flycatcher*	*Empidonax minimus*	5
Vireonidae	Vireos	Red-eyed vireo	*Vireo olivaceus*	61
		Warbling vireo	*Vireo gilvus*	2

Bird Species Richness

Objectives

1. Calculate and map bird richness around the shoreline of Ten Mile Lake

Summary

Species richness varied from one to 21 species at a single sampling station.

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.

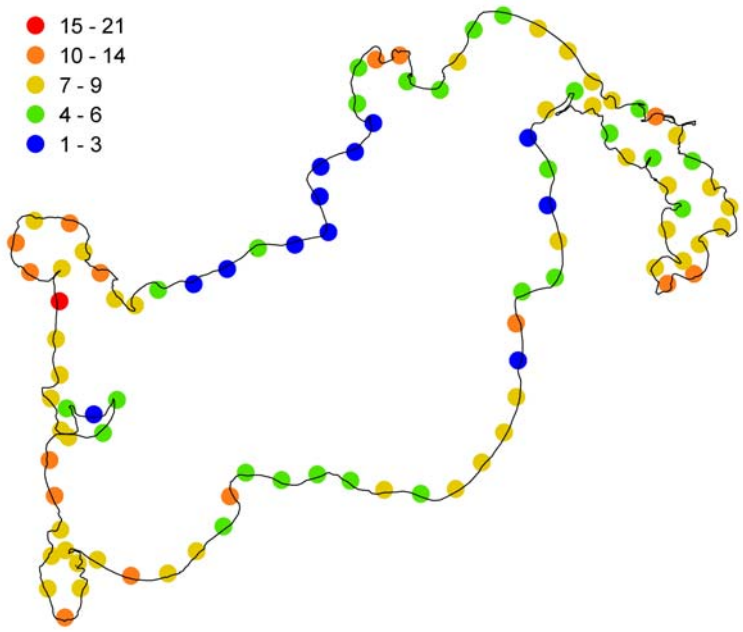
Methods

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

Maximum species diversity was 21 species at a single sample location. Sixteen additional sites contained 10 or more species. Less than 5% of the stations contained one or fewer species. The maximum number of SGCNs at a single sample site was four. Species richness was generally higher in the bays; however, multiple stations along the shoreline of the main basin did contain six or more species (Figure 48).

Figure 48. Bird species richness (number of species per sample site) at sample sites, May – July 2006.



Loon Nesting Areas

Objectives

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

Summary

Volunteer loon watchers have been reporting on Ten Mile Lake loon nesting sites since 1980. During that time, 22 reports have documented 11 probable different nesting sites in five areas of the lake.

Introduction

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.

Loon pair with chick

Photo by: Paul Bolstad

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.

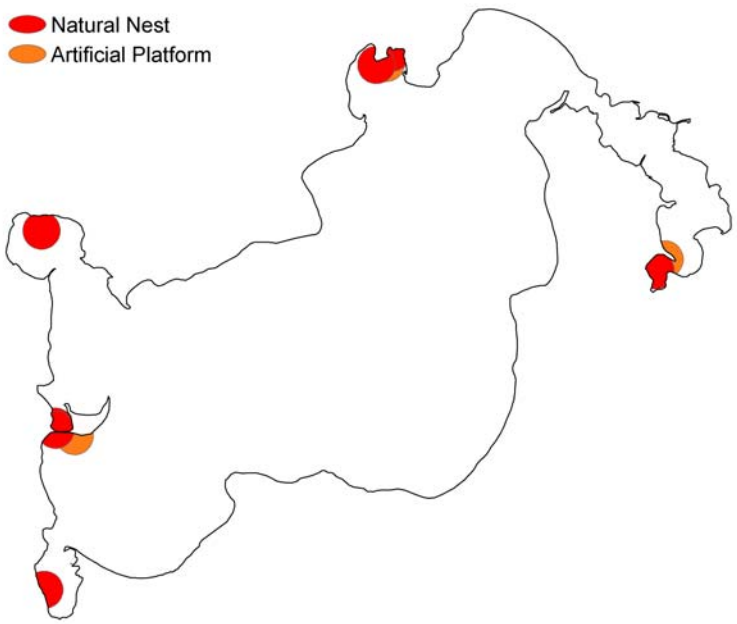
Methods

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.

Results

Between 1980 and 2007, volunteers identified 11 probable loon nesting sites. Of these, eight were natural nests and three were manmade loon platforms (Figure 49). All documented nests were located within bays. Three nests were identified as active nests in 2007. These nests were located in Long Bay, Flower Pot Bay, and Lundstrom's Bay.

Figure 49. Location of natural loon nests and manmade loon platforms recorded on Ten Mile Lake between 1980 and 2007.



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

Summary

Aquatic frog surveys of Ten Mile Lake were conducted between June 20 and June 27, 2006. Surveyors visited 97 stations located around the lakeshore. Mink frogs were heard calling at 30 of the stations, and green frogs were heard at 16 stations. Abundance of both species ranged from 0 to between 20 – 100 individuals. Gray tree frogs were also heard, for a total of 3 species documented. The vast majority of the green and mink frogs heard were located in bays.

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.

Mink frogs (Figure 50) 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 50. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

Green frogs (Figure 51) 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.

Figure 51. Green frog

Photo by: Jeff LeClere, www.herpnet.net

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 the most common frog species found during the surveys, detected at 30 of the 97 sites. Estimates of abundance for mink frogs ranged from 1 individual (at 8 sites) to 20 – 100 individuals (at 3 sites; Figure 52). Index values were 1 or 2 (individuals distinct to individuals with some overlap of calls). Mink frogs occurred along the western shore of Ten Mile Lake as well as in several areas along the northern and northeastern shoreline (Figure 54). Surveyors heard green frogs at 16 sites. They were found exclusively in the eastern portion of the lake, and were concentrated in the bays (Figure 54). Abundance estimates varied from 1 individual (at 2 sites) to 20 – 100 individuals (at 3 sites; Figure 53), and index values ranged from 1 to 2. Both mink and green frog detections were closely associated with the presence of waterlily beds.

Other species

The only additional anuran species heard during the surveys was the gray treefrog (*Hyla versicolor*). All detections were in or near Flower Pot Bay, and all index values equaled two. Other frog or toad species that may be found near Ten Mile Lake, such as wood frog (*Rana sylvatica*), spring peeper (*Pseudacris crucifer*), chorus frog (*Pseudacris triseriata*), leopard frog (*Rana pipiens*), and American toad (*Bufo americanus*), breed earlier in the year and are not strongly associated with larger lakes.

Figure 52. Abundance of mink frogs heard during surveys, June 2006.

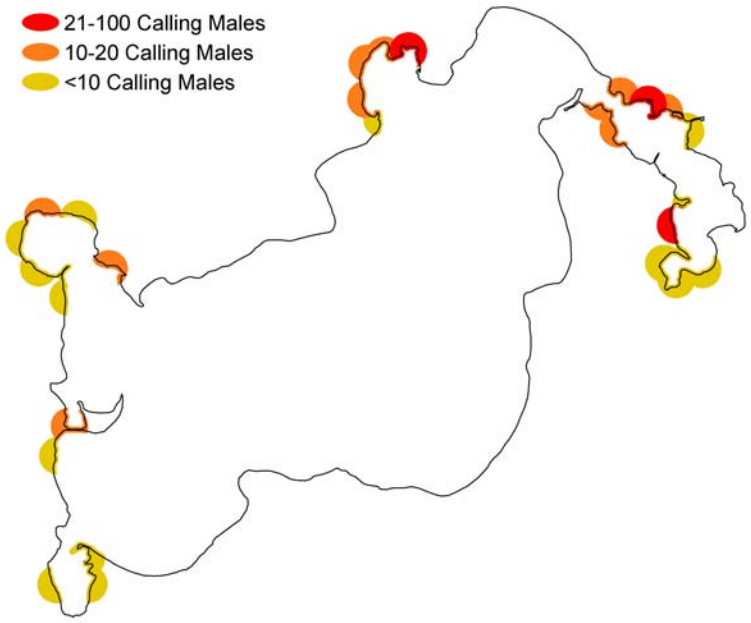


Figure 53. Abundance of green frogs heard during surveys, June 2006.

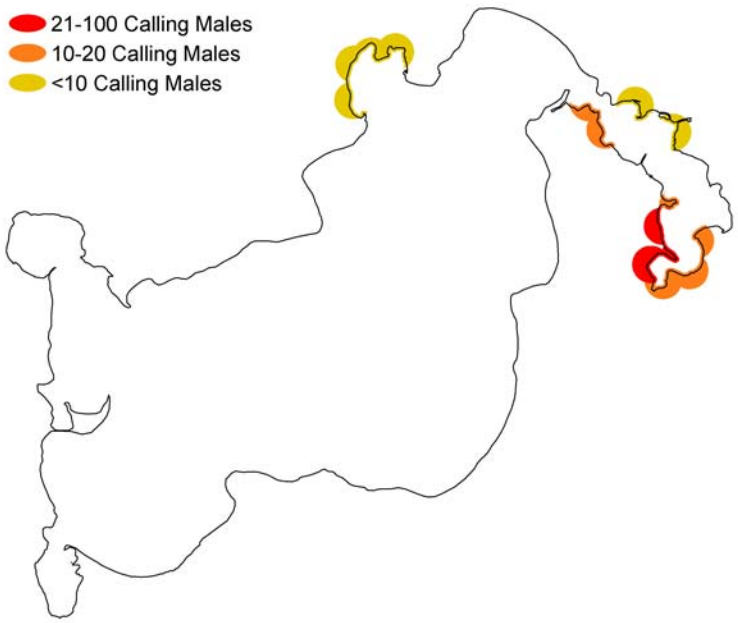
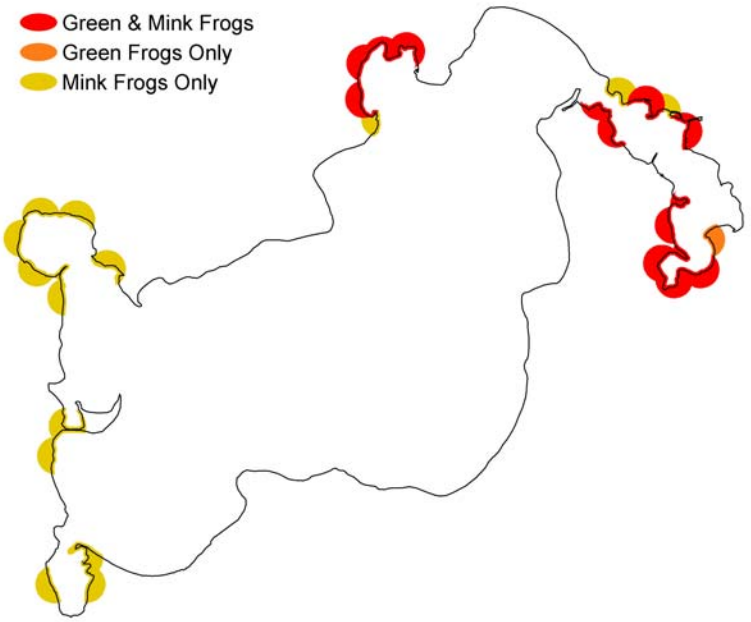


Figure 54. Distribution of mink and green frogs, June 2006.



Nongame Fish Surveys

Objectives

1. Record presence and abundance of fish species of greatest conservation need, including pugnose shiner (*Notropis anogenus*), least darter (*Etheostoma microperca*), and longear sunfish (*Lepomis megalotis*)
2. Record presence and abundance of proxy species, including blackchin shiner (*Notropis heterodon*), blacknose shiner (*Notropis heterolepis*), and banded killifish (*Fundulus diaphanus*)
3. Develop distribution maps for species of greatest conservation need and proxy species
4. Identify habitat (substrate and aquatic vegetation biovolume) associated with presence and absence of species of greatest conservation need and proxy species
5. Identify near-shore fish assemblages

Summary

Nongame fish surveys of Ten Mile Lake were conducted between August 14 and September 20, 2006. Surveyors visited 67 stations located around the lakeshore. All three species of greatest conservation need were detected. Pugnose shiners were most common, with 36 specimens found at 11 sites. All three proxy species were also detected. Blacknose shiners were found most frequently; surveyors found 237 individuals at 16 different sites. A total of 31 fish species were identified during the surveys. Five fish species that were not previously documented in the lake were collected for this survey, bringing the total observed fish community to 38 species.

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 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 (Figure 55) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess a distinctively upturned mouth that gives them a "pugnose" appearance. They inhabit clear lakes and low-gradient streams and are intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 55. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (Figure 56) 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* sp.) are a preferred habitat feature. Removal of vegetation, riparian area modification, and poor water quality all pose threats to the least darter.

Figure 56. Least darter

Photo by: Konrad Schmidt

Longear sunfish (Figure 57) are a deep-bodied fish reaching a length of 71 – 94 mm. The belly 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 prefers clear, shallow, vegetated areas and is intolerant of turbidity.

Figure 57. 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 SGCNs.

Blackchin shiners (Figure 58) 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.

Figure 58. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (Figure 59) 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. Habitat includes clean, well-oxygenated lakes and streams with plentiful vegetation and low turbidity and pollution.

Figure 59. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (Figure 60) 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 60. Banded killifish

Photo by: Konrad Schmidt

Methods

Fish surveys were conducted using Minnesota's Lakeshore Sensitive Area Survey Protocol. Fish survey stations were located 400 meters apart, and were the same stations used for surveying 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 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 of a sampling area that contained submerged aquatic vegetation.

Results

Rare fish and their proxies

All three fish species of greatest conservation need were recorded at Ten Mile Lake. Pugnose shiners were found at the greatest number of sites, with 36 individuals identified at 11 sites. Least darters were similarly frequent, with 26 individuals found at 10 sites. Only one longear sunfish was identified during the survey. Sensitivity of these species of concern prohibits disclosure of exact locations; they are identified in the figure as "rare fish" (Figure 61). All three proxy species were also documented during the surveys (Figure 62). Blacknose shiners were by far the most abundant species. Surveyors counted 237 individuals at 16 sampling locations. Blackchin shiners were less abundant; 7 sites contained 41 individuals. Banded killifish were found least frequently, with 11 sites containing fewer than 30 specimens.

As with the frogs, most of the target species were found within bays. Species of greatest conservation need were found in sites with varying substrate types. However, the majority were found at sites with soft substrate types such as muck or silt. Sites containing species of greatest conservation need also had more submerged aquatic vegetation than those without. Sites with SGCNs had an average biovolume of 50%, while sites without averaged 18%.

The presence of least darter, longear sunfish, and pugnose shiner at Ten Mile Lake indicates minimal disturbance along several sections of shoreline. The sheltered bays, in particular, provide the calm water and abundant aquatic vegetation required by these species. However, because populations of these species of concern are declining across their ranges, 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. These conditions will also benefit multiple game fishes, including bass, muskellunge, and northern pike.

In total, 31 different species were identified at the 67 sampling stations (Table 3). Mimic shiners were most abundant, with surveyors counting over 4000 specimens, including over 1000 at a single sampling station. Spottail shiners, bluegills, and yellow perch were also present in numbers greater than 1000. Five fish species that were not previously documented in the lake were collected for this survey, bringing the total observed fish community to 38 species. The five new species recorded included blackchin shiner, pugnose shiner, brook stickleback, least darter, and longear sunfish. Species richness varied among the sites. One site contained 16 species, and 27 sites had 10 or more species.

Figure 61. Distribution of fish species of greatest conservation need (pugnose shiner, least darter, and longear sunfish), August – September 2006.

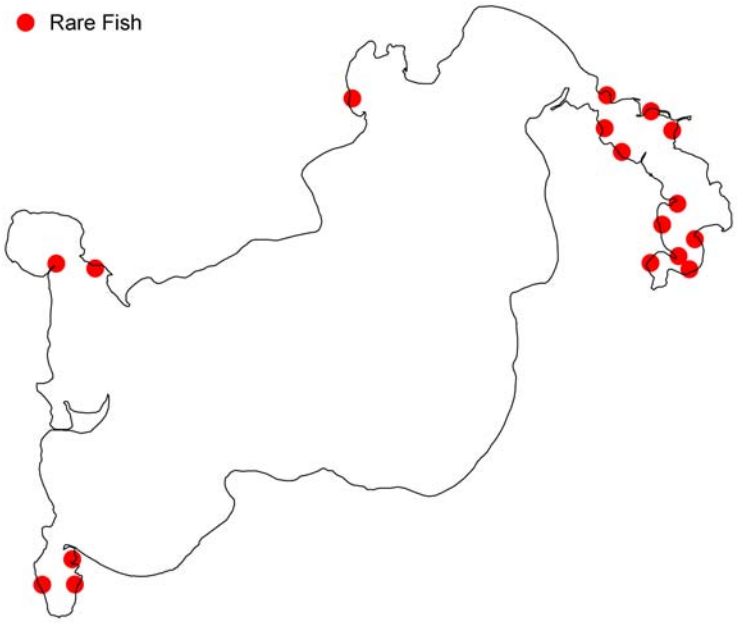


Figure 62. Distribution of proxy species, August – September 2006.

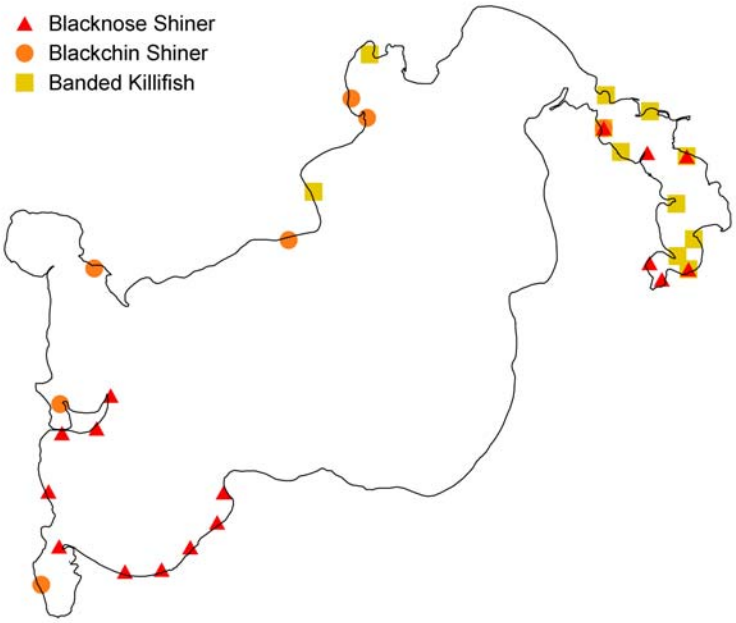


Table 3. Abundance and frequency of fish species identified during surveys, August – September 2006. * denotes species of greatest conservation need

[a] # – total number of individuals found

[b] % – percent of surveyed sample sites in which a species occurred

Family	Description	Common Name	Scientific Name	[a] #	[b] %
Amiidae	Bowfins	Bowfin	*Amia calva*	12	15
Catostomidae	Suckers	White sucker	*Catostomus commersonii*	3	5
Centrarchidae	Sunfishes	Black crappie	*Pomoxis nigromaculatus*	38	31
		Bluegill	*Lepomis macrochirus*	1309	90
		Largemouth bass	*Micropterus salmoides*	247	67
		Longear sunfish*	*Lepomis megalotis*	1	1
		Pumpkinseed	*Lepomis gibbosus*	205	67
		Rock bass	*Ambloplites rupestris*	387	78
		Smallmouth bass	*Micropterus dolomieu*	24	21
Cottidae	Sculpins	Mottled sculpin	*Cottus bairdii*	10	10
Cyprinidae	Minnows/carps	Blackchin shiner	*Notropis heterodon*	41	10
		Blacknose shiner	*Notropis heterolepis*	237	24
		Bluntnose minnow	*Pimephales notatus*	956	55
		Emerald shiner	*Notropis atherinoides*	1	1
		Longnose dace	*Rhinichthys cataractae*	47	13
		Mimic shiner	*Notropis volucellus*	4307	30
		Pugnose shiner*	*Notropis anogenus*	36	16
		Spottail shiner	*Notropis hudsonius*	1503	27
Esocidae	Pikes	Northern pike	*Esox lucius*	12	16
Fundulidae	Topminnows/ killifishes	Banded killifish	*Fundulus diaphanus*	28	16
Gasterosteidae	Sticklebacks/ tubesnouts	Brook stickleback	*Culaea inconstans*	3	4
Ictaluridae	North American freshwater catfishes	Black bullhead	*Ameiurus melas*	3	4
		Brown bullhead	*Ameiurus nebulosus*	28	21
		Yellow bullhead	*Ameiurus natalis*	236	57
Percidae	Perches	Iowa darter	*Etheostoma exile*	57	36
		Johnny darter	*Etheostoma nigrum*	176	39
		Least darter*	*Etheostoma microperca*	26	15
		Logperch	*Percina caprodes*	6	7
		Walleye	*Sander vitreus*	7	10
		Yellow perch	*Perca flavescens*	1147	73
Umbridae	Mudminnows	Central mudminnow	*Umbra limi*	336	31

Aquatic Vertebrate Richness

Objectives

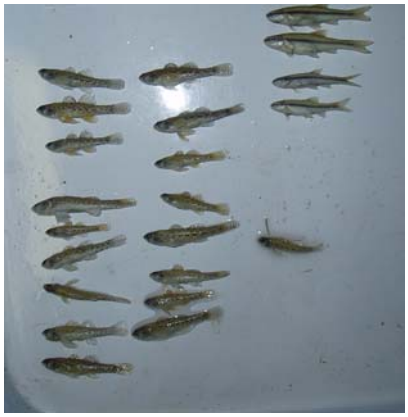
1. Calculate and map aquatic vertebrate richness around the shoreline of Ten Mile Lake

Summary

Species richness varied from two to 16 species at a single sampling station.

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.



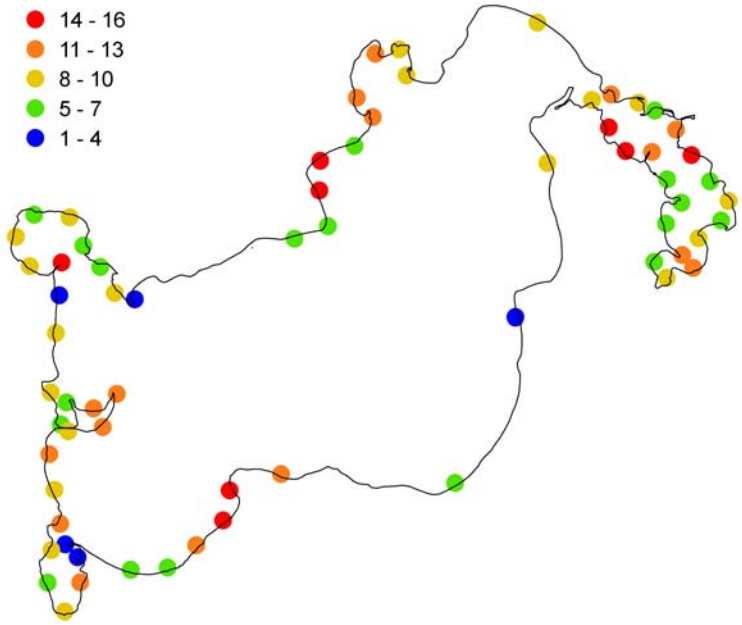
Methods

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

Species richness varied among the sites. Maximum species richness at a sampling station was 16 species, and 27 stations had 10 or more species. The majority of the documented species were fish, although mink frogs, green frogs, and painted turtles were also identified. All of the aquatic vertebrate species identified during the surveys were native. Species richness was generally highest in the bays (Figure 63).

Figure 63. Aquatic vertebrate species richness (number of species per sample site) at sample sites, August – September 2006.



Other Rare Features

Objectives

1. Map rare features occurring within the state-defined shoreland area of Ten Mile Lake

Summary

Three rare features have been documented near the shoreline of Ten Mile 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

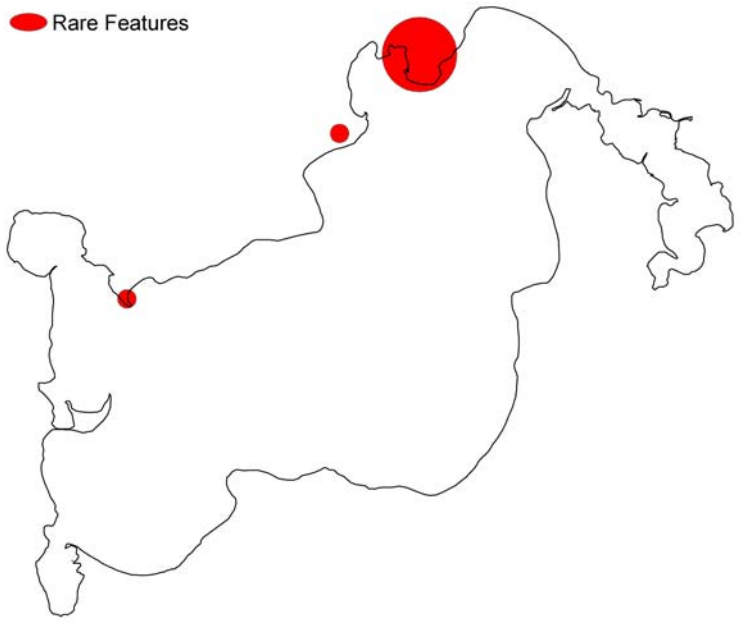
Researchers obtained locations of rare features from the Rare Features Database. Only "listed" animal species (Federal or State endangered, threatened, or special concern) were considered in this project; rare plant species were included in the "Unique Plant Species" section of this report. Rare features within 1320 feet of the shoreline were mapped using GIS. Varying buffer sizes around rare feature locations represent locational uncertainty.

Results

Three rare features have been documented near the shoreline of Ten Mile Lake (Figure 64). These features included bald eagle and red-shouldered hawk nests. The publication of exact locational information is prohibited in order to help protect these rare species.

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

Figure 64. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Ten Mile Lake shoreline.



Bay Delineation

Objectives

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

Summary

There were four isolated bays and one non-isolated bay in Ten Mile Lake.

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

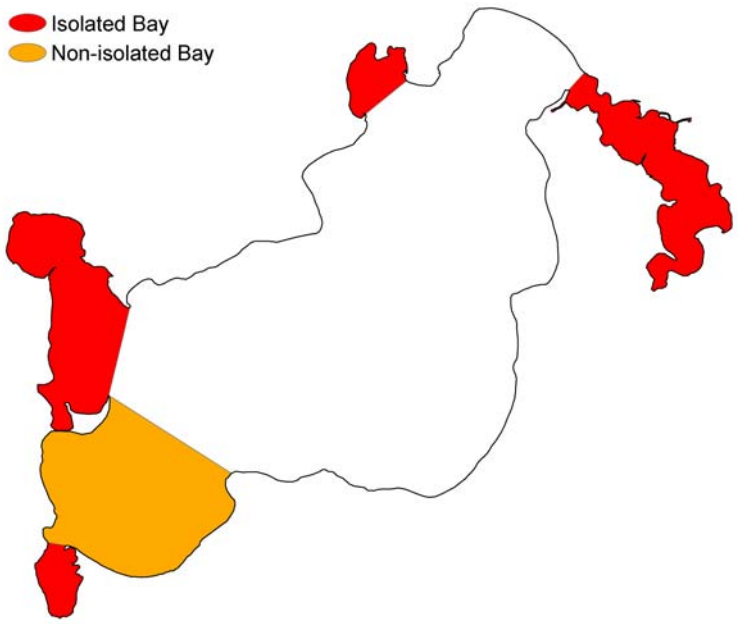
Bays were delineated using lake maps and aerial photos. Obvious bays (e.g., significant indentations of shoreline, bodies of water set off from main body or enclosed by land) were mapped based on inspection of lake maps. Additional bays were identified using aerial photos. Underwater shoals or reefs 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

Researchers identified four isolated bays and one non-isolated bay on Ten Mile Lake (Figure 65). Long Bay, Flower Pot Bay, and Kenfield Bay were all identified as isolated bays, as was a larger bay area that contained both Lundstrom's Bay and Robinson's Bay. A large, non-isolated bay was identified near Kenfield Bay in the southwestern corner of the lake.

Field surveys of aquatic plants, fish, frogs, and birds found that a large percentage of these species were located within bays. Of the 37 plant taxa that were found, 36 occurred in the bays. Over 90% of the mink and green frog detections were at sample stations within bays, and 95% of the loon nesting areas were in bays. All fish species of greatest conservation need found were within bays, and 75% of the bird SGCNs were within delineated bays.

Figure 65. Location of isolated and non-isolated bays.



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 4). 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 66). 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 67). 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 68).

Habitat Connectivity

In addition to the sensitive shorelands identified through the GIS model, surveyors considered adjacent river shorelines that provide habitat connectivity to and from the lake shorelands. As part of this consideration, they reviewed data from the Minnesota County Biological Survey (MCBS) of Cass County. Between 1992 and 1995, MCBS biologists conducted aerial photography interpretation and ground surveys to identify relatively large areas of intact native plant communities within Cass County (MN DNR 1998). The wetlands on the west side of Long Bay and the wetland along the Boy River connecting Long Bay to Birch Lake were originally identified as a potentially significant natural area (MN DNR 1998). This area was not included in the final MCBS prioritization of Cass County natural areas because there are extensive peatland systems in the northern part of the county. Nevertheless, this 250 acre wetland complex remains important because it is among the largest, relatively undisturbed marsh/wetland shrubland systems in the Leech Lake River Watershed.

In Ten Mile Lake, the Boy River and surrounding wetlands were identified as a potential ecological connection (Figure 68). These shorelands will also be forwarded to the local government.

Table 4. 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
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 Plants 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 and 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 SGCNs within analysis window
	2	Presence of 2 SGCNs
	1	Presence of 1 SGCN
	0	No SGCNs present

Bird Richness	3	Total number of bird species within analysis window > 18
	2	Total number of bird species 8 – 18
	1	Total number of bird species 1 – 7
	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
Fish	3	Presence of one or more SGCNs within analysis window
	2	Presence of one or more proxy species
	0	Neither SGCNs 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 66. Total score layer created by summing scores of all 15 variables. Highest total scores represent most sensitive areas of shoreline.

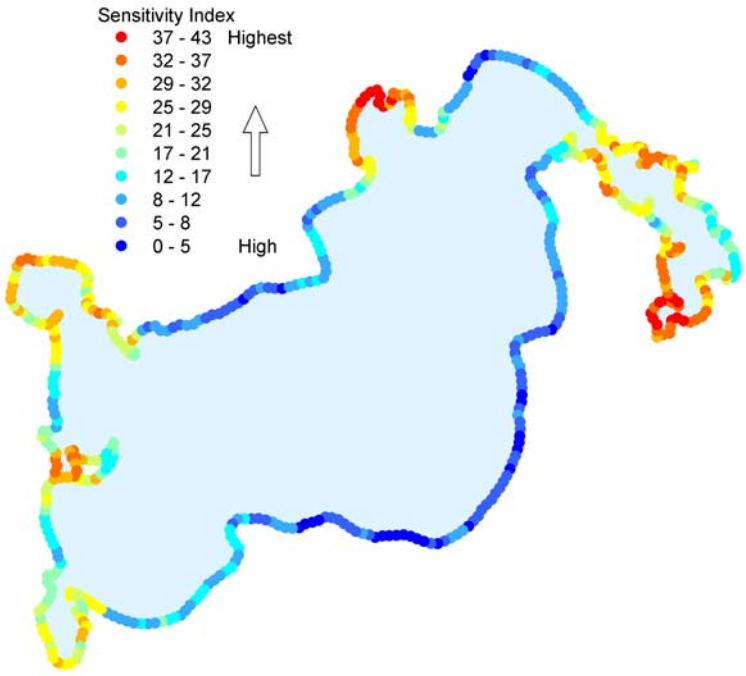


Figure 67. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland)

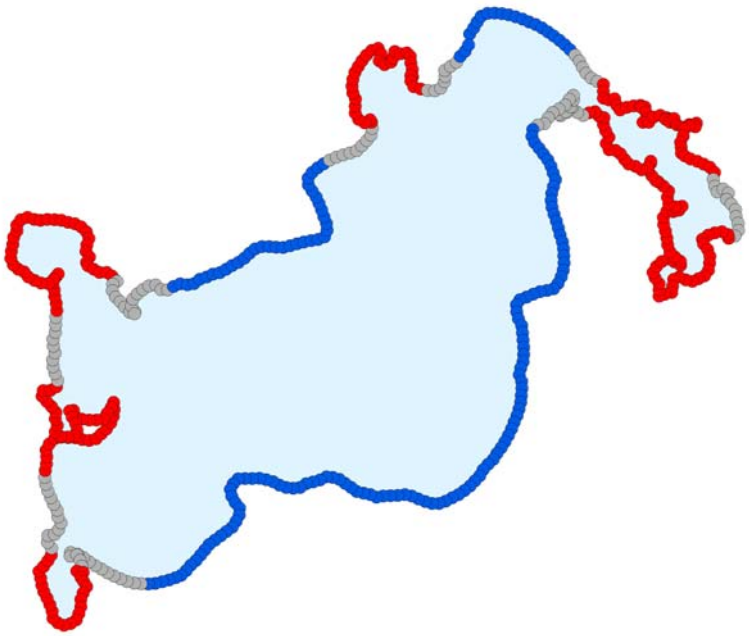
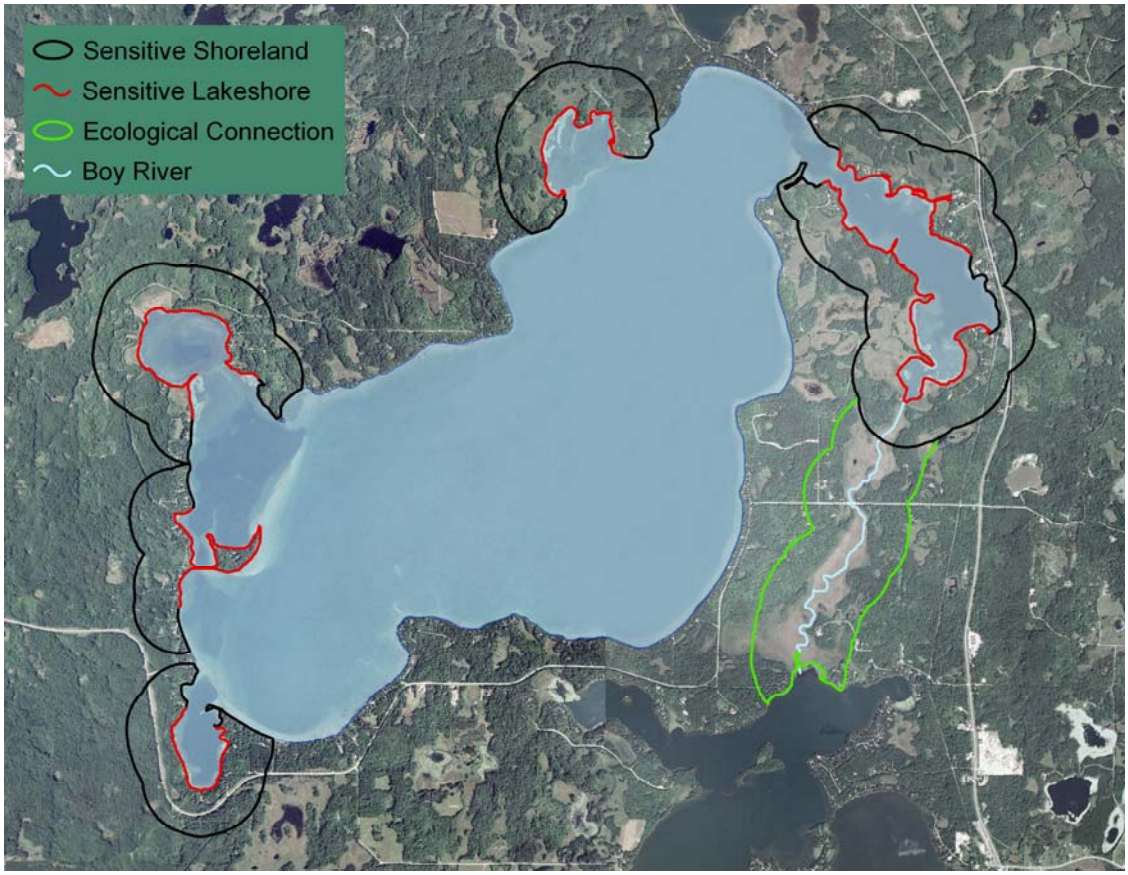


Figure 68. The sensitive lakeshore areas identified by the ecological model, and an ecological connection.



As the field surveys documented, the bays supported the greatest diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such as wetland habitat, was also present in the highest quantities near the bays. 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 has significant negative effects on many species. The most probable highly sensitive lakeshore areas also contain one area of important ecological connectivity between critical areas. Habitat connectivity allows movement of animals from various populations, increasing diversity. It allows animals with different vegetation requirements during different life stages to access those habitats. 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. 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 Ten Mile Lake, and the value of the lake itself.

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Appendix 1. Bird species list. Includes all species within Ten Mile Lake and shoreland recorded during surveys and casual observation, May – July 2007.

Common Name	Scientific Name
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Common Loon	*Gavia immer*
American White Pelican	*Pelecanus erythrorhynchos*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
Merlin	*Falco columbarius*
Virginia Rail	*Rallus limicola*
Sandhill Crane	*Grus canadensis*
Spotted Sandpiper	*Actitis macularia*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Sterna caspia*
Common Tern	*Sterna hirundo*
Black Tern	*Chlidonias niger*
Mourning Dove	*Zenaida macroura*
Barred Owl	*Strix varia*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle 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*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-throated Vireo	*Vireo flavifrons*
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*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Barn Swallow	*Hirundo rustica*

Appendix 1, cont.

Common Name	Scientific Name
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Sedge Wren	*Cistothorus platensis*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Swainson's Thrush	*Catharus ustulatus*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-throated Green Warbler	*Dendroica virens*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Scarlet Tanager	*Piranga olivacea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*