Final Report
Sensitive Lakeshore Survey
Pine Mountain Lake (11-0411-00)
Cass County, Minnesota

May 2009

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES

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

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

Prepared by
Kristin Thompson, Nongame Wildlife Biologist
Donna Perleberg, Aquatic Plant Ecologist
Stephanie Loso, Aquatic Biologist

Project manager
Paul Radomski

Surveys conducted by
Donna Perleberg, Aquatic Plant Ecologist
Paul Radomski, Project Manager
Kristin Thompson, Nongame Wildlife Biologist
Kevin Woizeschke, Nongame Wildlife Technician
Stephanie Loso, Aquatic Biologist/Intern
Lucas Wandrie, Natural Resources Specialist/Intern
Jesse Amo, Intern
Matt Brinkman, Intern
Rachel Bulman, Intern
Bethany Galster, Intern
Brent Vacinek, Intern

Rare plant surveys (2008): Karen Myhre, Botanist, Minnesota County Biological Survey Program

GIS technical guidance
Kevin Woizeschke, Nongame Wildlife Technician

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Executive Summary

Forty native aquatic plant species were recorded in Pine Mountain Lake, including 13 emergent, five floating-leaved, two free-floating and 20 submerged plants. Submerged plants were found to a depth of 20 feet but were most common from shore to the 10 feet depth where 95 percent of the sample sites contained vegetation. Emergent and floating-leaf plant beds ringed the lake and covered about 303 acres, or about 20 percent of the lake. Approximately 153 acres of bulrush (*Schoenoplectus* spp.), 105 acres of wild rice (*Zizania palustris*) and 45 acres of white and yellow waterlilies (*Nymphaea odorata* and *Nuphar variegata*) were mapped. Two unique aquatic plants, water arum (*Calla palustris*) and wiregrass sedge (*Carex lasiocarpa*), were documented during the surveys.

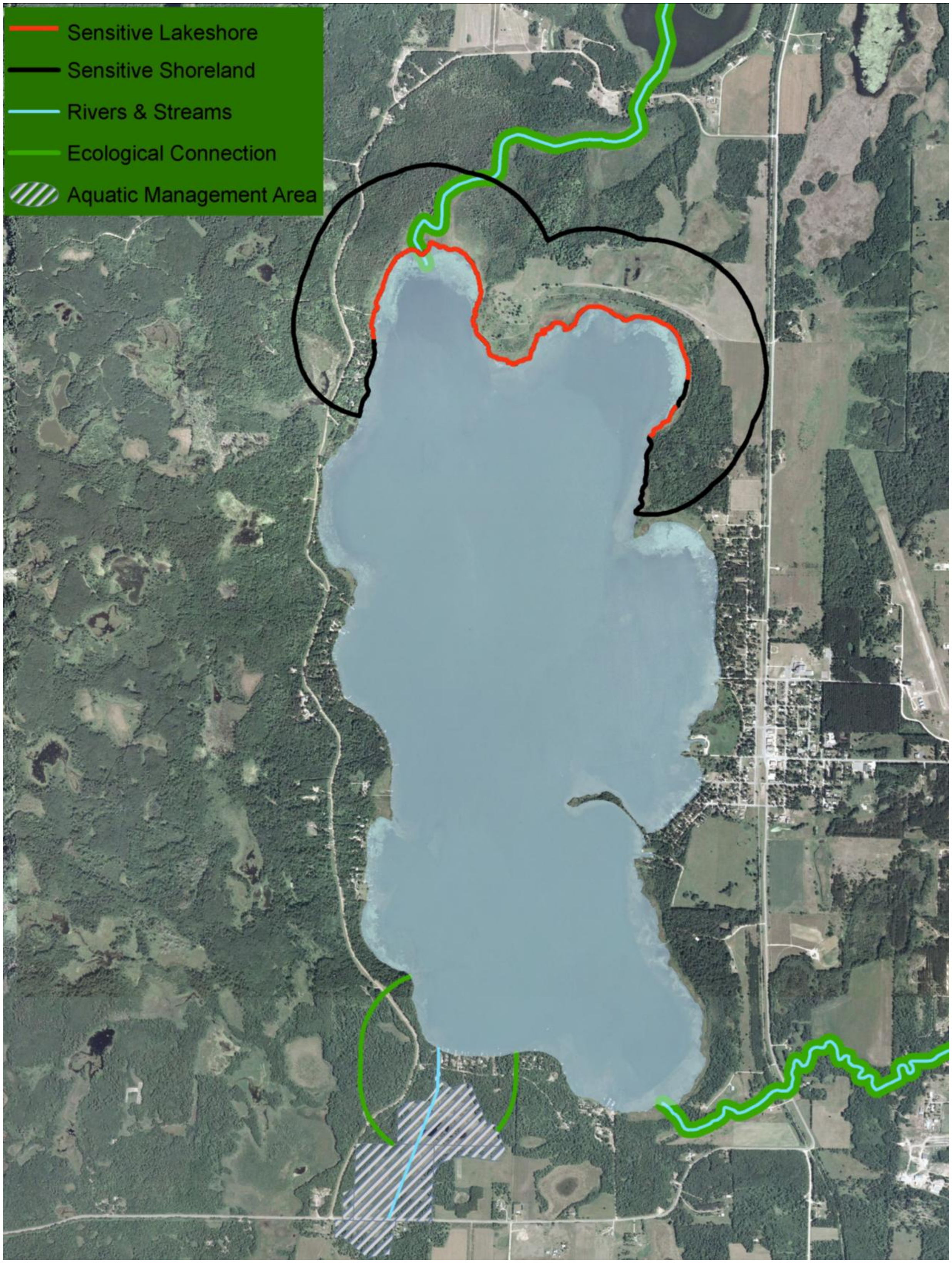
Eleven fish species previously not documented on Pine Mountain Lake were identified during the nongame fish surveys. These species were blackchin shiner, brook stickleback, central mudminnow, emerald shiner, golden shiner, Iowa darter, mimic shiner, mottled sculpin, spotfin shiner, spottail shiner, and tadpole madtom. Twenty-eight fish species were identified during the surveys, bringing the total historical observed fish community to 33 species. Mink frogs and green frogs were both documented on Pine Mountain Lake.

Seventeen bird species of greatest conservation need were identified at Pine Mountain Lake. Sixty additional species were documented, for a total of 77 bird species. Swamp sparrows and common loons were the most commonly documented species of greatest conservation need. Yellow warblers, red-winged blackbirds, and song sparrows were the most commonly identified species overall; surveyors documented each of these species at over 75 percent of the sample sites.

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

The ecological model identified one primary sensitive lakeshore area to be considered for potential resource protection districts by Cass County. Several rivers and streams near Pine Mountain Lake were identified as important ecological connections. 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 in 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 of 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 Pine Mountain Lake sensitive lakeshore areas.

Lake Description

Figure 1. Location of Pine Mountain Lake in Cass County, Minnesota.

Pine Mountain Lake (DOW 11-0411-00) located on the west side of the city of Backus, in Cass County, north-central Minnesota (Figure 1). The lake occurs in the northwest section of the Pine River Watershed and forms the headwaters for the main branch of the Pine River. A small stream enters the north side of Pine Mountain Lake and a second stream enters in the southwest corner (Figure 2). The main branch of the Pine River exits the southeast side of the lake and flows through a series of small lakes before reaching Whitefish Lake and eventually meeting the Mississippi River.

Pine Mountain Lake has a surface area of approximately 1,500 acres, and about 9.5 miles of shoreline. There is a public access located in a city park on the lake's east shore. The shoreline of Pine Mountain Lake is primarily forested and moderately developed with residential homes.

The lake has an irregular outline with several areas of extensive shallow water. It has a maximum depth of 80 feet and nearly half of the lake is less than 15 feet in depth (Figure 3).

Pine Mountain Lake is a mesotrophic lake, or a lake with moderate levels of nutrients. In 2004, a water quality study indicated that the lake was typical of minimally impacted lakes in the area (Lindon et al. 2005). The average Secchi depth (which measures water transparency) between 1998 and 2008 was 8.5 feet, indicating relatively high water clarity (MPCA 2008). The Minnesota DNR Section of Fisheries manages Pine Mountain Lake primarily for northern pike and walleye (MN DNR 2005).

Figure 2. Features of Pine Mountain Lake.

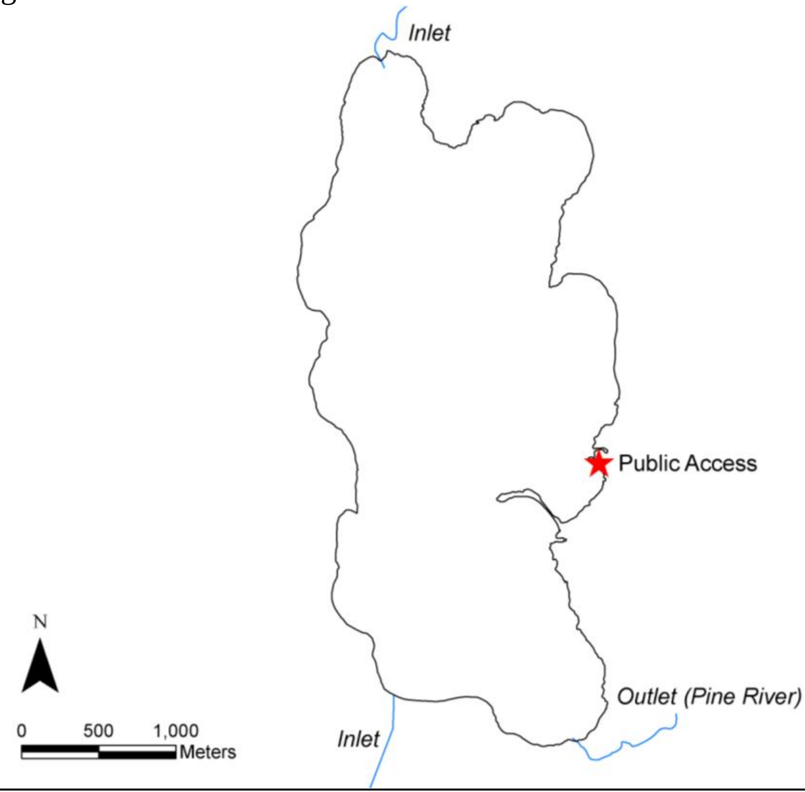
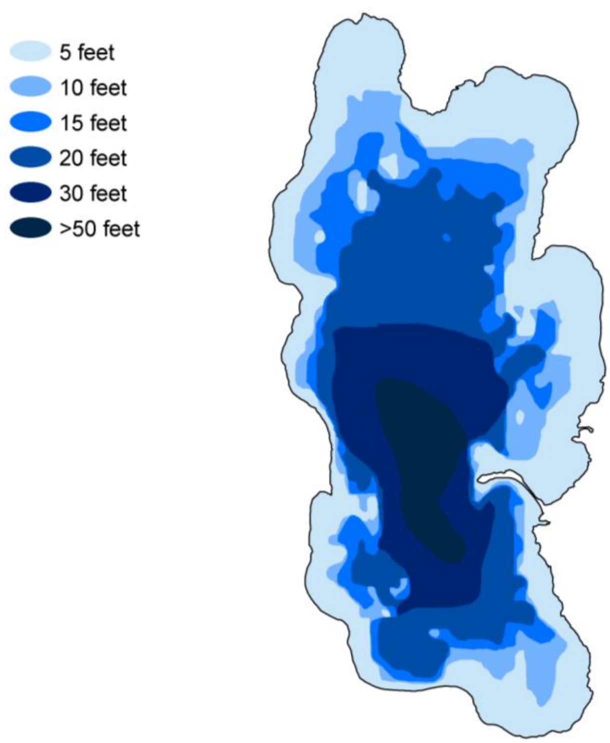


Figure 3. Depth contours of Pine Mountain Lake (based on 2007 data).



I. Field Surveys and Data Collection

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

Pugnose shiner photo courtesy of Konrad Schmidt

Wetlands

Objectives

1. Map wetlands within the extended state-defined shoreland area of Pine Mountain Lake

Introduction

Wetlands are important habitat types that provide a variety of services to the environment, to plants and animals, and to humans. Wetland vegetation filters pollutants and fertilizers, making the water cleaner. The roots and stems of wetland plants trap sediments and silt, preventing them from entering other water bodies such as lakes. They protect shorelines against erosion by buffering the wave action and by holding soil in place. Wetlands can store water during heavy rainfalls, effectively implementing flood control. This water may be released at other times during the year to recharge the groundwater. Wetlands also provide valuable habitat for many wildlife species. Birds use wetlands for feeding, breeding, and nesting areas as well as migratory stopover areas. Fish may utilize wetlands for spawning or for shelter. Numerous plants will grow only in the specific conditions provided by wetlands. Finally, wetlands provide a variety of recreational opportunities, including fishing, hunting, boating, photography, and bird watching.

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

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

Methods

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

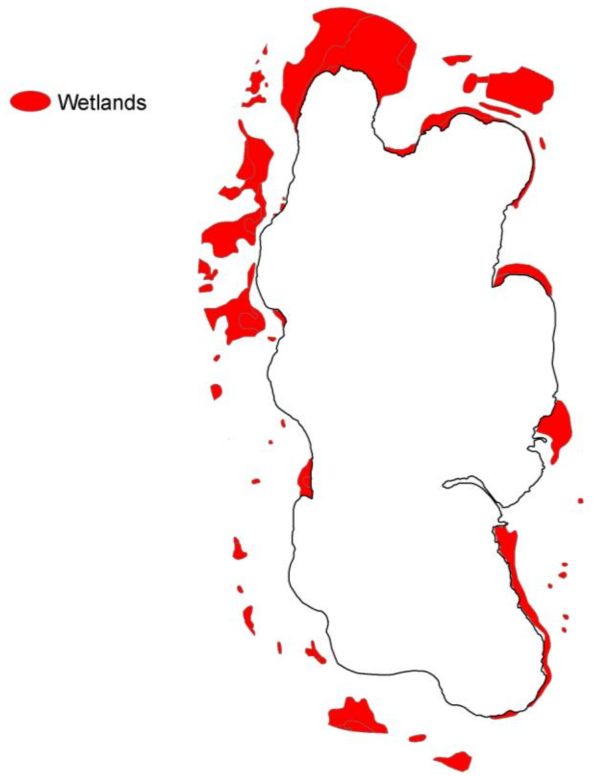
Results

Approximately 290 acres, or about 20 percent of the Pine Mountain Lake shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI. Wetlands were scattered along the Pine Mountain shoreline, but were most abundant along the northern and northwestern edges (Figure 4). Wetlands connect directly to the lake along 3.5 miles, or 35 percent of the Pine Mountain shoreline, including the north end of the lake and the southeast shoreline.

The largest wetlands were forested and shrub dominant wetland types were palustrine emergent and scrub-shrub systems (Cowardin et al. 1979).

Vegetation included perennial plants, shrubs, and deciduous trees. The water regime ranged from seasonally flooded to semi-permanently flooded.

Figure 4. Wetlands within 1320 feet of Pine Mountain Lake shoreline.



Hydric Soils

Objectives

1. Map hydric soils within the extended state-defined shoreland area of Pine Mountain 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.

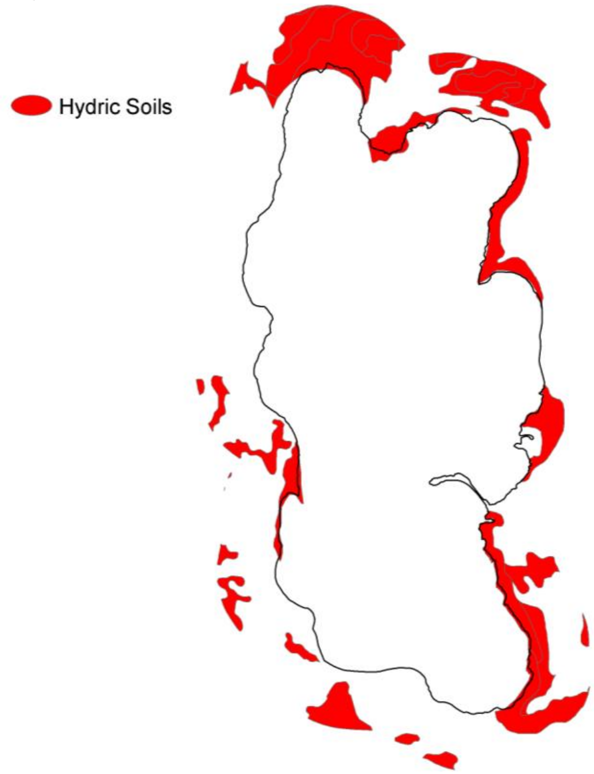
Methods

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

Nearly 375 acres of hydric soils occurred within the Pine Mountain Lake shoreland district. Some of the largest areas of hydric soils were located along the northern shoreline of the lake (Figure 5). Specific soil types included muck, peat, loam, and sand. Most soils were very poorly drained, and organic matter content ranged from moderate to very high.

Figure 5. Hydric soils within 1320 feet of Pine Mountain Lake shoreline.



Plant Surveys

Objectives

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

Summary

Plants occurred around the entire perimeter of Pine Mountain Lake and about 50 percent of the lake contained vegetation. Forty native aquatic plant species were recorded including 13 emergent, five floating-leaved, two free-floating and 20 submerged plants. Two unique emergent aquatic plants, water arum (*Calla palustris*) and wiregrass sedge (*Carex lasiocarpa*), were documented during the surveys. Fragments of the non-native species, curly-leaf pondweed (*Potamogeton crispus*) were found near the public water access (Myhre 2008), but rooted plants of this species have not been documented in the lake.

Submerged plants were found to a depth of 20 feet but were most common from shore to the 10 feet depth where 95 percent of the sample sites contained vegetation. Plant occurrence was sparse beyond the 15 feet depth. The two most common submerged plant species were muskgrass (*Chara* sp.) (39 percent occurrence within the shore to 20 feet depth zone) and coontail (*Ceratophyllum demersum*) (20 percent occurrence). Other submerged plants included flat-stem pondweed (*Potamogeton zosteriformis*), several broad-leaf pondweeds (*Potamogeton* spp.), and bushy pondweed (*Najas flexilis*).

Emergent and floating-leaf plant beds ringed the lake and covered about 303 acres, or about 20 percent of the lake. Approximately 153 acres of bulrush (*Schoenoplectus* spp.), 105 acres of wild rice (*Zizania palustris*) and 45 acres of white and yellow waterlilies (*Nymphaea odorata* and *Nuphar variegata*) were mapped.

Introduction

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity, water chemistry, water depth, substrate and wave activity. Deep or wind-swept areas may lack aquatic plant growth, whereas sheltered shallow areas may support an abundant and diverse native aquatic plant community that in turn, provides critical fish and wildlife habitat and other lake benefits.

The annual abundance, distribution and composition of aquatic plant communities may change due to environmental factors, predation, the specific phenology of each plant species, introductions of non-native plant or animal species, and human activities in and around the lake.

If non-native aquatic plants invade a lake, they may directly or indirectly impact the native plant community. Non-native plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that shade out native plants. The impact of these invasive species varies among lakes but the presence of a healthy native plant community may help mitigate the harmful effects of these exotics.

Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant growth if it results in changes to the overall water quality and clarity. Limiting these types of activities can help protect native aquatic plant species.

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

<u>Muskgrass</u> (*Chara* sp.; Figure 6) is a large algae that is common in many hard water Minnesota lakes. Large algae resemble higher plants but do not form flowers or true leaves, stems and roots. These plants grow entirely submerged, are often found at the deep edge of the plant zone (Arber 1920), and may form thick "carpets" on the lake bottom. Muskgrass has a brittle texture and is named for its characteristic "musky" odor. Beds of muskgrass provide important habitat for fish spawning and nesting. Muskgrass is adapted to a variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer.

Figure 6. Bed of muskgrass


<u>Coontail</u> (*Ceratophyllum demersum*; Figure 7) is the most common submerged flowering plant in Minnesota lakes. It grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is a perennial and can over-winter as a green plant under the ice before beginning new growth early in spring. Because it is only loosely rooted to the lake bottom it may drift between depth zones (Borman et al. 2001). Coontail provides important cover for young fish, including bluegills, perch, largemouth bass and northern pike. It also supports aquatic insects beneficial to both fish and waterfowl.

Figure 7. Coontail


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

Figure 8. Flat-stem pondweed

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 8) is a perennial plant that is anchored to the lake bottom by underground rhizomes and can over-winter by winter buds. It is named for its flattened, grass-like leaves. Depending on water clarity and depth, flat-stem pondweed may reach the water surface and produce flowers that extend above the water.

Figure 9. Illinois pondweed

Photo by: Allison Fox, Univ. of Florida. Copyright 2006.

Illinois pondweed (*Potamogeton illinoensis*; Figure 9) is a rooted, perennial plant with broad leaves. It is one of several pondweeds that are often called "cabbage" plants by anglers. These plants are primarily submerged but many will form floating leaves in shallower water. The fruits of pondweeds are a favorite duck food and the broad leaves provide food and shelter for fish. Illinois pondweed is found scattered throughout central Minnesota (Ownbey and Morley 1991).

Figure 10. Bushy pondweed

Bushy pondweed (*Najas flexilis*; Figure 10) is unusual because it is one of the few annual submerged species in Minnesota and must re-establish every year from seed. Bushy pondweed grows entirely below the water surface. It prefers hard substrates and is not tolerant of turbidity (Nichols 1999b). The seeds and foliage of this plant are an important duck food and beds of this plant provide good fish cover.

Floating-leaf and emergent plants

Floating-leaf and emergent aquatic plants are anchored in the lake bottom and their root systems often form extensive networks that help consolidate and stabilize bottom substrate. Beds of floating-leaf and emergent plants help buffer the shoreline from wave action, offer shelter for insects and young fish, and provide shade for fish and frogs. These beds are also sources of food, cover and nesting material for waterfowl, marsh birds and muskrat. Floating-leaf and emergent plants are most often found in shallow water to depths of about six feet and may extend lake-ward onto mudflats and into adjacent wetlands.

Figure 11. White waterlily

Floating-leaf plants include white waterlily (*Nymphaea odorata),* and yellow waterlily (*Nuphar variegata*). These are perennial plants that can reproduce by seed and by vegetative growth. Waterlilies typically over-winter by hardy rhizomes.

White and yellow waterlilies can be found in lakes in both northern and southern Minnesota. White waterlily (Figure 11) has showy white flowers and round leaves with radiating veins. Yellow waterlily (Figure 12) has smaller yellow flowers and oblong leaves with parallel veins. These species often co-occur in mixed beds but yellow waterlily is generally restricted to depths less than seven feet and white waterlily may occur to depths of ten feet (Nichols 1999b).

Figure 12. Yellow waterlily

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

Figure 13. Bulrush stand in Pine Mountain Lake, 2007.

Bulrush (*Schoenoplectus* spp.) are emergent, perennial plants that occur in lakes and wetlands throughout Minnesota (Ownbey and Morley 1991). Bulrush stems are round in cross section and lack showy leaves (Figure 13). Clusters of small flowers form near the tips of long, narrow stalks. This emergent may occur from shore to water depths of about six feet and its stems may extend several feet above the water surface. Bulrush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans.

Figure 14. Emergent stage of wild rice in flower

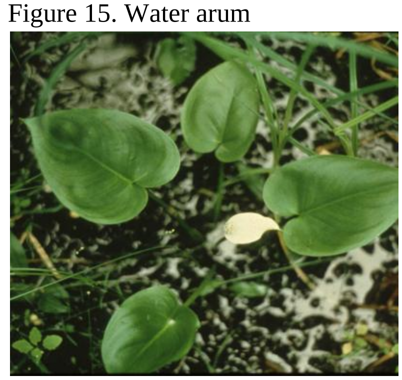
Wild rice (*Zizania palustris*) is an emergent annual plant (Figure 14) that reproduces each year from seed set in the previous fall. Wild rice is most commonly found in lakes of central and northern Minnesota. Cass County is one of five Minnesota counties with the highest concentration of lakes supporting natural wild rice stands (MN DNR 2008b). Wild rice generally requires habitat with some water flow, such as lakes with inlets and outlets. This plant most often is found in water depths of 0.5 to three feet in soft substrates (MN DNR 2008b). Wild rice is one of the most important waterfowl foods in North America and is used by more than 17 species of wildlife listed by the MN DNR as "species of greatest conservation need" (MN DNR 2008b). Other ecological benefits associated with wild rice stands include habitat for fish and aquatic invertebrates, shoreline protection and stabilization, and nutrient uptake. This plant also has special cultural and spiritual significance to the Ojibwe people and wild rice harvest provides important economic benefits to local economies (MN DNR 2008b)

Unique aquatic plants

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

1. 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.
2. Plant 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.

Figure 15. Water arum



Water arum (*Calla palustris*; Figure 15) 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 1993+). Within Minnesota, water arum primarily occurs in the northeast half of the state (Ownbey and Morley 1991).

Figure 16. Wiregrass sedge

Wiregrass sedge (*Carex lasiocarpa*; Figure 16) is an emergent, perennial plant. As its name implies, it is 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 1993+) 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 can potentially occur in a lake (Moyle 1945), and thus, indirectly influences lakewide species richness. The trophic status of a lake also 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 (Stuckey 1971, Nicholson 1981, Niemeier and Hubert 1986) and shoreland development (Meredith 1983).

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

Methods

The aquatic plant communities of Pine Mountain Lake were described and measured using several techniques as found in Minnesota's Sensitive Lakeshore Identification Manual. Plant nomenclature follows MNTaxa 2009.

Grid point-intercept survey
A grid point-intercept survey was conducted on Pine Mountain Lake in late August 2007 (Perleberg and Loso 2009). A GIS computer program was used to establish aquatic plant survey points throughout the littoral (i.e., vegetated) zone of the lake to a depth of 20 feet. Points were spaced 65 meters apart and 829 sites were sampled. Surveyors navigated to each site using a handheld Global Positioning System (GPS) unit. At each sample site, water depth was recorded and all vegetation within a one-meter squared sample area was sampled using a double-headed garden rake. All aquatic plant species present within the sample plot were recorded and frequency of occurrence was calculated for each species. Any additional species found outside the sample plots were recorded as present in the lake. Voucher specimens were collected for most species and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Emergent and floating-leaf bed delineation
Protocol for mapping plant beds were based on the procedures documented in the DNR draft Aquatic Vegetation Mapping Guidelines (MN DNR 2005b). 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 bulrush beds, which were difficult to see on aerial photos. Bulrush beds were mapped in 2007 using handheld GPS technology. Reconnaissance surveys were conducted of other plant beds to verify species composition and, if needed, modify boundary lines.

Near-shore vegetation surveys
Near-shore vegetation surveys were conducted at six plots in August 2008. Plots were selected based on the presence of nongame fish. Each plot measured 15 meters along the shoreline and 16 meters lakeward, and 30 (one-meter squared) sites were sampled within each plot. Surveyors recorded plant species present, water depth, substrate and presence of woody debris.

Searches for unique and rare plant species

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

Surveyors searched for unique and rare plant species in 2007 during the lakewide point-intercept surveys and in 2008 during the near-shore plot surveys. If unique or rare plant species were located, surveyors recorded the site location, the plant species found, associated plant species, approximate water depth and substrate type. Any new sites of rare plant species were documented and entered into the MN DNR Natural Heritage Information System.

A targeted search for rare aquatic vascular plants in Pine Mountain Lake was conducted by the Minnesota County Biological Survey Program on July 7, 2008 (Myhre 2008). This search focused on sites that were most likely to contain rare plant species. Botanists used professional experience to select rare species search sites and included factors such as shoreline development, substrate type, water depth, and natural community type in their site selection. To gain access to shallow vegetated areas, searches were conducted by slowly kayaking, canoeing and/or wading through the site.

A brief habitat description and a list of all plant taxa found in the search area were recorded. When necessary, plant specimens were sent to the authority in the field for identification verification and annotation. Voucher specimens were collected to document county records and several additional species, and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Results

Distribution of plants by water depth

Submerged plants were found from shore to a maximum depth of 20 feet and within that depth zone, 66 percent of the sites were vegetated (Figure 17). Plants were common in the shore to 15 feet depth zone where 81 percent of the sites were vegetated. This vegetated zone covers about 737 acres, or 46 percent of the lake. Emergent and floating-leaved plant beds ringed the shoreline and were mostly restricted to water depths of five feet and less.

Aquatic plant species observed

A total of 40 native aquatic plant taxa were recorded in Pine Mountain Lake. These included 22 submerged or free-floating taxa (Table 1), five floating-leaved, and 13 emergent taxa (Table 2). An additional 26 shoreline emergent taxa were also recorded (Appendix 1).

Figure 17. Distribution of aquatic plants in Pine Mountain Lake, 2007.

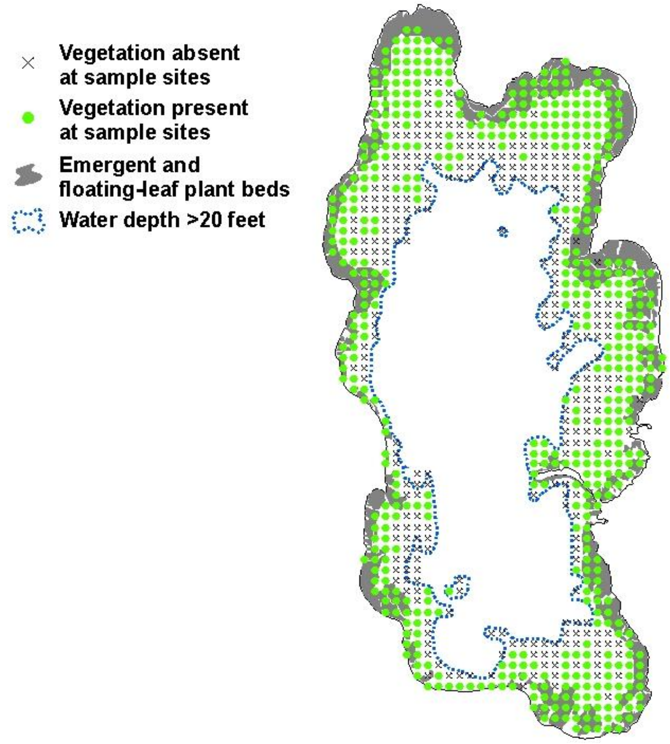


Table 1. Submerged and free-floating aquatic plants recorded in Pine Mountain Lake, 2007-2008.

Description		Common Name	Scientific Name	Frequency[a] N = 829
SUBMERGED and/or FREE-FLOATING	Algae and mosses	Muskgrass	*Chara* sp.	39
		Watermoss	Not identified to genus	2
		Stonewort	*Nitella* sp.	<1
	Dissected-leaf plants	Coontail	*Ceratophyllum demersum*	20
		Greater bladderwort	*Utricularia vulgaris*	7
		Northern watermilfoil	*Myriophyllum sibiricum*	3
		White water buttercup	*Ranunculus aquatilis*	<1
	Grass-leaf plants	Flat-stem pondweed	*Potamogeton zosteriformis*	18
		Wild celery	*Vallisneria americana*	1
		Water stargrass	*Zosterella dubia*	<1
	Broad-leaf plants	Illinois pondweed	*Potamogeton illinoensis*	11
		Variable pondweed	*Potamogeton gramineus*	5
		White-stem pondweed	*Potamogeton praelongus*	2
		Clasping-leaf pondweed	*Potamogeton richardsonii*	1
		Large-leaf pondweed	*Potamogeton amplifolius*	<1
		Curly-leaf pondweed	*Potamogeton crispus*	Present[c]
	Small-leaf plants	Bushy pondweed	*Najas flexilis*	10
		Canada waterweed	*Elodea canadensis*	8
	Narrow-leaf plants	Narrow-leaf pondweed	*Potamogeton* sp.[d]	4
		Fries' pondweed	*Potamogeton friesii*	2
		Small pondweed	*Potamogeton pusillus*	Present[b]
		Sago pondweed	*Stuckenia pectinata*	2
	Free-Floating	Star duckweed	*Lemna trisulca*	4
		Greater duckweed	*Spirodela polyrhiza*	<1

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

[b]Present = Located in lake in 2007 but not found at point-intercept sample stations.

[c]Non-native species. Located only during Minnesota County Biological Survey, 7 July 2008 (this plant was found floating near the public water access; rooted plants have not been documented in the lake).

[d]Although *Potamogeton friesii* (Fries' pondweed) and *P. pusillus* (small pondweed) were identified in the lake, some specimens of "narrow-leaved pondweeds" could not be identified to the species level. Those plants were grouped as "unidentified narrow-leaf pondweeds" (*Potamogeton* sp.) and are not counted in the species tally.

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaved and emergent aquatic plants recorded in Pine Mountain Lake, 2007-2008.

Description		**Common Name**	**Scientific Name**	**Frequency[a] N = 829**
FLOATING-LEAF		Yellow waterlily	*Nuphar variegata*	3
		White waterlily	*Nymphaea odorata*	2
		Floating-leaf pondweed	*Potamogeton natans*	1
		Floating smartweed	*Persicaria amphibian*	Present[b]
		Narrow-leaf burreed	*Sparganium emersum*	Present[b]
EMERGENT	Narrow-leaf emergents	Hardstem bulrush	*Schoenoplectus acutus*	16
		Three-square bulrush	*Schoenoplectus pungens*	<1
		Spikerush	*Eleocharis* sp.	<1
		Needlegrass	*Eleocharis* sp.	<1
		Horsetail	*Equisetum fluviatile*	<1
	Leafy emergents	Wild rice	*Zizania palustris*	6
		River bulrush	*Bolboschoenus fluviatilis*	Present[c]
		Giant cane	*Phragmites australis*	<1
		Arum-leaved arrowhead	*Sagittaria cuneata*	Present[b]
		Arrowhead	*Sagittaria latifolia*	1
		Giant burreed	*Sparganium eurycarpum*	Present[b]
		Narrow-leaf cattail	*Typha angustifolia*	<1
		Broad-leaf cattail	*Typha latifolia*	<1

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

[b]Present = Present in lake but not found at point-intercept sample stations.

[c]Located only during Minnesota County Biological Survey, 7 July 2008

Nomenclature follows MNTaxa 2009.

Submerged plants

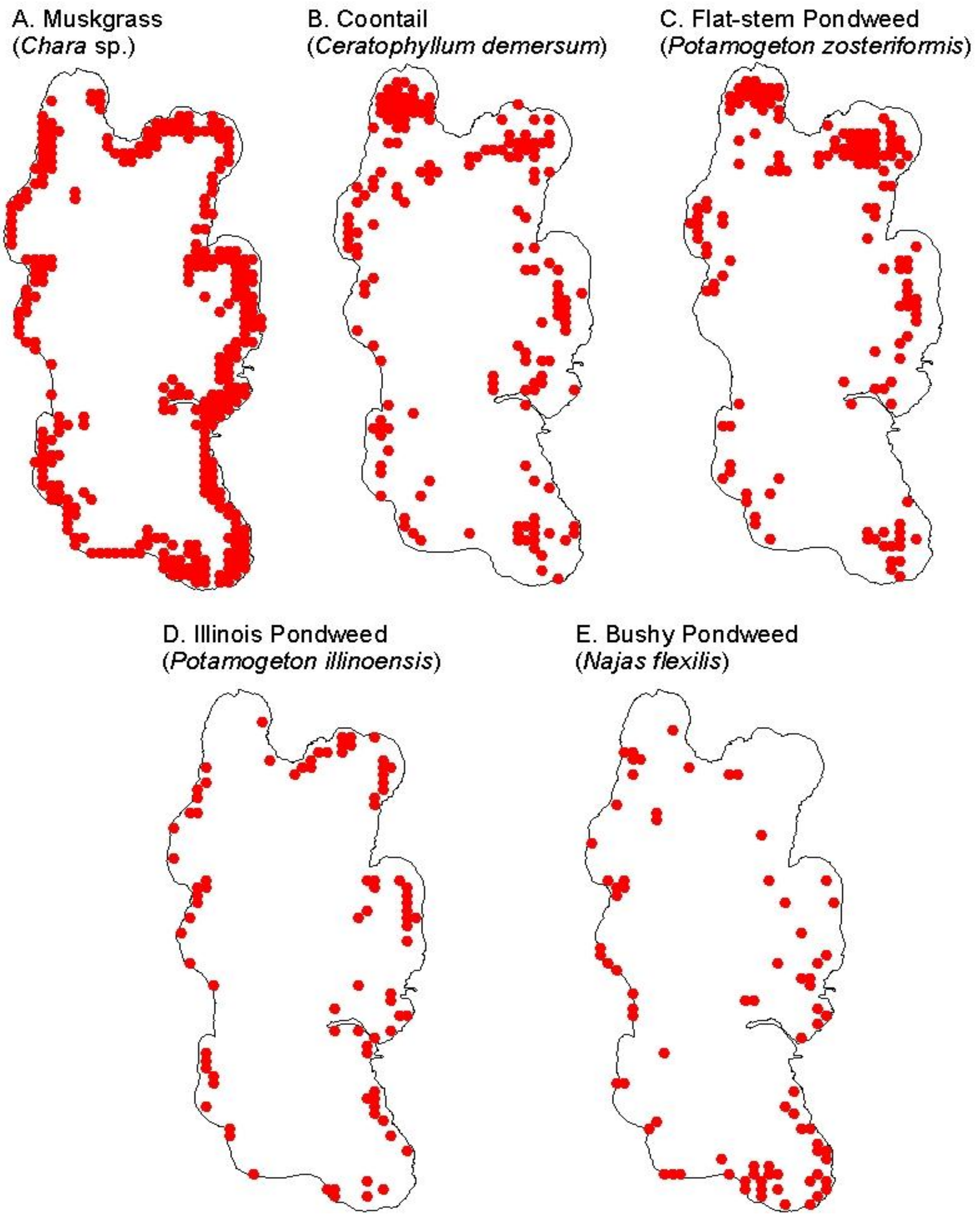
Submerged plants occurred in 65 percent of Pine Mountain Lake sample sites. The plant community included leafy plants that are anchored to the lake bottom by roots as well as large algae that may resemble leafy plants but are weakly anchored to the lake bottom or drift freely with the currents.

Muskgrass was the most frequently sampled species; it occurred in 39 percent of the sample sites and was most common in depths from shore to five feet (Figure 18A). Coontail was found in 20 percent of the sites but occurred in deeper waters (6 to 10 feet) than muskgrass (Figure 18B).

Flat-stem pondweed occurred in 18 percent of the sites and was most common in depths of six to ten feet (Figure 18C). Illinois pondweed and bushy pondweed were most frequent in depths of five feet and less and occurred in 11 and 10 percent of the sites, respectively (Figure 18D, 18E).

Fragments of the non-native plant curly-leaf pondweed were found during the July 2008 rare plant search of Pine Mountain Lake. To date, rooted plants of this species have not been documented in the lake.

Figure 18. Distribution of common submerged aquatic plants in Pine Mountain Lake, 2007.



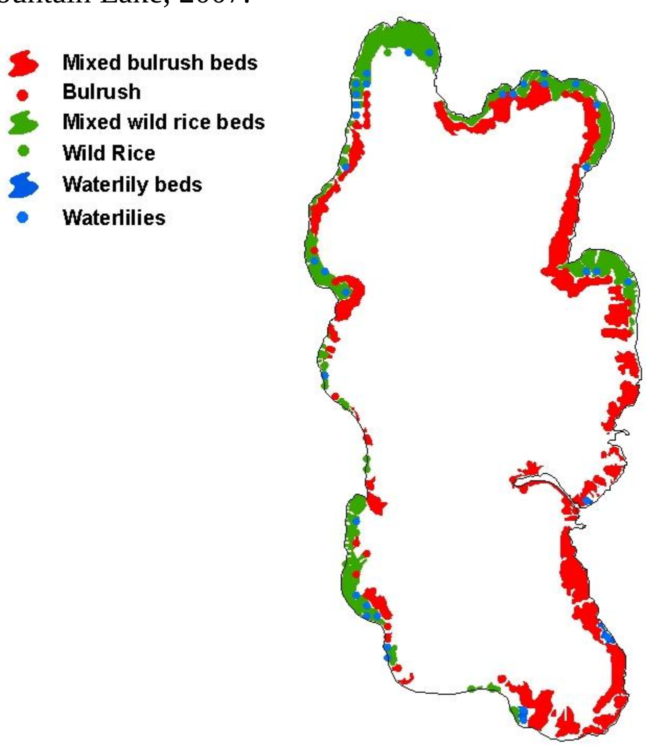
Floating-leaf and emergent plants

Because surveyors avoided motoring into floating-leaf and shallow emergent plant beds, the frequency values obtained for these taxa (Table 2) represent the occurrence of these taxa only within the sites that were surveyed and are lower than the actual occurrence. About 45 acres of floating-leaf plant beds were mapped and the most common species were white waterlily and yellow waterlily. Waterlily beds often contained scattered bulrush and wild rice plants as well as submerged plants and were usually associated with muck sediments. Bulrush was the most common emergent plant and occurred in 41 percent of the sites in the shore to five feet depth zone.

Waterlily and wild rice beds, Pine Mountain Lake, 2007.

A total of 153 acres of bulrush beds were delineated and they occurred around the entire perimeter of the lake, immediately adjacent to shore and on the lakeward edge of waterlily beds (Figure 19). Wild rice occurred in 14 percent of the shallow water (shore to five feet) sites and about 105 acres were mapped including wild rice mixed with waterlilies and bulrush. It was most common along the northern shores and the southwestern bay (Figure 19) and was often associated with soft substrates.

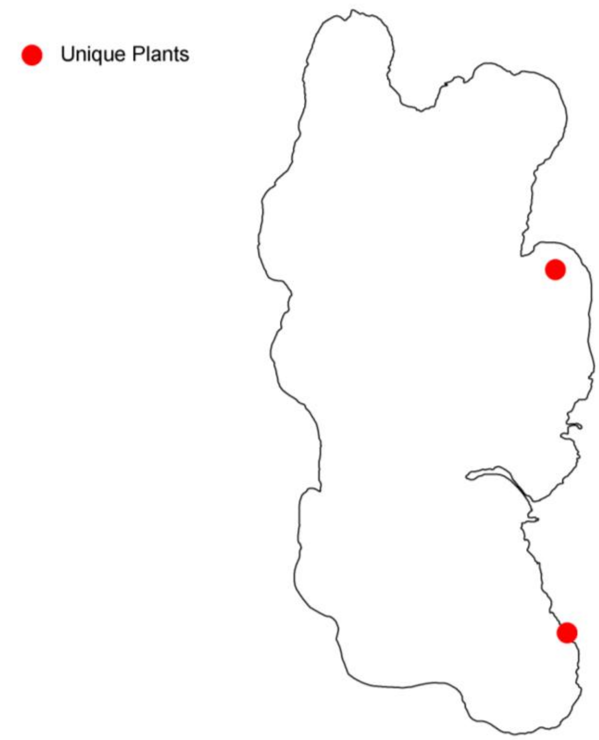
Figure 19. Distribution of emergent and floating-leaf plant beds in Pine Mountain Lake, 2007.



Unique plants

In addition to the commonly occurring plants in Pine Mountain Lake, two unique emergent plants were located along the eastern shores. Water arum and wiregrass sedge were located in soft substrates at the shore-water interface (Figure 20).

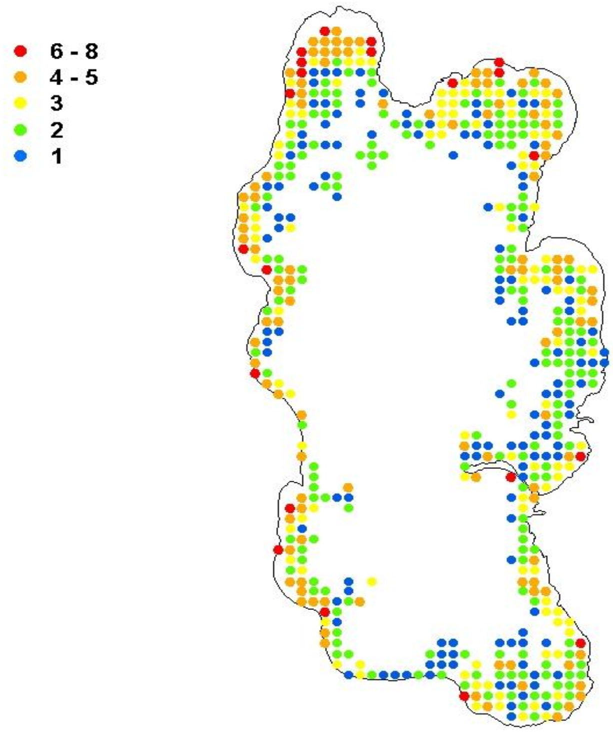
Figure 20. Unique aquatic plants in Pine Mountain Lake, 2007.



Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to eight (Figure 21). Sites near shore, in shallow water, contained the greatest number of plant taxa and in water depths greater than 15 feet, most sites contained one or no taxa.

Figure 21. Aquatic plant richness (number of species per sampling station) in Pine Mountain Lake, 2007.



Near-shore Substrates

Objectives

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

Introduction

Rubble shoreline at Pine Mountain 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 sand. Other species, such as walleye, prefer hard bottom substrates with a larger diameter, such as gravel and rubble. A diverse substrate will also allow plants with different habitat requirements to exist within a system. For example, bulrush may occur on sand, gravel or marl while yellow waterlily prefers soft substrates (Nichols 1999b).

Methods

Near-shore substrate in Pine Mountain Lake was evaluated at a total of 436 sampling stations set up in the grid point-intercept aquatic plant and near-shore fish surveys. Plant point-intercept sample stations were 65 meters apart and occurred in a grid from shore to a depth of 20 feet. Surveyors described substrate at 397 of these sites that were located between the shore and the eight feet 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. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 39 of these stations.

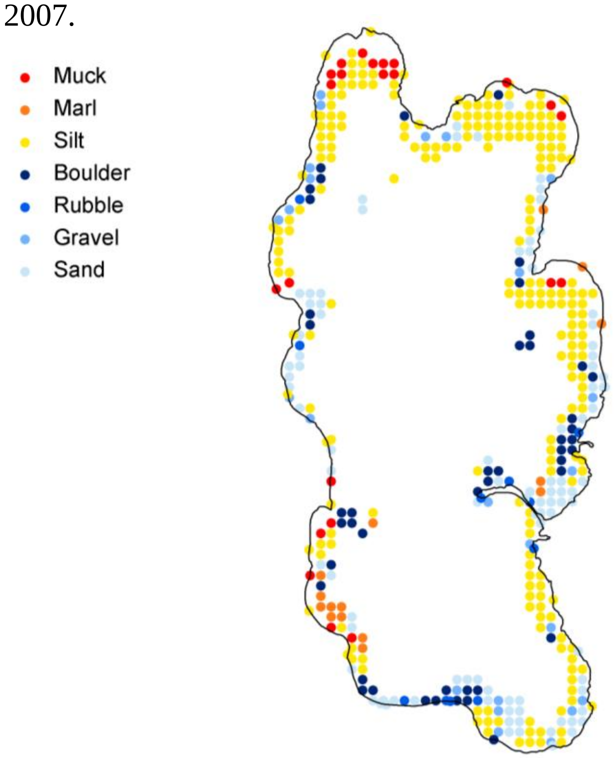
Surveyors evaluated substrate by tapping a pole into the lake bottom; soft substrate could usually be brought to the surface on the pole or sampling rake for evaluation. If this method was not feasible, substrate was evaluated by visual observation of the lake bottom. Standard lake substrate classes 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

Both hard bottom and soft bottom substrates occurred in Pine Mountain Lake (Figure 22). Silt was the most common substrate type, and occurred in over half of the sampled locations, particularly along the northern and eastern shorelines. The western shoreline was a mix of soft substrates, such as muck and marl, and hard substrates such as sand. Boulders were grouped in several locations along the shoreline.

Figure 22. Distribution of near-shore substrates around Pine Mountain Lake, 2007.



Bird Surveys

Objectives

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

Introduction

Bird Species of Greatest Conservation Need
There are 97 bird species of greatest conservation need (SGCN) in Minnesota. 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 Pine Mountain Lake.

Figure 23. American white pelican

Photo by: Carrol Henderson

American white pelicans (*Pelecanus erythrorhynchos*; Figure 23) are one of the largest birds in North America. These white waterbirds have a wingspan of nearly 10 feet, and weigh up to 30 pounds. They have black wingtips and an orange bill with a pouch. Unlike some pelicans, American white pelicans do not dive for their food, but feed while swimming. They nest in colonies on remote freshwater lakes, and depend on wetlands for many stages of their life cycle. Habitat loss is the largest known cause of nesting failure, although predation and boating disturbance can also be factors.

Figure 24. Bald eagle

Photo by: Carrol Henderson

Bald eagles (*Haliaeetus leucocephalus*; Figure 24) are an increasingly common sight in Minnesota. Once listed as an endangered species, bald eagle numbers have rebounded due to effective environmental protection laws and conservation efforts. Adult bald eagles are easily identified by the white head and tail, although these colors don't appear until birds are 4 or 5 years old. Prior to that, eagles are generally dark brown with white feathers scattered along the wings, head, tail and back. With a wingspan of up to 7 feet, bald eagles are one of the largest birds in North America. They are found in forested areas near large, open bodies of water. Although bald eagle numbers are increasing, these birds still face threats from environmental contaminants and destruction of habitat. Bald eagles are listed as a species of Special Concern in the state of Minnesota.

Black terns (*Chlidonias niger*; Figure 25) are distinguished by a black head and chest with gray wings, back, and tail. The nonbreeding plumage is lighter in color, and much of the black is replaced with white or gray. Black terns are loosely colonial, and often are found in freshwater marshes or wetlands. They may also occur along lake margins with abundant emergent vegetation. Black tern populations have declined dramatically since the 1960s. Habitat loss, environmental contamination, and human disturbance are often cited as causes of the decline.

Figure 25. Black tern

Photo by: Carrol Henderson

Common loons (*Gavia immer*; Figure 26) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. These large diving birds possess red eyes and a large, dark pointed bill that is well-adapted for catching fish. Loons spend most of their time in water, and go ashore only to mate and incubate eggs. Summer plumage is spotted black and white, while in winter the colors are gray above and white below. Loon populations are closely monitored in Minnesota; however, these birds still face threats, particularly in the form of human disturbance and lead poisoning.

Figure 26. Common loon

Photo by: Carrol Henderson

Common terns (*Sterna hirundo*; Figure 27) 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, often on sandy substrates of islands or peninsulas of large lakes. 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 27. Common tern

Photo by: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 28) are medium-sized, nondescript birds common in Eastern forests. They are grayish-olive above, with a paler throat and belly and whitish wingbars. They forage in throughout the canopy, often flying out from their perch to catch insects before returning to the same perch. Eastern wood-pewees breed in the deciduous and mixed woods of eastern North America and migrate to Central and South America in the winter. Populations of eastern wood-pewees are declining throughout much of their range. Possible causes of the decline include loss of forest habitat in the winter range, and the increase in white-tailed deer, who browse and decrease the lower-canopy foraging area available to the pewee.

Figure 28. Eastern wood-pewee

Photo by: J.A. Spendelow

Marsh wrens (*Cistothorus palustris*; Figure 29) are small, stocky wrens. Their color is brown with black and white streaks on the back and black barring on the tail. They have a dark brown or black cap and a white eye line. Marsh wrens are noisy birds, and sing almost continually during the breeding season. They often hold their tails in an upright position, in "classic" wren posture. Marsh wrens inhabit a variety of marshes. Emergent vegetation, such as cattails or bulrush, is one of the most important habitat components. While populations of marsh wrens are increasing in some areas, others are threatened by loss and degradation of wetland habitat.

Figure 29. Marsh wren

Photo by: Dave Herr

Ovenbirds (*Seiurus aurocapillus*; Figure 30) are rarely seen birds of the forest. However, their loud "teacher, teacher, teacher" call is commonly heard during the summer months. They dwell on the ground, and build a covered nest that resembles a Dutch oven. Ovenbirds are olive-brown with a boldly streaked breast. Two black stripes border an orange crown. They have a thin bill and a white eye ring. They breed in mature deciduous and mixed forests, especially those with minimal undergrowth. Ovenbird numbers appear to be stable, but the birds are vulnerable to forest fragmentation and parasitism by brown-headed cowbirds (*Molothrus ater*).

Figure 30. Ovenbird

Photo source: U.S. Fish and Wildlife Service

Red-necked grebes (*Podiceps grisegena*; Figure 31) are one of the larger grebe species. The red neck, which distinguishes the bird, is visible only during the breeding season; in the winter it turns to whitish or gray. The back is dark, and the head is characterized by white cheeks and a black cap. Red-necked grebes breed in a variety of water bodies, from marshes to small, shallow lakes to the bays of large lakes. These birds are uncommon in Minnesota, and populations are imperiled by the loss and modification of wetland habitat.

Figure 31. Red-necked grebe

Rose-breasted grosbeaks (*Pheucticus ludovicianus*; Figure 32) are summer visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes, meadows, and woodlands, and suburban parks and gardens. The winter range spans from southern Mexico to South America and the Caribbean. Significant regional declines in rose-breasted grosbeak populations have been noted.

Figure 32. Rose-breasted grosbeak

Photo by: J.A. Spendelow

Sedge wrens (*Cistothorus platensis*; Figure 33) are small, brown wrens with buffy underparts and white streaks on the back and crown. They have an indistinct white eye stripe, and often hold their short tails in a cocked, upright position. As their name implies, they prefer marshes and meadows with abundant dense sedges and grasses. The nest is often made of sedges, as well. They are unpredictable in their migration patterns, and may be abundant in an area one year and completely absent the next. Human development of wetlands is the primary reason for the recent noteable declines in sedge wren populations.

Figure 33. Sedge wren

Photo by: Berlin Heck

The swamp sparrow's (*Melospiza georgiana*; Figure 34) slow trill is a familiar sound in swampy areas in the summer. Other wetlands, such as bogs and meadows, may also harbor populations of this species. Swamp sparrows eat mainly seeds and fruits, but may also be adventurous feeders, wading in the water and putting their heads underneath in order to capture aquatic insects. This rusty-colored bird has black streaks on the back and an unstreaked gray breast and neck. A reddish cap is easily visible during the breeding season. Swamp sparrows thrive in suitable habitat; however, destruction of wetlands has put this species at risk.

Figure 34. Swamp sparrow

Photo by: Jim Stasz

The veery (*Catharus fuscescens*; Figure 35) 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, but the birds also produce a flute-like descending song. 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 35. Veery

Photo by: Deanna Dawson

Virginia rails (*Rallus limicola*; Figure 36) 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, and the eyes are red. The Virginia rail rarely flies, and spends most of its time walking through dense vegetation in freshwater marshes. It can also swim underwater, propelling itself with its wings. Because of their secretive nature, few characteristics and behaviors have been documented. Population information is limited, but several reports have indicated declines in some areas.

Figure 36. Virginia rail

Photo by: David Arbour

White-throated sparrows (*Zonotrichia albicollis*; Figure 37) 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.

Figure 37. White-throated sparrow

Photo by: Dave Herr

The loud, bubbly song of the winter wren (*Troglodytes troglodytes*; Figure 38) belies its small size. At four inches in length, the winter wren is the smallest of the North American wrens. They are dark brown in color and have fine barring on the wings, tail, and underparts. They often hold their short tail in an upright position. Winter wrens are sometimes described as "mouse-like" because of their small stature and tendency to stay near the ground, foraging around like a rodent. The winter wren inhabits a variety of habitats, including conifer forests and riparian areas. Loss of forested habitat may pose a threat to the winter wren.

Figure 38. Winter wren

Photo source: U.S. Fish and Wildlife Service

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 39) 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 39. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Bird surveys were conducted between mid-May and late June, 2008. Surveyors used several techniques to collect information on bird species. Point counts were conducted at 38 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 took place in the evening. Both survey techniques were dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or on the lakeshore were also recorded.

Results

Seventeen bird species of greatest conservation need were identified at Pine Mountain Lake. Swamp sparrows were the most abundant; surveyors documented this species at 14 different stations. Common loons were also widespread, and were found at 11 stations. Ovenbirds, rose-breasted grosbeaks, red-necked grebes, and the veery were all documented at five or more stations. The other species of greatest conservation need identified during the bird surveys were: American white pelican, bald eagle, black tern, common tern, eastern wood-pewee, marsh wren, sedge wren, Virginia rail, white-throated sparrow, winter wren, and yellow-bellied sapsucker.

Common loons were distributed along much of the Pine Mountain Lake shoreline. Several other aquatic habitat-dependent species of greatest conservation need, such as the black tern and American white pelican, were found only along the eastern half of Pine Mountain Lake (Figure 40). Two of the forest habitat-dependent species of greatest conservation need, the veery and eastern wood-pewee, were also documented mainly along the eastern shoreline of Pine Mountain Lake (Figure 41). The winter wren and yellow-bellied sapsucker were found only along the western shoreline, while the ovenbird and rose-breasted grosbeak were found scattered along the entire shoreline. The vast majority of the wetland-dwelling species of greatest conservation need were found along the eastern edge of the lake (Figure 42), and several bald eagles were documented there as well (Figure 43).

Surveyors identified 71 species during the point-count and call-playback surveys at Pine Mountain Lake (Table 3). An additional six species were recorded during casual observation of the lake, for a total of 77 species (Appendix 2). Yellow warblers, red-winged blackbirds, and song sparrows were the most commonly identified species; surveyors documented each of these species at over 75 percent of the sample sites. Nineteen of the species were rare at the lake, and were heard or seen only once.

Figure 40. Distribution of aquatic habitat-dependent bird species of greatest conservation need on Pine Mountain Lake, May – June 2008.

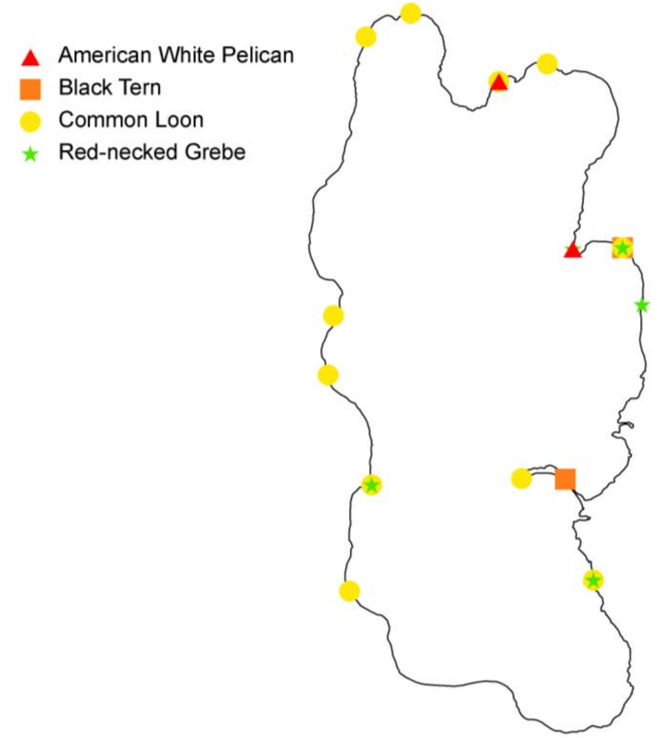


Figure 41. Distribution of forest habitat-dependent bird species of greatest conservation need on Pine Mountain Lake, May – June 2008.

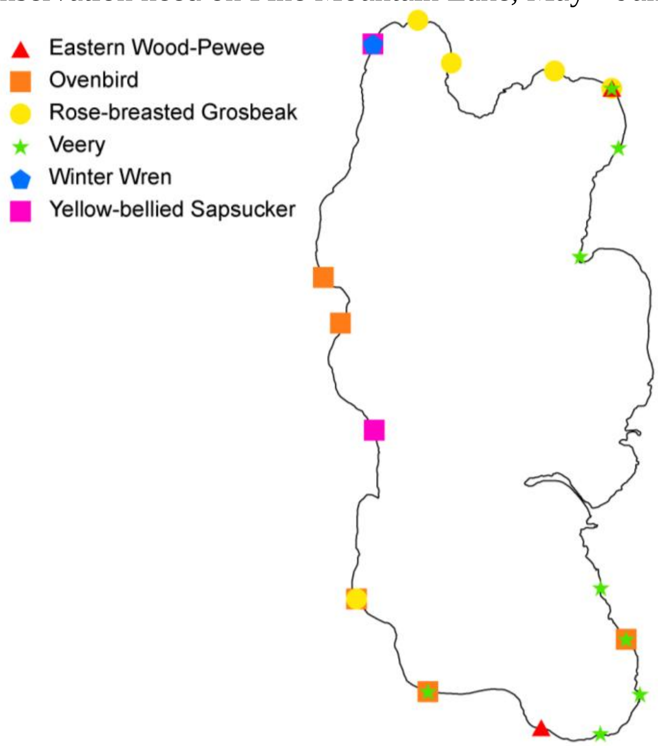


Figure 42. Distribution of wetland habitat-dependent bird species of greatest conservation need on Pine Mountain Lake, May – June 2008.

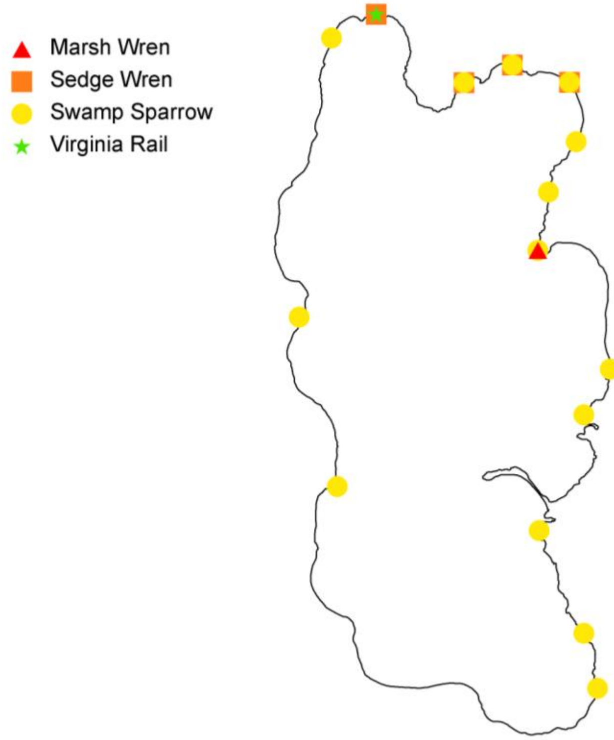


Figure 43. Distribution of bird species of greatest conservation need that occupy other habitats on Pine Mountain Lake, May – June 2008.

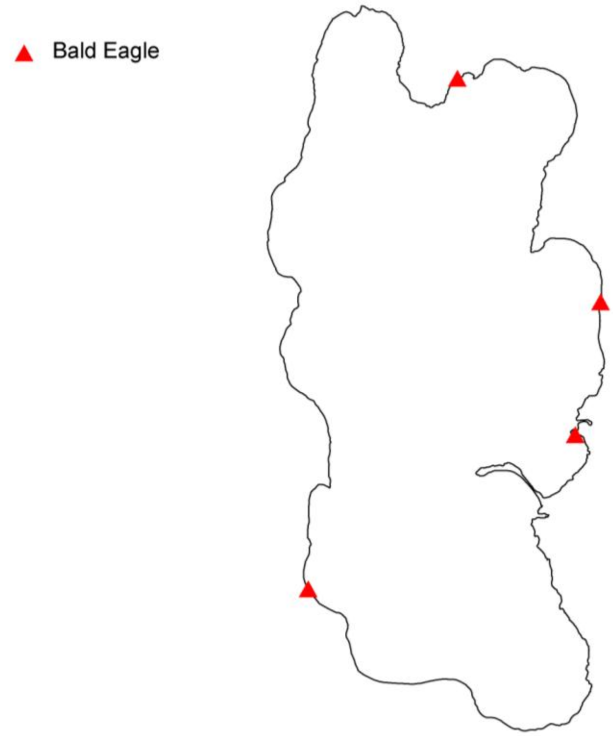


Table 3. Species list and frequency of occurrence of bird species identified during Pine Mountain Lake surveys, May – June 2008. * denotes a species of greatest conservation need.

Description	Common Name	Scientific Name	% [a]
Waterfowl	Canada Goose	*Branta canadensis*	18
	Wood Duck	*Aix sponsa*	29
	Mallard	*Anas platyrhynchos*	50
	Blue-winged Teal	*Anas discors*	21
	Common Goldeneye	*Bucephala clangula*	26
	Hooded Merganser	*Lophodytes cucullatus*	5
Loons	Common Loon*	*Gavia immer*	29
Grebes	Pied-billed Grebe	*Podilymbus podiceps*	5
	Red-necked Grebe*	*Podiceps grisegena*	13
Pelicans	American White Pelican*	*Pelecanus erythrorhynchos*	5
Herons/bitterns	Great Blue Heron	*Ardea herodias*	24
	Green Heron	*Butorides virescens*	29
Hawks/eagles	Bald Eagle*	*Haliaeetus leucocephalus*	11
	Cooper's Hawk	*Accipiter cooperii*	3
Falcons	Merlin	*Falco columbarius*	3
Rails	Virginia Rail*	*Rallus limicola*	3
	Sora	*Porzana carolina*	21
Cranes	Sandhill Crane	*Grus canadensis*	5
Plovers	Killdeer	*Charadrius vociferus*	5
Sandpipers/allies	Spotted Sandpiper	*Actitis macularius*	3
	Wilson's Snipe	*Gallinago delicata*	5
Gulls/terns	Ring-billed Gull	*Larus delawarensis*	13
	Black tern*	*Chlidonias niger*	5
Pigeons/doves	Mourning Dove	*Zenaida macroura*	5
Hummingbirds	Ruby-throated Hummingbird	*Archilochus colubris*	8
Kingfishers	Belted Kingfisher	*Megaceryle alcyon*	21
Woodpeckers	Red-bellied Woodpecker	*Melanerpes carolinus*	13
	Yellow-bellied Sapsucker*	*Sphyrapicus varius*	5
	Downy Woodpecker	*Picoides pubescens*	11
	Hairy Woodpecker	*Picoides villosus*	3
	Northern Flicker	*Colaptes auratus*	8
	Pileated Woodpecker	*Dryocopus pileatus*	3
Flycatchers	Eastern Wood-Pewee*	*Contopus virens*	5
	Alder Flycatcher	*Empidonax alnorum*	21
	Eastern Phoebe	*Sayornis phoebe*	21
	Great Crested Flycatcher	*Myiarchus crinitus*	8
	Eastern Kingbird	*Tyrannus tyrannus*	11

Table 3, continued.

Description	**Common Name**	**Scientific Name**	**%** [a]
Vireos	Warbling Vireo	*Vireo gilvus*	5
	Red-eyed Vireo	*Vireo olivaceus*	42
Jays/crows	Blue Jay	*Cyanocitta cristata*	13
	American Crow	*Corvus brachyrhynchos*	16
Swallows	Tree Swallow	*Tachycineta bicolor*	32
	Barn Swallow	*Hirundo rustica*	16
Chickadees	Black-capped Chickadee	*Poecile atricapillus*	16
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	3
	White-breasted Nuthatch	*Sitta carolinensis*	3
Wrens	House Wren	*Troglodytes aedon*	5
	Winter Wren*	*Troglodytes troglodytes*	3
	Sedge Wren*	*Cistothorus platensis*	11
	Marsh Wren*	*Cistothorus palustris*	3
Thrushes	Veery*	*Catharus fuscescens*	21
	American Robin	*Turdus migratorius*	32
Mockingbirds	Gray Catbird	*Dumetella carolinensis*	13
Starlings	European Starling	*Sturnus vulgaris*	3
Waxwings	Cedar Waxwing	*Bombycilla cedrorum*	5
Warblers	Nashville Warbler	*Vermivora ruficapilla*	3
	Yellow Warbler	*Dendroica petechia*	79
	Chestnut-sided Warbler	*Dendroica pensylvanica*	13
	Black-and-white Warbler	*Mniotilta varia*	13
	American Redstart	*Setophaga ruticilla*	5
	Ovenbird*	*Seiurus aurocapilla*	13
	Common Yellowthroat	*Geothlypis trichas*	45
Sparrows	Chipping Sparrow	*Spizella passerina*	21
	Song Sparrow	*Melospiza melodia*	74
	Swamp Sparrow*	*Melospiza georgiana*	37
Cardinals/grosbeaks	Rose-breasted Grosbeak*	*Pheucticus ludovicianus*	13
	Indigo bunting	*Passerina cyanea*	3
Blackbirds/orioles	Red-winged Blackbird	*Agelaius phoeniceus*	76
	Common Grackle	*Quiscalus quiscula*	42
	Baltimore Oriole	*Icterus galbula*	24
Finches	American Goldfinch	*Carduelis tristis*	21

[a] % – Percent of surveyed sample sites in which a bird species occurred (N=38).

Bird Species Richness

Objectives

1. Calculate and map bird richness around the shoreline of Pine Mountain Lake

Introduction

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

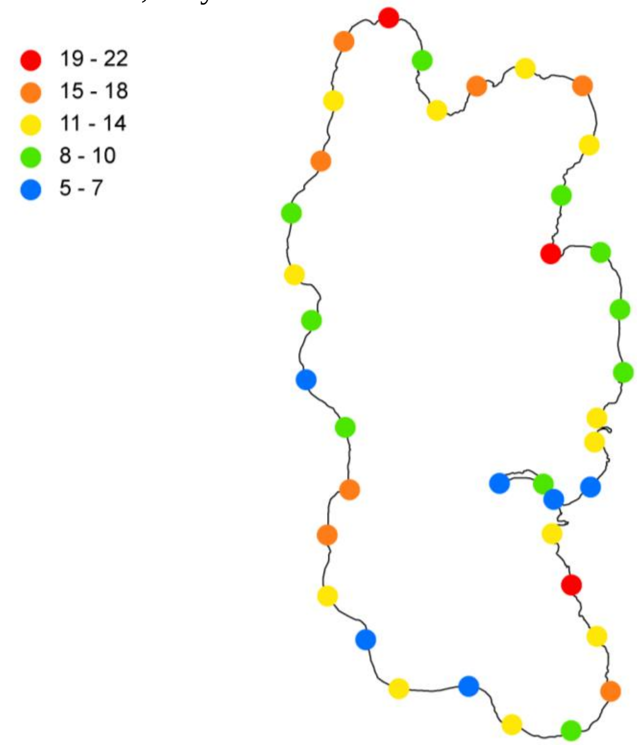
Methods

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

Results

Bird species richness ranged from five to 22 species per sampling station (Figure 44). Nearly 70 percent of the stations contained 10 or more species, and only one station contained five species. The maximum number of bird species of greatest conservation need at a single sample station was five, and the minimum number was zero. Twelve of the 38 stations contained three or more species of greatest conservation need.

Figure 44. Bird species richness (number of species per sample site) at Pine Mountain Lake, May – June 2008.



Loon Nesting Areas

Objectives

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

Introduction

Pine Mountain Lake loon with chick

Photo by: Matt Brinkman

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

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

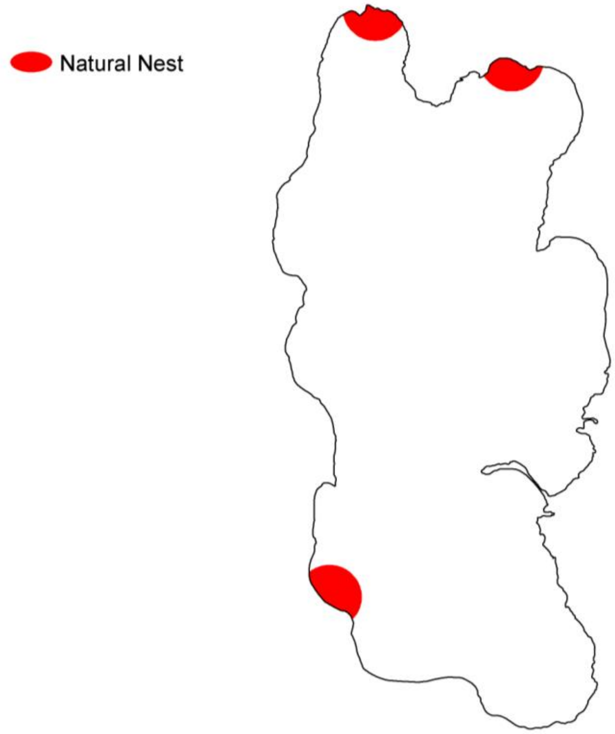
Methods

Using information from LoonWatcher reports and bird, fish, and vegetation survey crews, researchers mapped loon nesting locations in GIS. Mapped nests were buffered by 200 meters to account for locational uncertainty. Nests were identified as either natural or manmade (artificial platforms). All former and current natural nesting locations and artificial platforms used by loons were included in the maps and analysis; artificial platforms not utilized by loons were not included. Volunteers have reported on Pine Mountain Lake loons in 1980, 1981, and 2008.

Results

Between 1980 and 2008, three probable loon nesting areas were identified on Pine Mountain Lake (Figure 45). All of these nests were natural loon nests. Two of the nests were located along the northern shoreline, and one nest was in the southwestern corner of the lake. In 2008, all three of these nests were documented as active nests.

Figure 45. Location of natural loon nests and manmade loon platforms recorded on Pine Mountain Lake between 1980 and 2008.



Aquatic Frog Surveys

Objectives

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

Introduction

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

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

Figure 46. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

<u>Mink frogs</u> (Figure 46) 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 47. Green frog

Photo by: Jeff LeClere, www.herpnet.net

<u>Green frogs</u> (Figure 47) are medium-sized, greenish or brownish frogs with small dark spots. The belly is often brighter in color than the back. A large tympanum (eardrum) helps identify the green frog. They can be found in a variety of habitats surrounding lakes, streams, marshes, and swamps, but are strongly associated with the shallow water of lakeshores. Although green frog populations are generally stable, regional declines and local extinctions have been noted.

Methods

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

Results

Target species

Both mink and green frogs were documented at Pine Mountain Lake. Mink frogs were heard at 16 stations, primarily on the northern half of the lake. Abundance estimates ranged from one to six calling males (Figure 48). Surveyors heard green frogs at 22 stations. Numbers of calling males ranged from one to between 10 - 20 individuals (Figure 49). Green frogs were located along much of the Pine Mountain Lake shoreline, and occurred with mink frogs at several stations on the northern part of the lake (Figure 50). Index values for both mink and green frogs equaled one (frog calls did not overlap, and individual frog calls could be distinguished).

Other species

One additional species, the gray treefrog (*Hyla versicolor*) was documented during the 2007 frog calling surveys. This species was heard calling from a station on the southwestern part of the lake. Also in 2007, surveyors conducting nongame fish surveys on Pine Mountain Lake found leopard frogs (*Rana pipiens*). Other frog or toad species that may be found near Pine Mountain Lake, such as wood frog (*Rana sylvatica*), spring peeper (*Pseudacris crucifer*), chorus frog (*Pseudacris triseriata*), and American toad (*Bufo americanus*), breed earlier in the year and are not strongly associated with larger lakes.

Figure 48. Abundance of mink frogs heard during surveys at Pine Mountain Lake, July 2008.

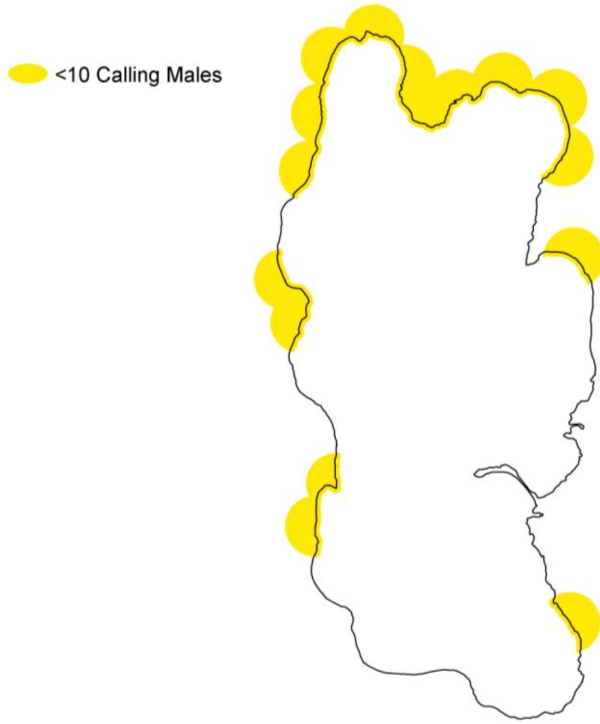


Figure 49. Abundance of green frogs heard during surveys at Pine Mountain Lake, July 2008.

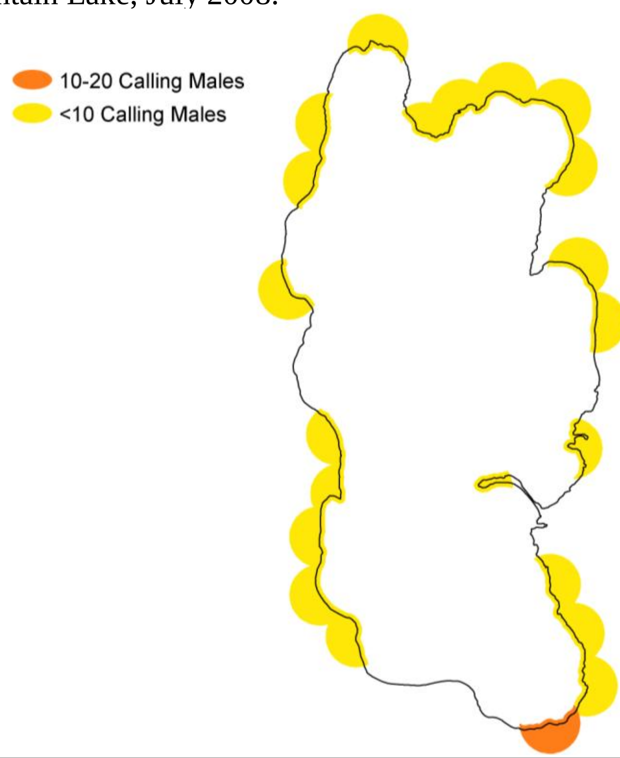
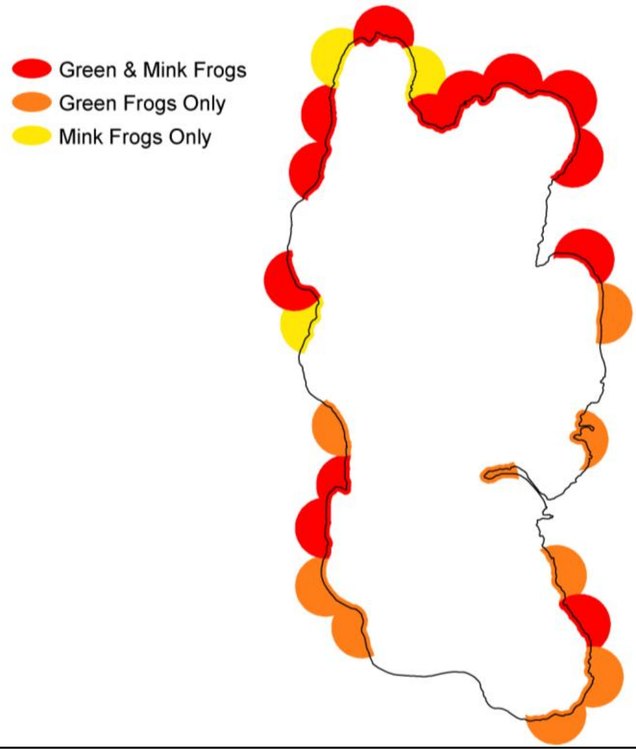


Figure 50. Distribution of mink and green frogs at Pine Mountain Lake, July 2008.



Nongame Fish Surveys

Objectives

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

Introduction

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

Pugnose shiners (*Notropis anogenus*; Figure 51) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess a distinctively upturned mouth that gives them a "pugnose" appearance. These are secretive minnows, and are often found in schools of 15 to 35 individuals. Pugnose shiners inhabit clear lakes and low-gradient streams and are intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 51. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (*Etheostoma microperca*; Figure 52) are Minnesota's smallest fish, averaging only 25 – 38 mm in length. They are olive-brown in color with scattered dark brown spots and markings and four dark bars radiating from the eye. Males possess an extremely long pectoral fin. Least darters are found in clear, shallow areas of low-gradient streams or lakes. Extensive beds of muskgrass (*Chara* spp.) are a preferred habitat feature. Removal of vegetation, riparian area modification, and poor water quality all pose threats to the least darter.

Figure 52. Least darter

Photo by: Konrad Schmidt

Longear sunfish (*Lepomis megalotis*; Figure 53) are a deep-bodied fish reaching a length of 71 – 94 mm. These colorful fish have a belly that is orange-red, and the sides are speckled with turquoise. Adults have an elongated opercular "ear flap" that is trimmed in white. Like the other species of greatest conservation need, the longear sunfish prefers clear, shallow, vegetated areas and is intolerant of turbidity.

Figure 53. 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 (*Notropis heterodon*; Figure 54) are small (50 – 75 mm) fish with a bronze-colored back and silver sides and belly. A dark lateral band extends through the chin. Like the species of greatest conservation need, the blackchin shiner inhabits clear water with abundant submerged aquatic vegetation; it also prefers a clean sand or gravel substrate. This species cannot tolerate turbidity or loss of aquatic vegetation.

Figure 54. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (*Notropis heterolepis*; Figure 55) are similar in size and coloration to blackchin shiners. However, the dark lateral line does not extend through the lips or chin. Scales on the back are outlined in a dark color, giving them a crosshatch appearance. Blacknose shiners are sensitive to turbidity and pollution, and their range has contracted since the beginning of the century. Habitat includes clean, well-oxygenated lakes and streams with plentiful vegetation and low turbidity and pollution.

Figure 55. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 56) 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 56. Banded killifish

Photo by: Konrad Schmidt

Methods

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

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

Results

No fish species of greatest conservation need were documented during the 2007 fish surveys. However, surveyors did identify all three proxy species. Banded killifish were found most frequently and in the greatest numbers; over 700 individuals were counted at 29 of the sample sites (Table 4). Blackchin shiners and blacknose shiners were similar in abundance; surveyors documented between 100-200 individuals at 14 and 13 sample sites, respectively.

Proxy species were located along nearly the entire Pine Mountain Lake shoreline (Figure 57). These species were generally located at sites with small diameter substrate, such as silt or sand. Biovolume at these sites averaged 25 percent, slightly higher than at sites that did not contain proxy species.

The presence of the proxy species at Pine Mountain Lake indicates minimal disturbance along some sections of shoreline. However, because populations of these species are at risk throughout 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.

Twenty-eight different fish species were documented during the nongame fish surveys (Table 4). Bluegills were found most frequently, and were located at every sample station. Yellow perch were found at every station except one, and in the greatest numbers (over 55,000). Bluntnose minnows, mimic shiners, and spottail shiners were also present in numbers greater than 5,000.

Surveyors identified 11 fish species not previously documented in Pine Mountain Lake, bringing the total historical observed fish community to 33 species. The newly documented species were blackchin shiner, brook stickleback, central mudminnow, emerald shiner, golden shiner, Iowa darter, mimic shiner, mottled sculpin, spotfin shiner, spottail shiner, and tadpole madtom.

Species richness ranged from six to 19 fish species at a single sample station. Thirty of the 39 sites included 10 or more species.

Figure 57. Distribution of fish proxy species, at Pine Mountain Lake, August 2007.

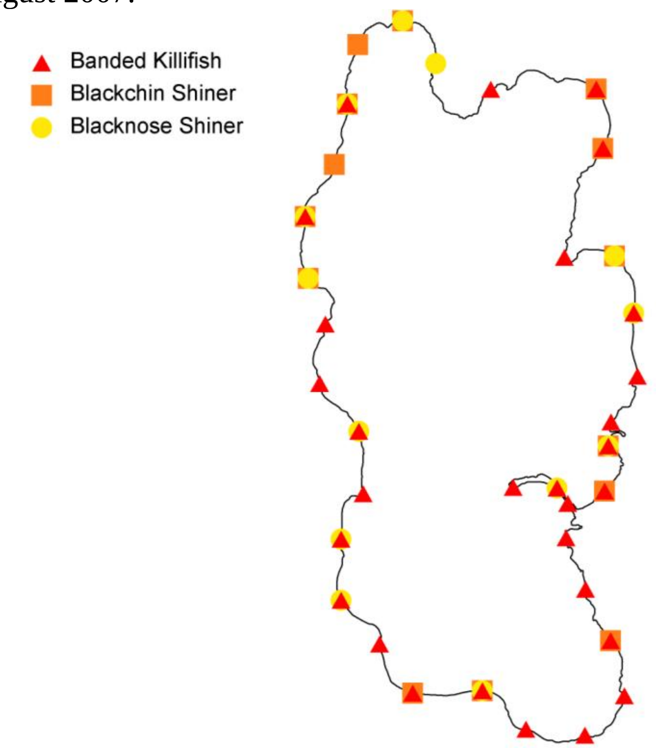


Table 4. Abundance and frequency of fish species identified during Pine Mountain Lake surveys, August 2007.

Description	Common Name	Scientific Name	# [a]	% [b]
Bowfins	Bowfin	*Amia calva*	9	15
Minnows/carps	Spotfin shiner	*Cyprinella spiloptera*	12	10
	Golden shiner	*Notemigonus crysoleucas*	28	15
	Emerald shiner	*Notropis atherinoides*	37	15
	Blackchin shiner	*Notropis heterodon*	170	36
	Blacknose shiner	*Notropis heterolepis*	111	33
	Spottail shiner	*Notropis hudsonius*	~3000	77
	Mimic shiner	*Notropis volucellus*	~3900	87
	Bluntnose minnow	*Pimephales notatus*	~5000	95
Suckers	White sucker	*Catostomus commersonii*	10	21
North American freshwater catfishes	Black bullhead	*Ameiurus melas*	7	13
	Yellow bullhead	*Ameiurus natalis*	121	67
	Brown bullhead	*Ameiurus nebulosus*	6	13
	Tadpole madtom	*Noturus gyrinus*	47	33
Pikes	Northern pike	*Esox lucius*	3	8
Mudminnows	Central mudminnow	*Umbra limi*	14	15
Killifishes	Banded killifish	*Fundulus diaphanus*	739	74
Sticklebacks	Brook stickleback	*Culaea inconstans*	1	3
Sculpins	Mottled sculpin	*Cottus bairdii*	20	8
Sunfishes	Rock bass	*Ambloplites rupestris*	141	74
	Pumpkinseed	*Lepomis gibbosus*	102	64
	Bluegill	*Lepomis macrochirus*	~8000	100
	Largemouth bass	*Micropterus salmoides*	103	74
Perches	Iowa darter	*Etheostoma exile*	96	44
	Johnny darter	*Etheostoma nigrum*	86	36
	Yellow perch	*Perca flavescens*	~55000	97
	Logperch	*Percina caprodes*	65	41
	Walleye	*Sander vitreus*	16	41

[a] # – Total number of individuals found. Numbers over 1000 were rounded to the nearest 100. Numbers over 10000 were rounded to the nearest 1000.

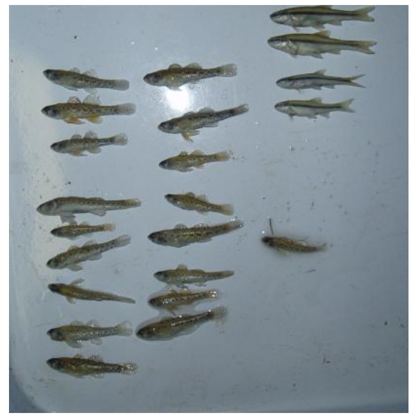
[b] % – Percent of surveyed sample sites in which a species occurred (N=39)

Aquatic Vertebrate Richness

Objectives

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

Introduction



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

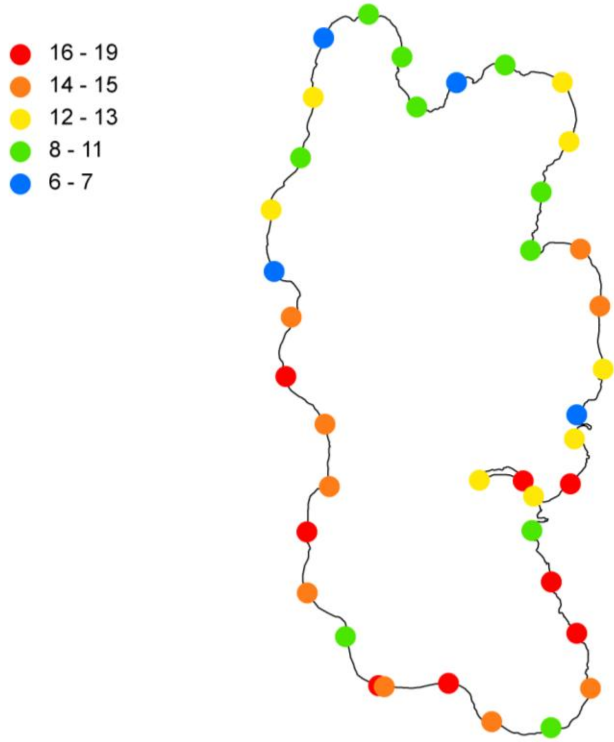
Methods

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

Results

Maximum aquatic vertebrate species richness at a single sample station was 19 species, and 31 of 39 sites contained 10 or more species (Figure 58). The majority of the sites with the highest diversity were located in the southern half of the lake. Most of the documented species were fish, although northern leopard frogs, painted turtles, and snapping turtles were also identified. All aquatic vertebrate species documented during the surveys were native.

Figure 58. Aquatic vertebrate species richness (number of species per sample site) at Pine Mountain Lake sample sites, August 2007.



Other Rare Features

Objectives

1. Map rare features occurring within the extended state-defined shoreland area of Pine Mountain Lake

Introduction

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

Methods

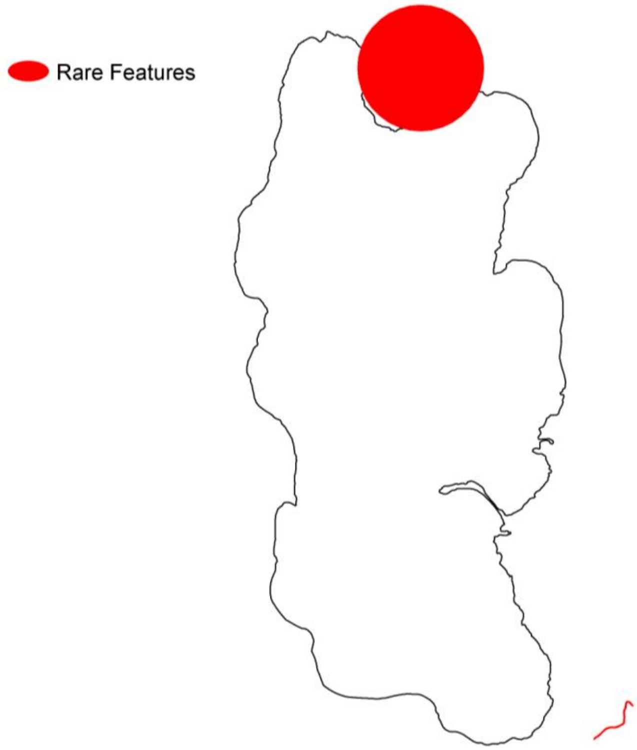
Researchers obtained locations of rare features from the Rare Features Database. Only “listed” plant and animal species (Federal or State endangered, threatened, or special concern) were considered in this project; non-listed unique plant species were included in the “Unique Plant Species” section of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

Results

Two rare features have been identified within the Pine Mountain Lake shoreland district (Figure 59). The features include a bird species and a mussel of Special Concern status. The publication of exact descriptive and 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 Pine Mountain Lake, practices that maintain good water quality and the integrity of the shoreline will be beneficial to all species involved.

Figure 59. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Pine Mountain Lake shoreline.



 Rare features data have been provided by the Division of Ecological Resources, Minnesota Department of Natural Resources (MNDNR) and were current as of February 15, 2009. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Bay Delineation

Objectives

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

Introduction

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

Methods

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

Results

No bays were delineated on Pine Mountain Lake.

II. Ecological Model Development

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

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

Scores for each of the layers were summed (Figure 60). 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 61). 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 62).

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

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

Table 5, continued.

Variable	Score	Criteria
Aquatic Plant Richness	3	Total number of plant taxa per analysis window > 10
	2	Total number of plant taxa 5 – 10
	1	Total number of plant taxa 1 – 4
	0	No vegetation present
Presence of Emergent and Floating-leaf 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 SGCN within analysis window
	2	Presence of 2 SGCN
	1	Presence of 1 SGCN
	0	No SGCN present
Bird Richness	3	Total number of bird species within analysis window > 25
	2	Total number of bird species 11 – 25
	1	Total number of bird species 1 – 10
	0	No bird species observed
Loon Nesting Areas	3	Presence of natural loon nest within analysis window
	2	Presence of loon nest on artificial platform
	0	No loon nesting observed
Frogs	3	Presence of both mink and green frogs within analysis window
	2	Presence of mink or green frogs
	0	Neither mink nor green frogs present

Table 5, continued.

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

Figure 60. Total score layer created by summing scores of all 15 variables. Highest total scores represent most sensitive areas of shoreline.

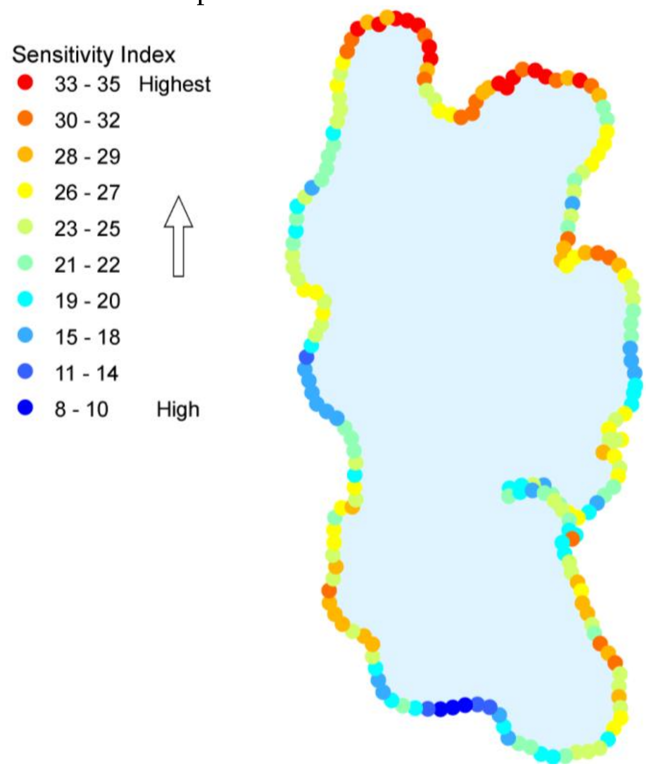


Figure 61. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland)

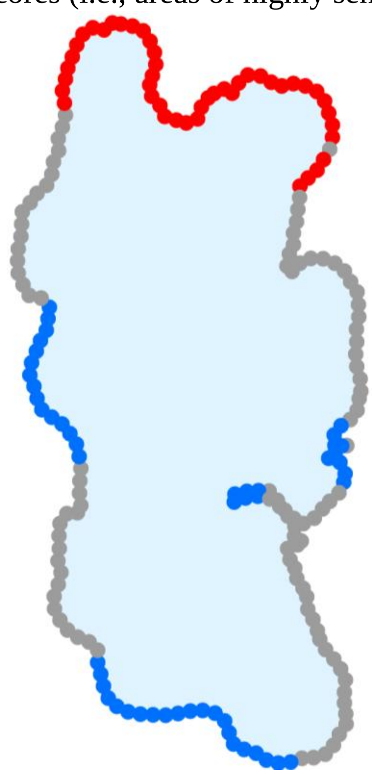
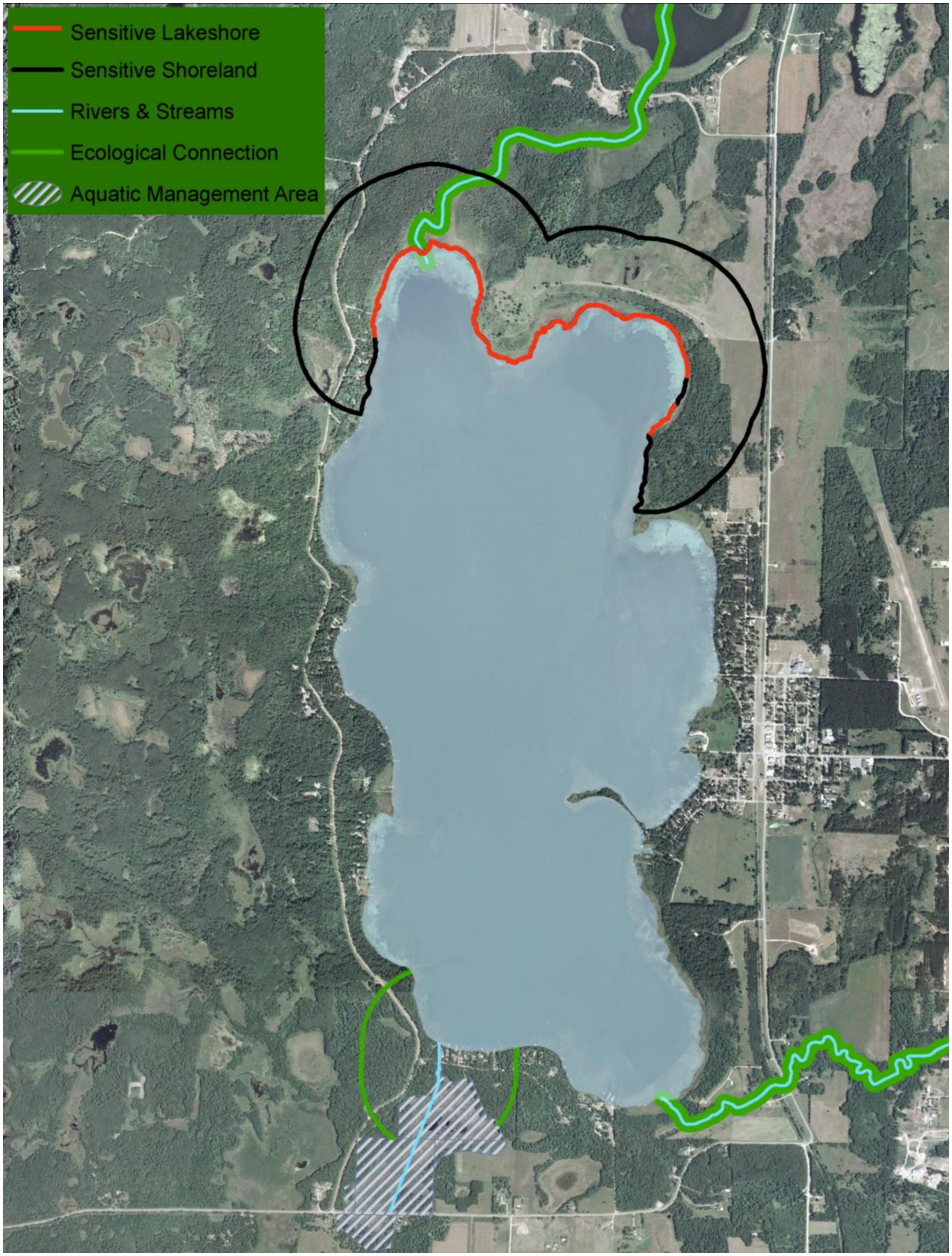


Figure 62. The Pine Mountain Lake sensitive lakeshore area identified by the ecological model and ecological connections.



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. Aquatic habitat connectivity allows for movement of organisms within a watershed. Organisms can move between exisiting habitats, colonize new areas, or recolonize former habitat in the wake of local extinctions. The inlet on the northern end of Pine Mountain Lake, the inlet on the southern end of the lake, and the outlet on the east were all identified as important ecological connections. The northern inlet connects to several lakes nearby, including Island Lake and Beuber Lake. The southern inlet enters from a state-owned Aquatic Management Area. This 92 acre management area encompasses a large wetland tract and provides spawning habitat for northern pike. The outlet forms the beginning of the Pine River, and flows into Bowen and Line Lakes to the east. Depending on the existing shoreland classification of these waters, the County may use the ecological connection recommendation to consider reclassifying to a more protective river class.

Other Areas of Ecological Significance
There are other areas near Pine Mountain Lake that contain important aquatic plant communities, but are not necessarily associated with priority shoreland areas. Often, these sites are too small to warrant inclusion as part of a shoreline protection district, but their small size is a defining feature that adds to their importance within the lake. Identifying these sites is important, although exact delineation of their boundaries can be difficult because they occur in the water and may be patchy in distribution.

Emergent and floating-leaf plant beds that occur outside of the Pine Mountain Sensitive Shoreland districts are areas of ecological significance. Nearly the entire shoreline of Pine Mountain Lake is ringed by beds of bulrush, wild rice and/or waterlilies. Many of these beds have already been fragmented by boat channels. Further destruction of bulrush plants would be particularly detrimental because attempts to restore these types of plants have had limited success.

Native submerged plant beds are also considered sites of ecological significance, regardless of whether or not they are associated with priority shorelines. Not only do these beds provide critical habitat for fish and wildlife, but they may also help mitigate the potentially harmful impacts if invasive plants occur in the lake. Muskgrass, the dominant submerged plant in Pine Mountain Lake, may form continuous submerged mats where other plant species are not present. Despite the low plant species richness in these sites, this habitat is unique and valuable. Certain rare fish species, such as pugnose shiners, have been associated with muskgrass beds (Becker 1983).

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

Sensitive Lakeshore

The northern shoreline of Pine Mountain Lake 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 along this shoreline. The ecological model displays this area both as sensitive shoreline and as high priority shoreland. Although the shoreline itself is important, development and land alteration nearby has significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. The rivers and streams associated with Pine Mountain Lake are also a vital part of the lake ecosystem, and provide important habitat connectivity. 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. 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 Pine Mountain Lake, and the value of the lake itself.

References

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

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison. 1052 pp. http://www.digital.library.wisc.edu/1711.dl/EcoNatRes.FishesWI

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

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

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

Crow, G.E. and C.B. Hellquist. 2000. Aquatic and wetland plants of Northeastern North America. 2 volumes. The University of Wisconsin Press.

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

Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford. http://www.efloras.org

Lindon, M., S. Heiskary, and Pine Mountain Lake Association. 2005. Lake assessment program, Pine Mountain Lake 11-0411. Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division. http://www.pca.state.mn.us/publications/reports/wq-lar3-04.pdf

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

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

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

Minnesota Department of Natural Resources. 2005. Lake information report, Pine Mountain Lake. Minnesota Department of Natural Resources, Division of Fish and Wildlife. http://www.dnr.state.mn.us/lakefind/index.html

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

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

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

Minnesota Department of Natural Resources. 2008b. Natural wild rice in Minnesota. A wild rice study document submitted to the Minnesota Legislature by the Minnesota Department of Natural Resources, February 15, 2008. 117 pp. http://files.dnr.state.mn.us/fish_wildlife/legislativereports/20080215_wildricestudy.pdf

Minnesota Pollution Control Agency. 2008. Clean lake monitoring program. Minnesota Pollution Control Agency, St. Paul. http://www.pca.state.mn.us/water/clmp.html

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

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

Myhre, K. 2008. Plant survey of Pine Mountain Lake (11-0411-00), Cass County, Minnesota, July 8, 2008. Minnesota Department of Natural Resources, Ecological Resources Division. Minnesota County Biological Survey Program. Unpublished data.

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

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

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

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

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

Perleberg, D and S. Loso. 2009. Aquatic vegetation of Pine Mountain Lake (DOW 11-0411-00), Cass County, Minnesota, 2007. Minnesota Department of Natural Resources, Ecological Resources Division, Brainerd. 21 pp.

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

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

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

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

Appendix 1. Shoreline emergent aquatic plants and shrubs recorded in Pine Mountain Lake, 2008.

Common Name	**Scientific Name**	**Survey type**[a]
Canada blue-joint grass	*Calamagrostis canadensis*	2
Water sedge	*Carex aquatilis*	2
Wiregrass sedge	*Carex lasiocarpa* var. *americana*	1
Swamp milkweed	*Asclepias incarnata*	1,2
Beggarticks	*Bidens* sp.	2
White bell flower	*Campanula aparinoides*	2
Porcupine-like sedge	*Carex hystricina*	1
Prairie sedge	*Carex prairea*	1
Hummock sedge	*Carex stricta*	1
Spotted water hemlock	*Cicuta maculata*	1
Wild rye	*Elymus* sp.	2
Spotted joe-pye weed	*Eutrochium maculatum*	1,2
Bottle gentian	*Gentian andrewsii*	2
Touch-me-not	*Impatiens capensis*	2
Northern bugleweed	*Lycopus uniflora*	1,2
Tufted loosestrife	*Lysimachia thyrsiflora*	2
Wild mint	*Mentha arvensis*	2
Reed canary grass	*Phalaris arundinaceae*	1,2
Clearweed	*Pilea pumila*	2
Red-tinged bulrush	*Scirpus microcarpus*	1
Marsh skullcap	*Scutellaria galericulata*	2
Stinging nettle	*Utrica dioica*	2
Red-osier dogwood	*Cornus stolonifera*	2
Wild rose	*Rosa* sp.	2
Willow	*Salix* sp.	1,2
High-bush cranberry	*Viburnum trilobum*	2

[a]Survey type: 1 = July 8, 2008 (K. Myhre, MN DNR Minnesota County Biological Survey), 2 = August 6, 2008 (Perleberg and Loso, nearshore vegetation plots)

Nomenclature follows MNTaxa 2009

Appendix 2. Bird species list. Includes all species within Pine Mountain Lake and shoreland recorded during surveys and casual observation, May – June 2008.

Common Name	**Scientific Name**
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Red-necked Grebe	*Podiceps grisegena*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Cooper’s Hawk	*Accipiter cooperii*
Merlin	*Falco columbarius*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Sandhill Crane	*Grus canadensis*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularius*
Wilson’s Snipe	*Gallinago delicata*
Bonaparte’s Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Black Tern	*Chlidonias niger*
Common Tern	*Sterna hirundo*
Mourning Dove	*Zenaida macroura*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Alder Flycatcher	*Empidonax alnorum*
Eastern Phoebe	*Sayornis phoebe*

Appendix 2, continued.

Common Name	Scientific Name
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Tree Swallow	*Tachycineta bicolor*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Veery	*Catharus fuscescens*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
European Starling	*Sturna vulgaris*
Cedar Waxwing	*Bombycilla cedrorum*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Indigo Bunting	*Passerina cyanea*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Baltimore Oriole	*Icterus galbula*
American Goldfinch	*Carduelis tristis*