Final Report Sensitive Lakeshore Survey Long Lake (11-0142-00) Cass County, Minnesota

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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*

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Executive Summary

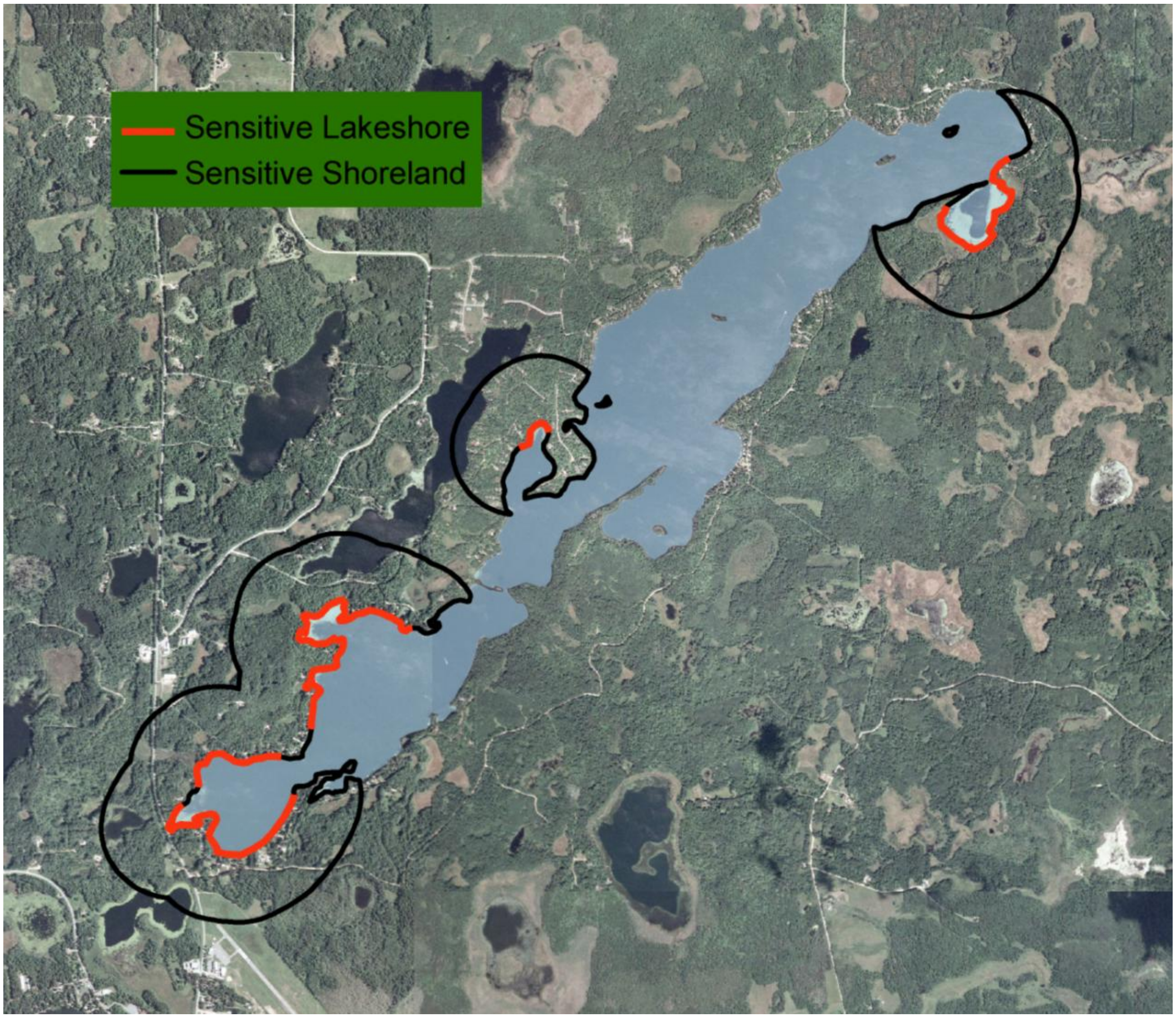
Aquatic plants occurred around the entire shoreline. A total of 45 native aquatic plant taxa were recorded in Long Lake, including 29 submerged, five floating-leaved and 11 emergent taxa. Submerged plants occurred to a depth of 30 feet but were most common in the shore to 15 feet depth zone where 96 percent of the sample sites contained vegetation. Rooted submerged plants were most common in water depths of 15 feet and less, while large algae and moss were frequent in the 16 to 25 feet depth zone. Emergent and floating-leaf plants were abundant in most bays and covered approximately 34 acres. Several unique plants and a rare (Special Concern) submerged plant were documented during the surveys, and indicate a relatively undisturbed native plant community in Long Lake.

Twenty-two different fish species were identified during the survey, including nine species not previously documented in the lake. No fish species of greatest conservation need were observed, but surveyors did find three proxy species (blackchin shiner, blacknose shiner, and banded killifish). Both mink and green frogs were detected, with the majority located within or near protected bays.

Surveyors documented 66 species of birds, including 13 species of greatest conservation need. Song sparrows were the most frequently detected species overall, whereas ovenbirds were the most commonly detected species of greatest conservation need. Bird species were distributed both within the bays and along the shoreline of the main basins.

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. Lakeshore sensitive areas were buffered and important ecological connections or linkages mapped. The identification of sensitive lakeshore by this method is an objective, repeatable and quantitative approach to the combination of multiple lines of evidence through calculation of weight of evidence. The ecological model results are lake-specific, in that the model results are intended to recognize the most probable highly sensitive lakeshores for a specific lake. Plant and animal assemblages differ naturally between lakes, and sensitivity scores should not be compared across lakes.

The ecological model identified three primary sensitive lakeshore areas to be considered for potential resource protection districts by Cass County. The County may use this objective, science-based information in making decisions about districting and reclassification of lakeshore areas. The most probable highly sensitive lakeshore areas and the recommended resource protection districts are:


Sensitive Lakeshore
Sensitive Shoreland

Introduction

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

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

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

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

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

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

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

Lake Description

Long Lake (DOW# 11-0142-00) is located about one mile northeast of the city of Longville in Cass County, north-central Minnesota (Figure 1).

Figure 1. Location of Long Lake in Cass County, MN

The lake occurs within the Boy River Watershed but is not directly connected to the Boy River. It is a glacial ice block lake with no major inlet or outlet and receives most of its inflow from precipitation and groundwater flow.

As its name implies, it is one of the longest lakes in the county with about 15 miles of shoreline. Long Lake has a northeast to southwest orientation with several distinct basins and small bays (Figure 2). It has a maximum depth of 115 feet and about 38 percent of the lake is less than 15 feet in depth (Figure 3). The watershed is primarily forested with numerous wetlands, typical for lakes in this region. Because of this, the lake receives minimal phosphorus loading (MPCA 2002). The shoreline of Long Lake is heavily developed and has a public access on the northwestern side.

Long Lake is a described by the Minnesota Department of Natural Resources as a Class 25 lake, meaning it is clear, deep, and irregularly shaped (MN DNR 2004). In 2002, the water quality of Long Lake was described as better than reference lakes in the region, based on total phosphorus, chlorophyll-a, and Secchi disc transparency (MPCA 2002). Long Lake is a mesotrophic lake, and contains moderate levels of nutrients (Skon 2005). The Minnesota DNR Section of Fisheries manages the lake mainly for northern pike and largemouth bass (MN DNR 2004).

Figure 2. Features of Long Lake.

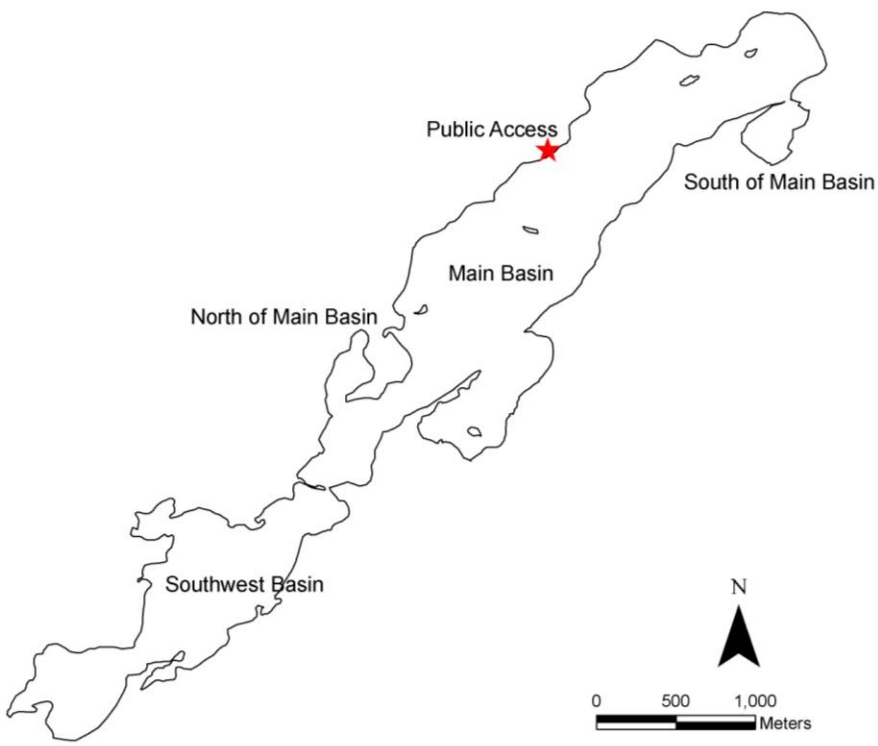
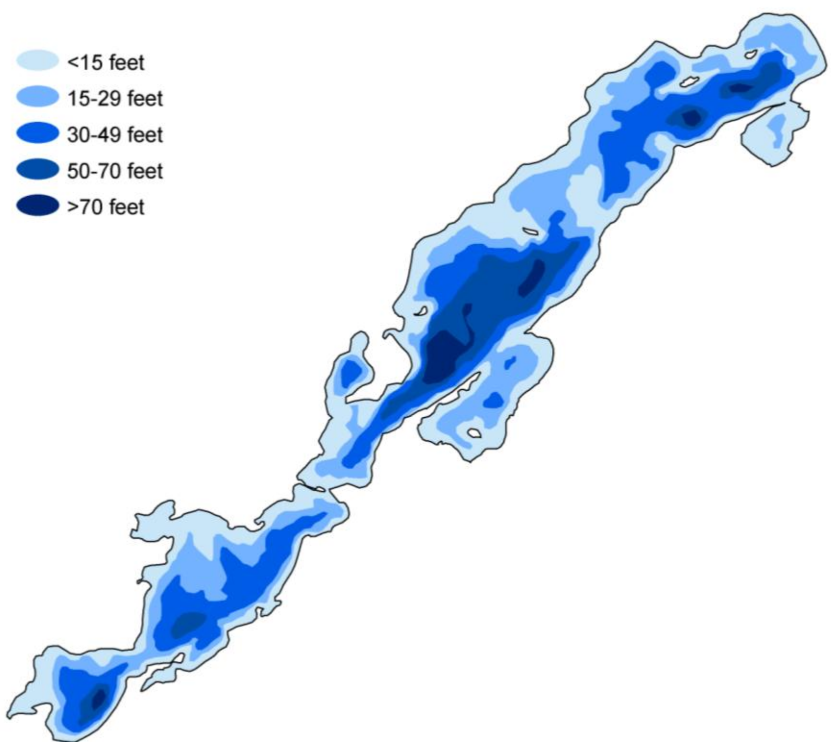


Figure 3. Depth contours of Long Lake.



I. Field Surveys and Data Collection

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

Pugnose shiner photo courtesy of Konrad Schmidt

Wetlands

Objectives

1. Map wetlands within the extended state-defined shoreland area of Long 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 Long Lake ordinary high water mark were excluded from this analysis.

Results

Approximately 245 acres, or about 14 percent of the Long Lake shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI (Figure 4).

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

Figure 5. Alder swamp wetland adjacent to Long Lake

The largest wetlands were 10 to 30 acres in area and occurred on the north end of the lake. These wetlands can be described as palustrine scrub shrub (Cowardin et al. 1979) or wetland shrubland (MN DNR 2003) systems, dominated by evergreen and/or deciduous shrubs, such as alder (Figure 5).

Smaller emergent wetland (Cowardin et al. 1979) or wet meadow and marsh (MN DNR 2003) systems occurred around the lake. These wetlands are characterized by herbaceous, emergent wetland vegetation, including sedges and flowering plants (Figure 6).

Figure 6. Marsh plants on Long Lake shore

Small tracts (less than ten acres in area) of forested wetlands (Cowardin et al. 1979, MN DNR 2003) were also present. These plant communities are dominated by deciduous and/or evergreen trees.

Hydric Soils

Objectives

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

Approximately 200 acres of hydric soils are scattered along the shoreline of Long Lake (Figure 7). Most of these soils are histosols, or soils comprised primarily of organic matter. They are very poorly drained, and are often acidic. These soils are also known as muck or peat.

Figure 7. Hydric soils within 1320 feet of Long Lake shoreline.

Plant Surveys

Objectives

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

Aquatic plants occurred around the entire perimeter of Long Lake and the widest bands of vegetation occurred in shallow areas, such as bays. A total of 45 native aquatic plant taxa were recorded in Long Lake and included 29 submerged, five floating-leaved and 11 emergent taxa.

Submerged plants occurred to a depth of 30 feet but were most common in the shore to 15 feet depth zone, where 96 percent of the sample sites contained vegetation. Rooted submerged plants were most common in water depths of 15 feet and less, while large algae and moss were frequent in the 16 to 25 feet depth zone. Common non-rooted submerged plants were stonewort (*Nitella* sp.), muskgrass (*Chara* sp.) and watermoss. Common rooted submerged plants included Robbins' pondweed (*Potamogeton robbinsii),* white-stem pondweed (*P. praelongus*), large-leaf pondweed *(P. amplifolius*), and Canada waterweed (*Elodea canadensis*).

Floating-leaf plants occupied about 34 acres and were mostly located in protected bays. Common species were watershield (*Brasenia schreberi*), white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*). About three acres of emergent bulrush (*Schoenoplectus acutus*) beds were mapped on sandy sites around the northern islands.

Unique submerged aquatic plants documented during the surveys included humped bladderwort (*Utricularia gibba*), lesser bladderwort (*U. minor*), flat-leaved bladderwort (*U. intermedia*), water bulrush (*Schoenoplectus subterminalis*), leafless watermilfoil (*Myriophyllum tenellum*) and creeping spearwort (*Ranunculus flammula*). Unique emergent aquatic plants were narrow-leaved burreed (*Sparganium angustifolium*) and three-way sedge (*Dulichium arundinaceum*).

An aquatic plant of Special Concern status, Vasey's pondweed (*Potamogeton vaseyi*), was documented for the first time in Long Lake in 2007. Another rare (Special Concern) aquatic plant, thread-like naiad (*Najas gracillima*), occurs in a nearby lake.

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.

Non-native submerged aquatic plant species have not been documented in Long Lake. However, if they invade the lake, they may directly or indirectly impact the native plant community. Non-native plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that shade out native plants. The impact of these invasive species varies among lakes but the presence of a healthy native plant community may help mitigate the harmful effects of these exotics.

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

Submerged plants

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

Pondweeds (*Potamogeton* 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. Robbins' pondweed

<u>Robbins' (fern) pondweed</u> (*Potamogeton robbinsii*; Figure 8) grows entirely submerged with flattened, grass-like leaves that resemble a palm branch. Robbins' pondweed occurs in

numerous lakes in northern Minnesota (Ownbey and Morley 1991). It is often found at the deep edge of the vegetation zone and can form dense colonies that cover the lake bottom (Flora of North America 1993+).

Figure 9. White-stem pondweed

White-stem pondweed (*Potamogeton praelongus*) and large-leaf pondweed (*P. amplifolius*) are broad-leaf pondweeds and are often called "cabbage" plants by anglers. White-stem pondweed (Figure 9) has only submerged leaves but large-leaf pondweed (Figure 10) may form floating leaves in sheltered sites. These two species are common in many clear water Minnesota lakes but are often among the first species to decline in degraded water. White-stem pondweed is not tolerant of turbidity and large-leaf pondweed may be negatively impacted by increased lake development (Nichols 1999b).

Figure 10. Large-leaf pondweed

Canada waterweed (*Elodea canadensis*) is a rooted, perennial submerged species that is widespread throughout Minnesota (Ownbey and Morley 1991) and is adapted to a variety of conditions. It is tolerant of low light and prefers soft substrates (Nichols 1999b). This species can over-winter as an evergreen plant and spreads primarily by fragments. The branching stems of this plant (Figure 11) can form thick underwater plant beds that are valuable habitat for a variety of fish and invertebrates.

Figure 11. Canada waterweed

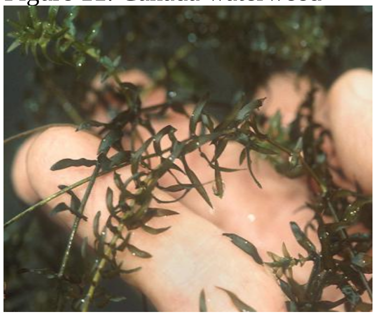


Photo by: Vic Ramey, U. of Florida

Large algae and mosses also occur in Minnesota lakes. They 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. These plant beds provide important habitat for fish spawning and nesting.

Figure 12. Bed of muskgrass

Muskgrass (*Chara* sp.; Figure 12) is a large algae that is common in many hard-water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. 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.

Stonewort (*Nitella* sp.) is also a large algae, but lacks the brittle texture and musky odor of muskgrass. Instead, it is odorless and soft to the touch. It has fine, bright green strands that resemble hair when pulled from the water (Figure 13). Stonewort is an important food source for waterfowl, especially ducks. It also provides habitat for invertebrate communities, which then serve as a food source for a variety of fish.

Figure 13. Stonewort

Watermoss is a submerged aquatic plant that does not form true roots, leaves or flowers. This plant may attach to rocks or logs in flowing water, or may float loose in still water. Watermoss provides habitat for aquatic insects, larvae, and other microorganisms. Small fish species may also nest in clumps of watermoss.

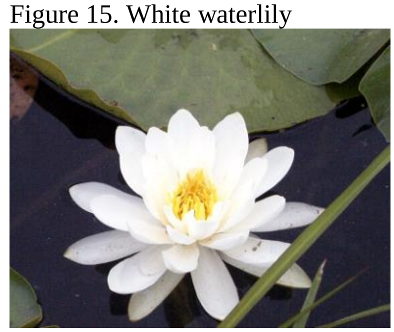
Floating-leaf and emergent plants

Floating-leaf and emergent aquatic plants are anchored to 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 areas 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 landward onto mudflats and into adjacent wetlands.

Figure 14. Watershield

Floating-leaf plants include watershield (*Brasenia schreberi*), white waterlily (*Nymphaea odorata),* and yellow waterlily (*Nuphar variegata*). These are perennial plants that can reproduce by seed and by vegetative growth. Watershield may produce winterbuds and waterlilies typically over-winter by hardy rhizomes.

Figure 15. White waterlily



Watershield is most often found in soft-water lakes (Borman et al. 2001) in northern Minnesota. It has relatively small, floating oval leaves and small reddish flowers (Figure 14). The leaves are green on top, while the underside of the leaves and stems are reddish-purple. The leaves and stems of watershield have a slippery, gelatinous coating.

White and yellow waterlilies can be found in lakes in both northern and southern Minnesota. White waterlily (Figure 15) has showy white flowers and round leaves with radiating veins. Yellow waterlily (Figure 16) 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 16. 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 as well as annual plants.

Figure 17. Bulrush stand in Long Lake

Figure 18. Spikerush bed in Long Lake

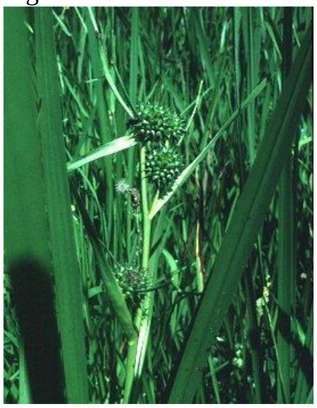
Narrow-leaved emergent plants include <u>bulrush</u> (*Schoenoplectus* spp.; Figure 17) and <u>spikerush</u> (*Eleocharis* spp.; Figure 18). These are perennial plants that occur in lakes and wetlands throughout Minnesota (Ownbey and Morley 1991). These plants have narrow stems that are typically round in cross section and lack showy leaves. Clusters of small flowers form near the tips of long, narrow stalks. Most of these plants occur as emergents, from shore to water depths of about six feet and their stems may extend several feet above the water surface. Some species may also grow as submerged forms. Bulrush and spikerush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans.

Figure 19. Arrowhead

There are several types of broad-leaved emergent plants and these often occur close to the shoreline. While these plants most often occur as emergents, several species may grow as floating-leaved plants for all or part of their life cycle.

<u>Arrowhead</u> (*Sagittaria* spp.; Figure 19) are broad-leaf, perennial plants that may form emergent, floating and/or submerged leaves. They may be found submerged in several feet of water or growing emergent along shore and in wetlands. These plants form small, but attractive white flowers that later develop into green seed heads. Arrowhead seeds and tubers are valuable food for waterfowl and marsh birds and leaves and tubers may be eaten by muskrats (Newmaster et al. 1997).

Figure 20. Giant burreed



<u>Burreed</u> (*Sparganium* spp.; Figure 20) are perennial, emergent plants with leaves that resemble cattails but are shorter in height with triangular leaves. Burreed grows in shallow water (less than 4 feet) along shorelines and in wetlands throughout Minnesota. Some burreed species form only floating leaves, some are only emergent or some can form both types of leaves. The plants produce fruits with nut-like achenes that are eaten by ducks, common snipe and rails; the stems and the leaves are a preferred food of muskrats and deer (Newmaster et al. 1997).

<u>Wild rice</u> (*Zizania palustris*) is an emergent annual plant (Figure 21) 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 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).

Figure 21. Wild rice

Unique aquatic plants

Unique aquatic plant species are of high conservation importance. These species are not listed as rare but are important because:

- They are uncommon in the state or locally. These may include species that are proposed for rare listing.
- They are 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.

Bladderworts (*Utricularia* spp.) are a group of submerged plants that produce roots but do not firmly anchor to the lake bottom. Greater bladderwort (*U. vulgaris)* is found in lakes and ponds throughout Minnesota, but several other species are much less common. Unique bladderwort species include humped bladderwort (*Utricularia gibba*), lesser bladderwort (*U. minor*) and flat-leaved bladderwort (*U. intermedia*). These small, submerged plants are often confused as algae because they have fine, hair-like stems and leaves. Bladderworts have specialized air bladders that regulate their position in the water column. They act as "underwater Venus fly-traps" by catching and digesting small insects in the bladders. Bladderworts produce small but showy flowers (Figure 22) that emerge above the water surface. They prefer soft substrates (Nichols 1999b) but also float freely in the water column and may be found in protected areas such as waterlily beds. They have been documented at scattered locations throughout northern Minnesota (Ownbey and Morley 1991).

Figure 22. Bladderwort in flower among watershield

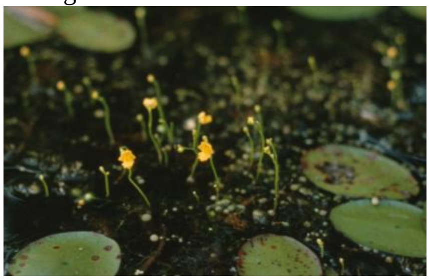


Figure 23. Water bulrush

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

Water bulrush (*Schoenoplectus subterminalis*) is a submerged, perennial plant with fine, grass-like leaves that may form mats and float near the water surface (Figure 23). In mid to late summer its leaf tips and flower stalk may emerge above the water surface. This species once had a patchy distribution throughout North America but may now be extirpated from Illinois (Flora of North America 1993+), and its conservation status is listed as critically impaired in several other states (NatureServe 2008). It is infrequently found in Wisconsin (Nichols 1999b) and Minnesota (Ownbey and Morley 1991) lakes.

Figure 24. Leafless watermilfoil

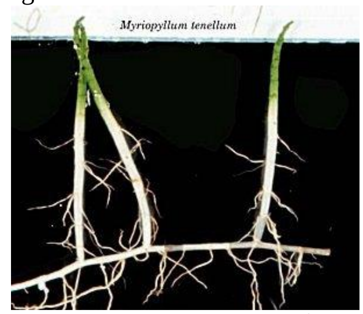


Photo by: Theodore Cochrane, U. of WI-Stevens Point Herbarium

Leafless watermilfoil (*Myriophyllum tenellum*; Figure 24) is a low growing, submerged plant found in low alkalinity, low conductivity waters (Nichols 1999b). This plant prefers hard substrates like sand and gravel (Nichols 1999b). Leafless watermilfoil stems arise singly along buried rhizomes. Its leaves are very small scales or bumps on the stems. Flowers form if the tips rise above the water. Leafless watermilfoil provides habitat for panfish and shelter for small invertebrates. The network of rhizomes it produces is a good sediment stabilizer (Borman et al. 2001).

Figure 25. Creeping spearwort

Photo by: Emmit Judziewicz, U. of WI-Stevens Point Herbarium

Creeping spearwort (*Ranunculus flammula*) is mostly found in the northern half of Minnesota (Flora of North America 1993+). It grows on hard substrates like sand and gravel (Borman et al. 2001). In Cass County lakes it often grows as a submerged plant but may also grow as a short emergent on mudflats. It has linear leaves that emerge in small clusters from the arched runners or stolons. This plant is in the buttercup family and if stranded on mudflats, it may form characteristic yellow buttercup flowers (Figure 25).

Figure 26. Narrow-leaved burreed

Photo by: Gary Fewless, U. of WI – Green Bay, Coffrin Center for Biodiversity, Herbarium, © 2005

Narrow-leaved burreed (*Sparganium angustifolium*; Figure 26) is a floating-leaf plant that occurs in scattered lakes of northeastern Minnesota. In Wisconsin it has been documented along shores of low conductivity and low alkalinity lakes (Nichols 1999b). It may grow in water up to five feet deep (Nichols 1999b). The grass-like leaves are narrow and rounded on the tip (Borman et al. 2001). This plant produces flowers in early summer and fruits in middle to late summer.

Figure 27. Three-way sedge

Photo by: A. Murray, U. of FL. Center for Aquatic Plants. © 2003.

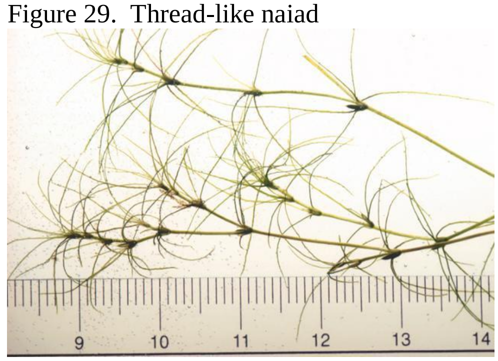
Three-way sedge (*Dulichium arundinaceum*; Figure 27) is an emergent, perennial plant that grows along soft bottom lakeshores and in marshes. This plant does not produce a showy flower but can be identified by its unique three-ranked leaf arrangement that resembles a three-armed airplane propeller from above (Newmaster et al. 1997). Three-way sedge is found along shores of lower alkalinity lakes (Nichols 1999b) throughout central and northern Minnesota (Ownbey and Morley 1991).

Rare plant species

Figure 28. Vasey's pondweed

Vasey's pondweed (*Potamogeton vaseyi*) is a perennial plant found primarily in low alkalinity, low conductivity waters (Nichols 1999b). It has fine submersed leaves and small floating leaves (Figure 28). This is a species of Special Concern in Minnesota because of its rarity in the state. Vasey's pondweed is vulnerable to disturbance of its habitat, including mechanical disturbance and certain types of herbicide.

Figure 29. Thread-like naiad



Thread-like naiad (*Najas gracillima*) is an annual, submerged aquatic plant. This species is similar in appearance to the more common plant, bushy pondweed (*Najas flexilis*), but has a more slender stem and leaves (Figure 29). Mature fruits are often important for identification. It is listed as a species of Special Concern in Minnesota and has primarily been found in northern, low alkalinity lakes. This species is intolerant of pollution and is now becoming rare throughout its range (Gleason and Cronquist 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 occur in a lake (Moyle 1945), and thus, indirectly influences lakewide species richness. The trophic status of a lake further influences plant species richness, and eutrophic and hypertrophic habitats have been associated with reduced species richness (Pip 1987). Within a region of Minnesota, lakewide aquatic plant species richness can be used as a general indicator of the lake clarity and overall health of the lake plant community. Loss of aquatic plant species has been associated with anthropogenic eutrophication (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 Long 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 Long Lake in late June 2007 (Perleberg 2008). A GIS computer program was used to establish aquatic plant survey points throughout the littoral (i.e., vegetated) zone of the lake to a depth of 30 feet. Points were spaced 40 meters apart and 1,501 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.

Emergent and floating-leaf bed delineation

Protocol for mapping plant beds were based on the procedures documented in the DNR draft Aquatic Vegetation Mapping Guidelines (MN DNR 2005). They included a combination of aerial photo delineation and interpretation, field delineation, ground-truthing and site specific surveys. Waterlily beds were delineated using 2003-2004 Farm Service Administration (FSA) true color aerial photos. Black and white aerial photos from 1999 were used to help distinguish the true shoreline from mats of perennial vegetation. Field mapping focused on bulrush stands, which were difficult to see on aerial photos. Bulrush stands were mapped in 2007 using handheld GPS technology. Surveys were conducted of the largest stands to verify species composition and, if needed, modify boundary lines.

Near-shore vegetation survey

Near-shore vegetation surveys were conducted at two plots. Plots were selected based on the presence of nongame fish. Each plot measured 15 meters along the shoreline and 16 meters lakeward, and 30 (1 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 species

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

Surveyors searched for unique plant species in 2007 during the lakewide point-intercept surveys and near-shore plot surveys. Any new sites of rare plant species were documented and entered into the MN DNR Natural Heritage Information System. 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 other 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

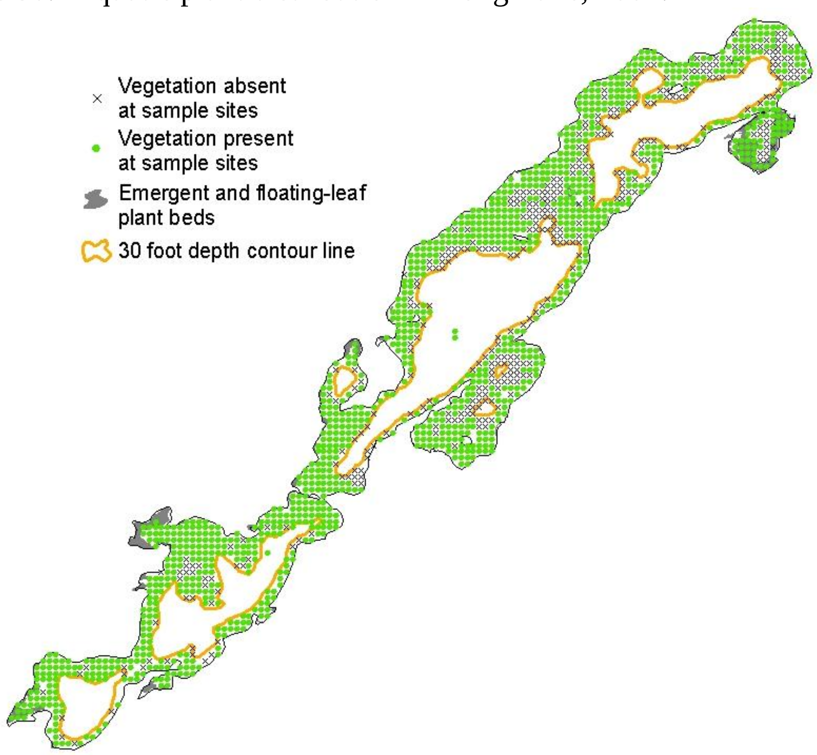
Submerged plants were found to a water depth of 30 feet, the maximum depth sampled. This vegetated zone includes about two-thirds of the lake and within this area, 76 percent of the survey sites contained vegetation. Plant occurrence was greatest in depths from shore to 15 feet, where 96 percent of the sites were vegetated. In water depths of 26 to 30 feet, only 28 percent of the sites contained plants.

Emergent plants occurred in water depths of five feet and less, and floating-leaf plants were restricted to water depths less than 10 feet. Rooted submerged plants were primarily restricted to depths of 15 feet and less. Submerged algae and moss were the most common plant types found beyond the 20 feet depth.

Distribution of plants in main basin versus bays

Aquatic plants occurred around the entire lake perimeter, but were most abundant in shallow areas such as bays and narrows (Figure 30). Vegetation beds were smaller along the southeast and northeast shores, where water depths increased sharply from shore. Emergent and floating-leaf plants were abundant in most bays.

Figure 30. Aquatic plant distribution in Long Lake, 2007.



Aquatic plant species observed

A total of 45 aquatic plant taxa were recorded in Long Lake. These included 29 submerged taxa (Table 1), five floating-leaved and 11 emergent taxa (Table 2). An additional 22 shoreline plants were recorded in Long Lake (Appendix 1).

Table 1. Submerged aquatic plants recorded in Long Lake, 2007.

Description			**Common Name**	**Scientific Name**	**Frequency[a] N = 1501**
SUBMERGED and/or FREE-FLOATING	**Rooted plants**	Grass-leaf plants	Robbins' pondweed	*Potamogeton robbinsii*	36
			Flat-stem pondweed	*Potamogeton zosteriformis*	5
			Water stargrass	*Zosterella dubia*	1
			Wild celery	*Vallisneria americana*	<1
		Bushy-leaf plants	Canada waterweed	*Elodea canadensis*	29
			Bushy pondweed	*Najas flexilis*	1
		Broad-leaf plants	White-stem pondweed	*Potamogeton praelongus*	16
			Large-leaf pondweed	*Potamogeton amplifolius*	15
			Variable pondweed	*Potamogeton gramineus*	6
			Illinois pondweed	*Potamogeton illinoensis*	<1
		Narrow-leaf plants	Small pondweed	*Potamogeton pusillus*	3
			Fries' pondweed	*Potamogeton friesii*	<1
			Vasey's pondweed	*Potamogeton vaseyi*	<1
			Snail-seed pondweed	*Potamogeton spirillus*	Present[b]
		Dissected-leaf plants	Coontail	*Ceratophyllum demersum*	9
			White water buttercup	*Ranunculus aquatilis*	1
			Humped bladderwort	*Utricularia gibba*	2
			Flat-leaved bladderwort	*Utricularia intermedia*	1
			Lesser bladderwort	*Utricularia minor*	1
			Greater bladderwort	*Utricularia vulgaris*	1
		Needle-leaf plants	Needlerush	*Eleocharis acicularis*	1
			Quillwort	*Isoetes* sp.	1
			Leafless watermilfoil	*Myriophyllum tenellum*	1
			Creeping spearwort	*Ranunculus flammula*	1
			Water bulrush	*Schoenoplectus subterminalis*	1
		Duckweed	Star duckweed	*Lemna trisulca*	<1
	Algae and mosses		Stonewort	*Nitella* sp.	13
			Muskgrass	*Chara* sp.	10
			Watermoss	Not identified to genus	11

[a]Frequency values represent the percent of the plant point-intercept sample stations that contained a plant taxon.

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

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaved and emergent aquatic plants recorded in Long Lake, 2007.

Description	Common Name	Scientific Name	Frequency[a] N = 1501
FLOATING-LEAF	Watershield	*Brasenia schreberi*	5
	Yellow waterlily	*Nuphar variegata*	3
	White waterlily	*Nymphaea odorata*	3
	Floating-leaf pondweed	*Potamogeton natans*	1
	Narrow-leaved burreed	*Sparganium angustifolium*	<1
Narrow-leaf EMERGENTS	Spikerush	*Eleocharis* sp.	1
	Horsetail	*Equisetum fluviatilis*	<1
	Juncus	*Juncus* sp.	Present[b]
	Hardstem bulrush	*Schoenoplectus acutus*	<1
Leafy EMERGENTS	Three-way sedge	*Dulichium arundinaceum*	<1
	Giant cane	*Phragmites australis*	Present[b]
	Broad-leaf arrowhead	*Sagittaria latifolia*	2
	Giant burreed	*Sparganium eurycarpum*	Present[b]
	Narrow-leaf cattail	*Typha* sp.	Present[b]
	Broad-leaf cattail	*Typha latifolia*	<1
	Wild rice	*Zizania palustris*	<1

[a]Frequency values represent the percent of the point-intercept sample stations that contained a plant taxon.

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

Nomenclature follows MNTaxa 2009.

Submerged plants

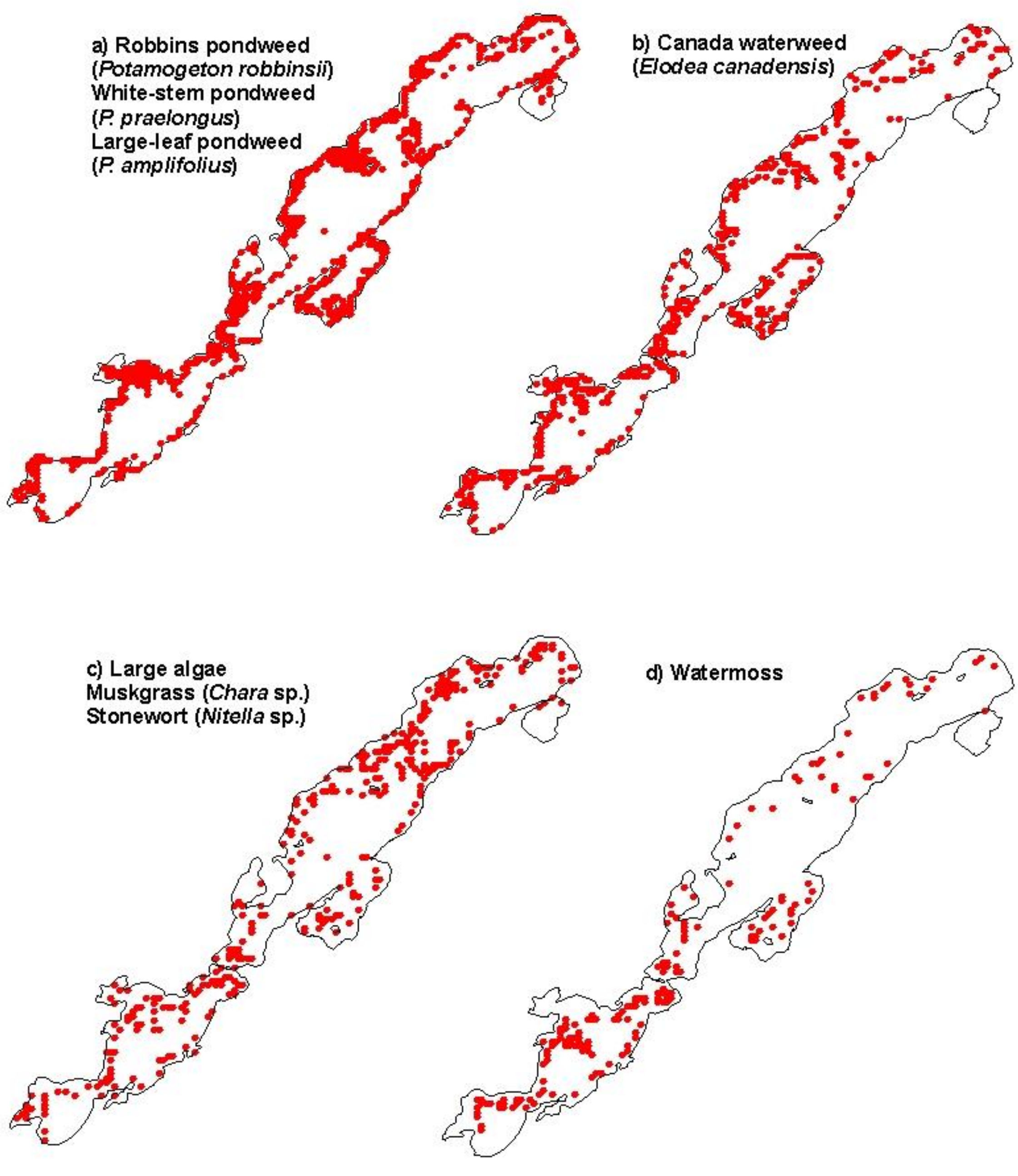
Submerged plants occurred in 63 percent of Long Lake sample sites. The plant community included leafy plants that are anchored to the lake bottom by roots as well as large algae and aquatic moss that may resemble leafy plants but are weakly anchored to the lake bottom or drift freely with the currents.

Ten different submerged pondweeds (*Potamogeton* spp.) occurred in Long Lake. Robbins' pondweed was the most abundant, and was found in 36 percent of all sample sites (Table 1). It was the dominant taxa in depths of 15 feet and less. White-stem pondweed and large-leaf pondweed occurred in 16 and 15 percent of the sites, respectively (Table 1). These pondweeds were found around the entire perimeter of Long Lake (Figure 31a), often co-occurred at sites, and were most frequent in depths of 15 feet and less.

Canada waterweed was the other important rooted plant found. It occurred in 29 percent of all sample sites (Table 1). Canada waterweed occurred to a depth of 22 feet but was most common in the six to 15 feet depth zone where it occurred in 49 percent of the sites (Figure 31b).

The other common plant taxa in Long Lake were large algae and mosses. Stonewort, muskgrass and watermoss occurred in 13, 10, and 11 percent of the sites, respectively (Table 1). These plants occurred throughout the lake (Figure 31c-d) in varying depths. Muskgrass was common in depth less than six feet, stonewort was the dominant taxa in the 16 to 25 feet depth, and watermoss was the most common taxa in the 26 to 29 feet depth.

Figure 31. Distribution of common aquatic plants in Long Lake, 2007.



Floating-leaf and emergent plants

About 34 acres of floating-leaf plant beds were mapped (Figure 32) and the most common species were watershield, white waterlily, and yellow waterlily. Because surveyors avoided motoring into floating-leaf plant beds, the frequency values obtained for these taxa (Table 2) were lower than the actual occurrence. Frequency values for floating-leaf taxa represent the occurrence of these taxa only within the sites that were surveyed. Waterlily beds often contained scattered bulrush plants as well as submerged plants and were usually associated with muck sediments (Figure 33, 34).

Surveyors delineated approximately three acres of emergent plants (Figure 32). Bulrush and spikerush were the most common emergent plants. Bulrush plants occurred to a maximum depth of seven feet and the largest stands occurred on the sandy shoals in the north basin. Large stands of spikerush were not present, but scattered patches were located around the shoreline.

Other emergent plants occurred at scattered locations around the lake and included wild rice, arrowhead, and burreed. Many of these emergent plants occupied the transitional zone between upland and lake, and several taxa extended into the water up to a depth of six feet.

Figure 32. Distribution of emergent and floating-leaf plant beds in Long Lake, 2007.

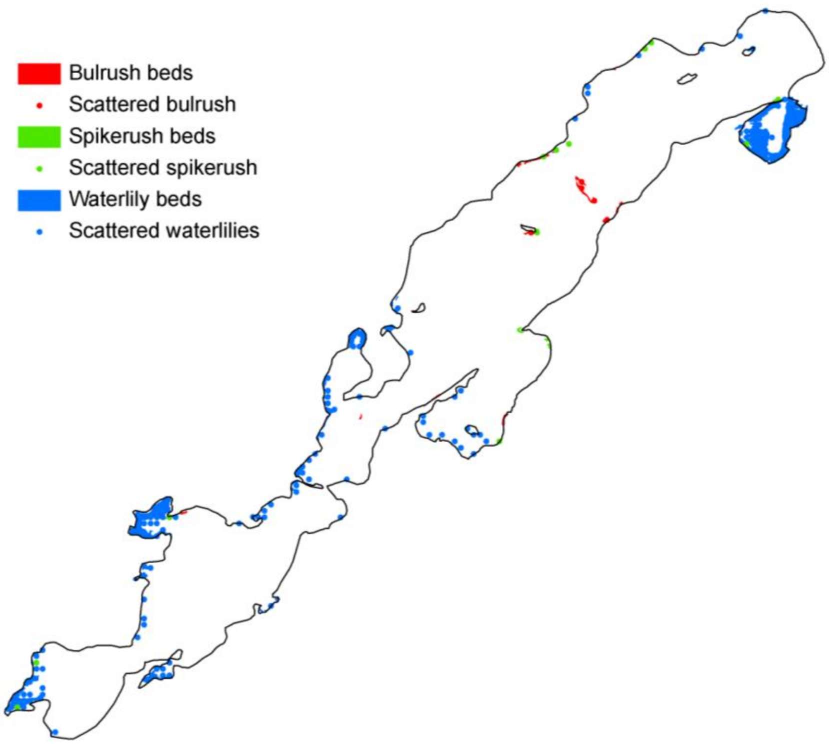


Figure 33. Yellow waterlily bed in Long Lake

Figure 34. Bulrush and waterlilies in Long Lake

Unique plants

In addition to the commonly occurring plants in Long Lake, eight unique plant species were documented at 85 locations during the surveys (Figure 35). These species are not listed as rare in Minnesota but their distribution is limited in the state. Their presence is indicative of relatively undisturbed native plant communities in Long Lake. Unique plants found in Long Lake were humped bladderwort, lesser bladderwort, flat-leaved bladderwort, water bulrush, leafless watermilfoil, creeping spearwort, narrow-leaved burreed, and three-way sedge.

Three-way sedge and all species of bladderworts were found in the protected bays and undisturbed areas of Long Lake. Leafless watermilfoil and creeping spearwort were located on the sandy shorelines throughout Long Lake. Water bulrush and narrow-leaved burreed were located in the shallow, muck bottom protected bays where waterlilies and wild rice were present.

Rare plants

Vasey's pondweed occurred within shallow waterlily beds in relatively protected bays. It was found on soft sediments and often co-occurred with a diversity of submerged and floating-leaved plants. This plant may be present in other locations of Long Lake, but it can be difficult to locate, particularly if floating leaves are not present.

Thread-like naiad was not found in Long Lake but has been documented in a nearby lake. This species can be negatively impacted by activities in the watershed that lead to increased turbidity in lakes.

Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to nine (Figure 36). 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 35. Unique aquatic plants in Long Lake, 2007.

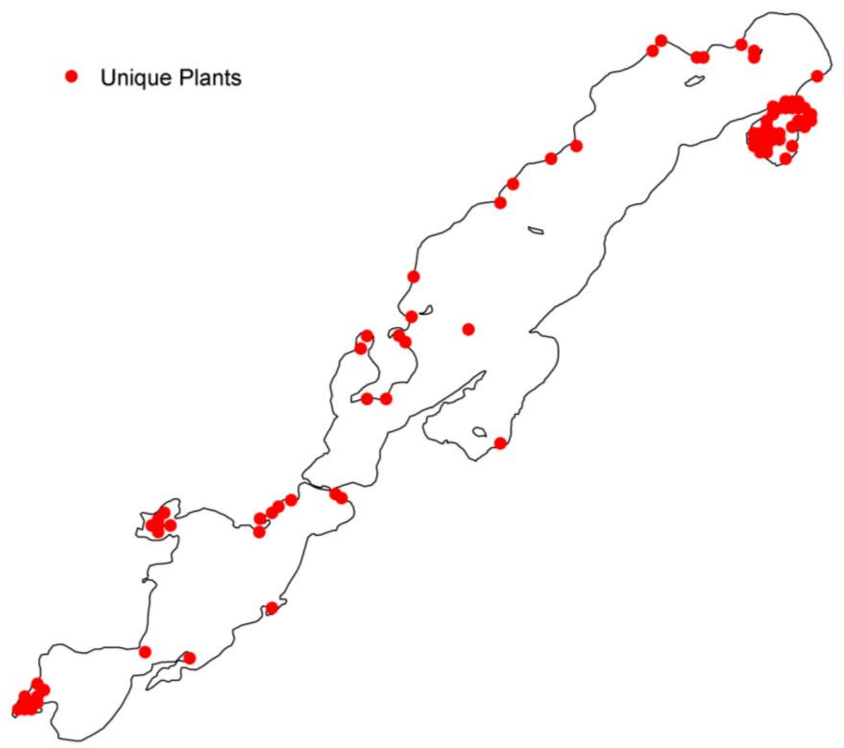
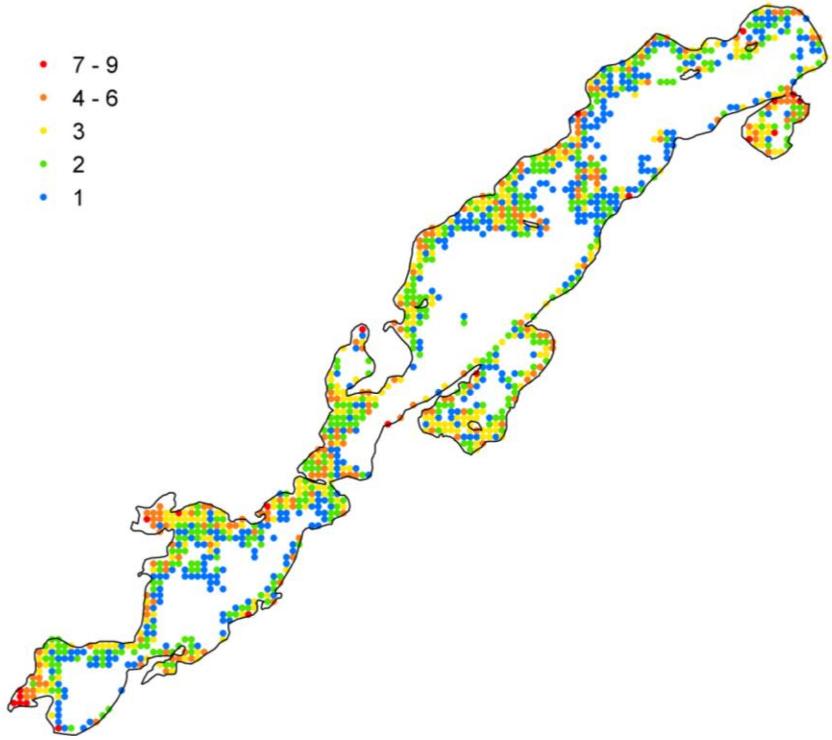


Figure 36. Aquatic plant richness (number of taxa per sampling station) in Long Lake, 2007.



Near-shore Substrates

Objectives

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

Introduction

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

Figure 37. Sand shoreline on Long Lake

Methods

Near-shore substrate in Long Lake was evaluated at a total of 456 sampling stations set up in the point-intercept aquatic plant surveys and near-shore fish surveys. Plant sample stations were 40 meters apart and occurred in a grid from shore to a depth of 30 feet. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore vegetation sample stations and near-shore fish sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 43 of these stations.

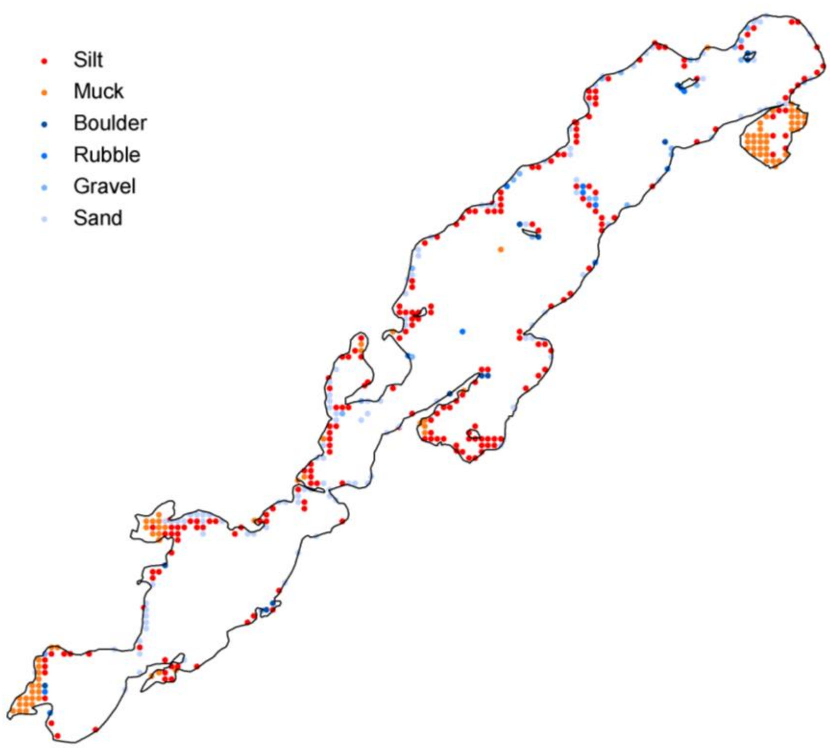
Surveyors evaluated substrate by tapping a pole into the lake bottom; soft substrate could usually be brought to the surface on the pole or sampling rake for evaluation. If this method was not feasible, substrate was evaluated by visual observation of the lake bottom. Standard lake substrate classes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

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

Results

Shallow water substrates of Long Lake included sand, gravel, rubble, boulder, silt and muck (Figure 38). Sand was the most common substrate type in water depths from shore to three feet, where it was found in 40 percent of the sites (Figure 37). Silt was most common in water depths of four to seven feet, where it was found in 61 percent of the sites. Muck substrates were found mainly in protected bays, whereas gravel, rubble, and boulder substrates were scattered around the shoreline near islands and along points.

Figure 38. Distribution of substrates around Long 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. Species of greatest conservation need are documented in Minnesota's State Wildlife Action Plan, Tomorrow's Habitat for the Wild and Rare (2006). Thirteen of these species were identified at Long Lake.

Bald eagles (*Haliaeetus leucocephalus*; Figure 39) 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.

Figure 39. Bald eagle

Photo by: Carrol Henderson

Black-billed cuckoos (*Coccyzus erythropthalmus*; Figure 40) are one of two cuckoo species regularly found in Minnesota. These slender, long-tailed birds summer and breed in Minnesota and the east-central United States before heading south to spend the winter in South America. Black-billed cuckoos have a brown back and white underside, and may be distinguished by a curved black bill and red ring around the eye. They inhabit deciduous forests and thickets, and are often found near water. The black-billed cuckoo is listed as a species of Regional Concern on the Partners in Flight watchlist.

Figure 40. Black-billed cuckoo

Photo source: U.S. Fish and Wildlife Service

Common loons (*Gavia immer*; Figure 41) 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 41. Common loon

Photo by: Carrol Henderson

Common nighthawks (*Chordeiles minor*; Figure 42) are most often seen in the air, exhibiting an erratic flight pattern as they forage for insects. They are cryptically colored with brown, gray, and white mottling. A white bar is visible across the wing when the bird is in flight. The breeding ritual includes a dramatic display during which the male dives straight toward the ground before quickly turning upward; air rushing through the wings makes a deep booming sound. Originally found in open, rural areas, the nighthawk has adapted to urban settings and will even nest on gravel rooftops. Despite their adaptability, nighthawks have declined in some areas. Predation and a decreased insect food base due to the use of pesticides may be factors in this decline.

Figure 42. Common nighthawk

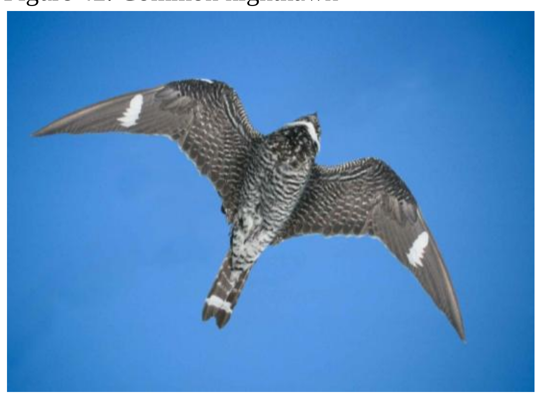


Photo by: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 43) 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 throughout the canopy, often flying out from their perch to catch insects before returning to the same perch. Populations of eastern wood-pewees are declining throughout much of their range. One possible cause of the decline is the increase in white-tailed deer, who browse and decrease the lower-canopy foraging area available to the pewee.

Figure 43. Eastern wood-pewee

Photo by: J.A. Spendelow

Figure 44. Golden-winged warbler

Photo by: Carrol Henderson

Golden-winged warblers (*Vermivora chrysoptera*; Figure 44) are small, active, insectivorous warblers. They possess a distinctive yellow crown and yellow patch on the wings. A black mask and throat contrast with the gray and white plumage on the back and breast. They often inhabit forest edges, such as those along marshes, bogs, and fields, and are also common in abandoned farms and alder shrub swamps. Regional declines of the golden-winged warbler are considerable. Human-caused disturbance and hybridization with increasing numbers of blue-winged warblers are correlated with the declines.

Figure 45. Least flycatcher

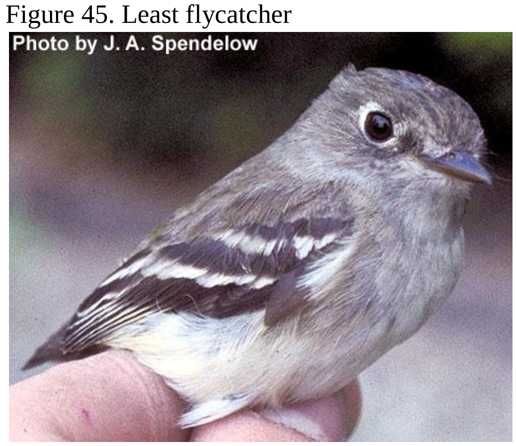


Photo by: J.A. Spendelow

Least flycatchers (*Empidonax minimus*; Figure 45) are the smallest flycatchers found in Minnesota. Like many other flycatchers, they are olive to gray in color with two white wingbars and whitish underparts. They have a small bill and a prominent white eye ring. The best way to distinguish least flycatchers from other flycatchers is the call, a harsh "che-bek." These birds are often found along water edges in mature, open woods. Least flycatchers are common throughout most of their range where habitat is suitable. However, they are sensitive to human disturbance and require large areas of forest to survive.

Figure 46. Ovenbird

Photo source: U.S. Fish and Wildlife Service

Ovenbirds (*Seiurus aurocapillus*; Figure 46) are rarely seen birds of the forest. However, their loud "teacher, teacher, teacher" song is commonly heard during the summer months. They dwell on the ground, and build a covered nest that resembles a Dutch oven. Ovenbirds are olive-brown with a boldly streaked breast. Two black stripes border an orange crown. They have a thin bill and a white eye ring. They breed in mature deciduous and mixed forests, especially those with minimal undergrowth, and often feed by picking insects off the forest floor. Ovenbird numbers appear to be stable, but the birds are vulnerable to forest fragmentation and parasitism by brown-headed cowbirds (*Molothrus ater*).

Rose-breasted grosbeaks (*Pheucticus ludovicianus*; Figure 47) are summer visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes and meadows and woodlands, and suburban parks and gardens. 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 47. Rose-breasted grosbeak

Photo by: J.A. Spendelow

The swamp sparrow's (*Melospiza georgiana*; Figure 48) 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 48. Swamp sparrow

Photo by: Jim Stasz

The veery (*Catharus fuscescens*; Figure 49) is one of the most easily identifiable thrushes. It has faint dark spots on a buffy breast and a reddish brown back and head. The legs are pink and the eyes are dark with an indistinct light eye ring. The veery was named after its most common call, a "vee-er" sound. Riparian areas with dense vegetation and wetlands within large forests are good places to find the veery. The veery is suffering declines throughout many parts of its range. Destruction of winter habitat and parasitism by brown-headed cowbirds are major reasons cited for the decline.

Figure 49. Veery

Photo by: Deanna Dawson

White-throated sparrows (*Zonotrichia albicollis*; Figure 50) 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, with a yellow spot above the eye. The chest is gray and the back is streaked with brown and black. White-throated sparrows 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 50. White-throated sparrow

Photo by: Dave Herr

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 51) 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 51. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Bird surveys were conducted between late May and late June, 2008. Surveyors used several techniques to collect information on bird species. Point counts were conducted at 62 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

Surveyors identified 13 species of greatest conservation need at Long Lake. The ovenbird, detected at 29 stations, was by far the most commonly found species of greatest conservation need. Common loons were also seen regularly; surveyors detected this species at 15 sampling locations. Golden-winged warblers, swamp sparrows, yellow-bellied sapsuckers, and the veery were all documented at 5 or more survey stations. The other species of greatest conservation need found at Long Lake were: bald eagle, black-billed cuckoo, common nighthawk, eastern wood-pewee, least flycatcher, rose-breasted grosbeak, and white-throated sparrow.

Species of greatest conservation need were widely distributed along the shoreline of Long Lake. The common loon, the only documented species of greatest conservation need described as primarily aquatic in nature, was found along much of the shoreline, with the exception of the southwestern portion of the lake (Figure 52). Forest-dwelling species were located at survey stations around much of the shoreline (Figure 53). The swamp sparrow, one of the wetland-dwelling species found on Long Lake, tended to be located within small bays, whereas the golden-winged warbler was also found along several stretches of the main shoreline (Figure 54). Bald eagles and common nighthawks were seen in several locations around the lake (Figure 55).

Song sparrows were the most common species overall, and were found at over 75 percent of the survey sites. Red-eyed vireos were also common, and were identified at over 60 percent of the sampling stations. Ovenbird and yellow warblers were found at 29 of 62 stations. Red-winged blackbirds (23/62 stations) rounded out the top five most common species list. The vast majority of the birds documented at Long Lake (63 species) were recorded during the point count and call-playback surveys (Table 3). Three additional species were recorded through casual observation of the lake, for a total of 66 species (Appendix 2).

Figure 52. Distribution of aquatic habitat-dependent bird species of greatest conservation need in Long Lake, May – June 2008.

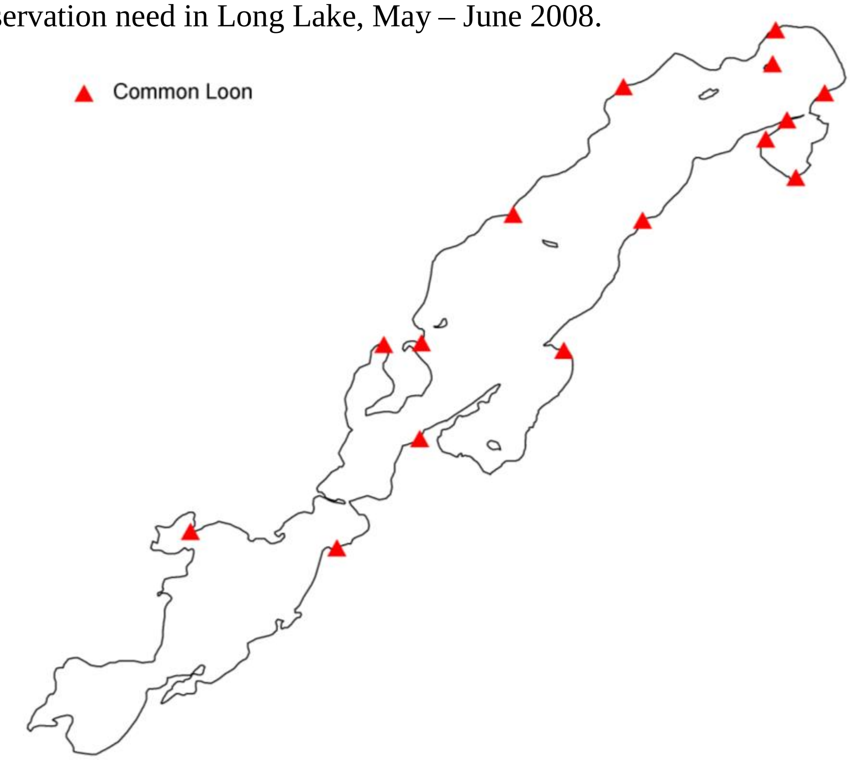


Figure 53. Distribution of forest habitat-dependent bird species of greatest conservation need in Long Lake, May – June 2008.

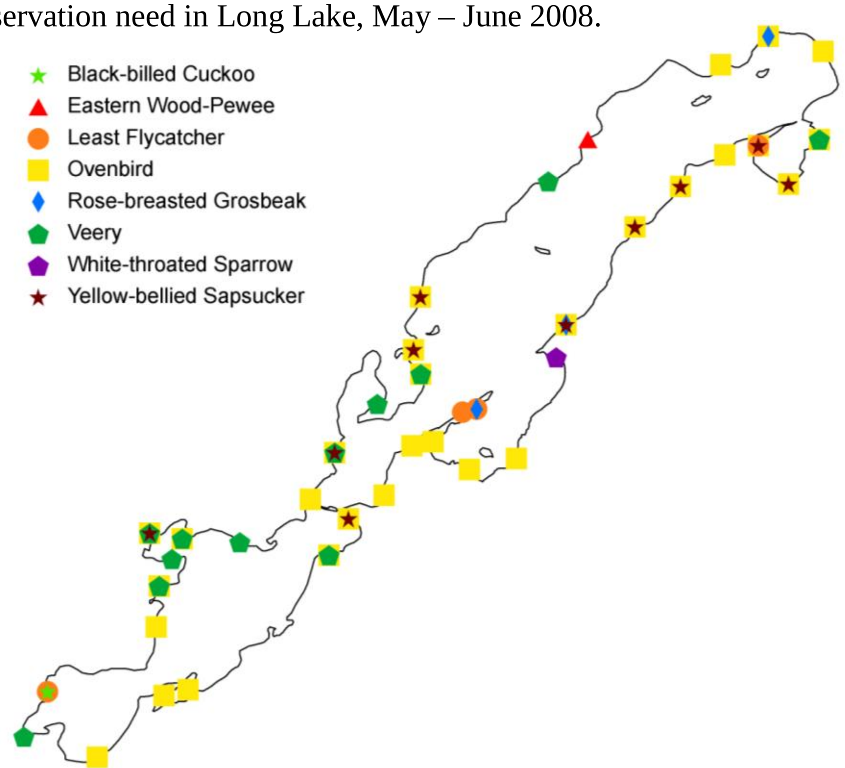


Figure 54. Distribution of wetland habitat-dependent bird species of greatest conservation need in Long Lake, May – June 2008.

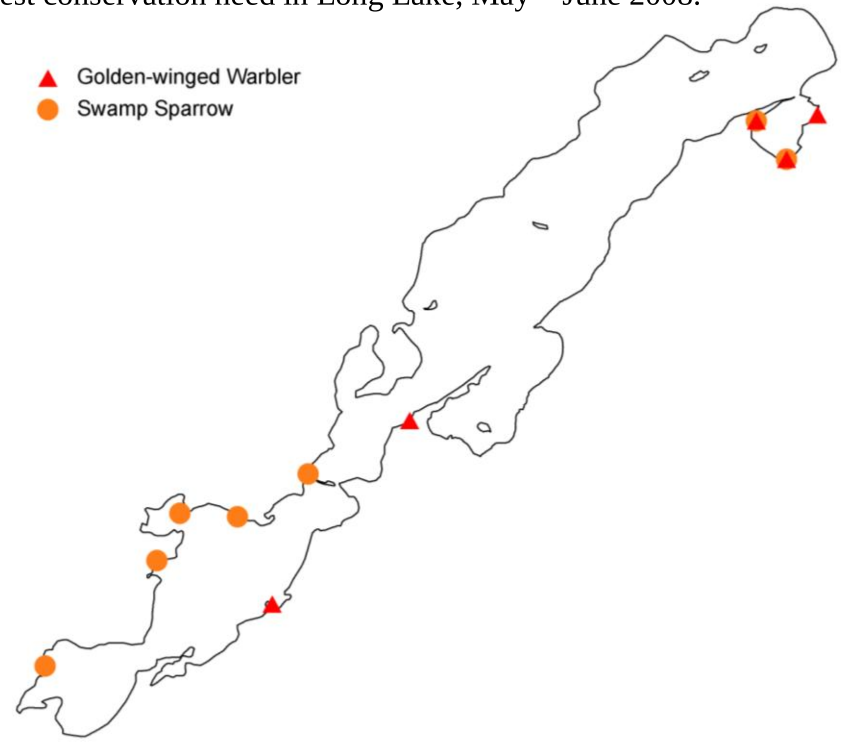


Figure 55. Distribution of bird species of greatest conservation need that occupy other habitats in Long Lake, May – June 2008.

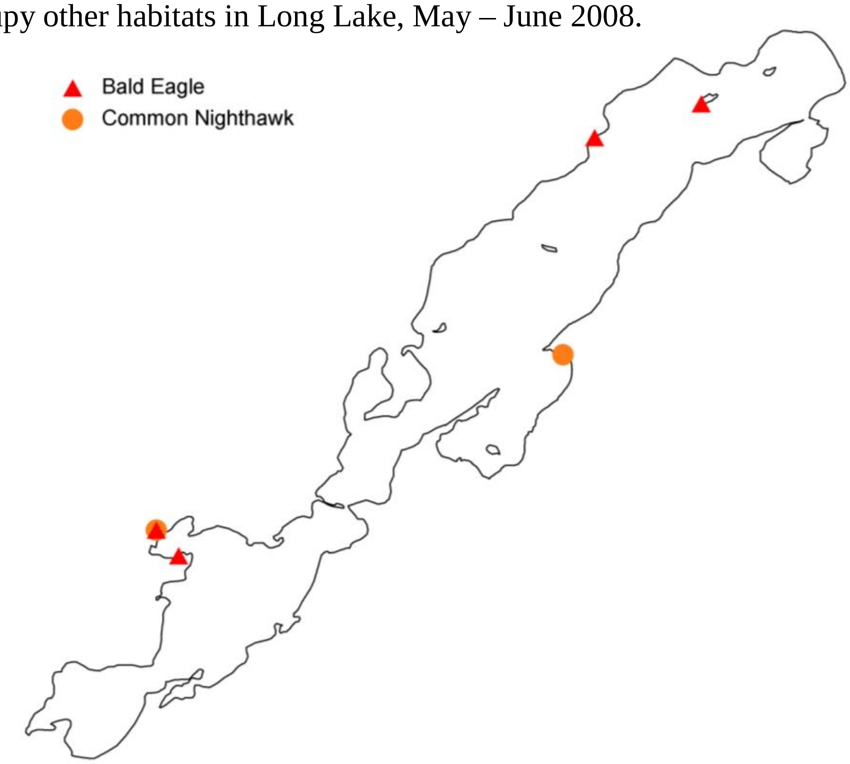


Table 3. Species list and frequency of occurrence of bird species identified during Long Lake bird surveys, May – June 2008. * denotes a species of greatest conservation need.

Description	Common Name	Scientific Name	%[a]
Waterfowl	Canada Goose	*Branta canadensis*	3
	Wood Duck	*Aix sponsa*	3
	Mallard	*Anas platyrhynchos*	27
	Common Goldeneye	*Bucephala clangula*	2
	Hooded Merganser	*Lophodytes cucullatus*	6
Pleasants/allies	Ruffed Grouse	*Bonasa umbellus*	2
Loons	Common Loon*	*Gavia immer*	24
Herons/bitterns	Great Blue Heron	*Ardea herodias*	11
	Green Heron	*Butorides virescens*	6
Hawks/eagles	Osprey	*Pandion haliaetus*	2
	Bald Eagle*	*Haliaeetus leucocephalus*	6
	Broad-winged Hawk	*Buteo platypterus*	2
Rails	Sora	*Porzana carolina*	3
Gulls/terns	Ring-billed Gull	*Larus delawarensis*	3
	Caspian Tern	*Sterna caspia*	2
Cuckoos	Black-billed Cuckoo*	*Coccyzus erythropthalmus*	2
Goatsuckers	Common Nighthawk*	*Chordeiles minor*	3
Hummingbirds	Ruby-throated Hummingbird	*Archilochus colubris*	6
Kingfishers	Belted Kingfisher	*Ceryle alcyon*	2
Woodpeckers	Red-bellied Woodpecker	*Melanerpes carolinus*	10
	Yellow-bellied Sapsucker*	*Sphyrapicus varius*	16
	Downy Woodpecker	*Picoides pubescens*	11
	Hairy Woodpecker	*Picoides villosus*	8
	Northern Flicker	*Colaptes auratus*	21
	Pileated Woodpecker	*Dryocopus pileatus*	10
Flycatchers	Eastern Wood-Pewee*	*Empidonax alnorum*	2
	Least Flycatcher*	*Empidonax minimus*	6
	Eastern Phoebe	*Sayornis phoebe*	15
	Great Crested Flycatcher	*Myiarchus crinitus*	6
	Eastern Kingbird	*Tyrannus tyrannus*	8
Vireos	Yellow-throated Vireo	*Vireo flavifrons*	2
	Red-eyed Vireo	*Vireo olivaceus*	65
Jays/crows	Blue Jay	*Cyanocitta cristata*	16
	American Crow	*Corvus brachyrhynchos*	24
Swallows	Tree Swallow	*Tachycineta bicolor*	11
	Barn Swallow	*Hirundo rustica*	6

Table 3, continued.

Description	**Common Name**	**Scientific Name**	**%**[a]
Chickadees	Black-capped Chickadee	*Poecile atricapillus*	15
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	6
	White-breasted Nuthatch	*Sitta carolinensis*	6
Wrens	House Wren	*Troglodytes aedon*	3
Thrushes	Veery*	*Catharus fuscescens*	19
	American Robin	*Turdus migratorius*	24
Mockingbirds	Gray Catbird	*Dumetella carolinensis*	10
Waxwings	Cedar Waxwing	*Bombycilla cedrorum*	10
Warblers	Golden-winged Warbler*	*Vermivora chrysoptera*	8
	Yellow Warbler	*Dendroica petechia*	47
	Chestnut-sided Warbler	*Dendroica pensylvanica*	15
	Black-throated Green Warbler	*Dendroica virens*	2
	Black-and-white Warbler	*Mniotilta varia*	24
	American Redstart	*Setophaga ruticilla*	8
	Ovenbird*	*Seiurus aurocapilla*	47
	Common Yellowthroat	*Geothlypis trichas*	29
Sparrows	Chipping Sparrow	*Spizella passerina*	31
	Song Sparrow	*Melospiza melodia*	77
	Swamp Sparrow*	*Melospiza georgiana*	11
	White-throated Sparrow*	*Zonotrichia albicollis*	2
Cardinals/grosbeaks	Rose-breasted Grosbeak*	*Pheucticus ludovicianus*	5
Blackbirds/orioles	Red-winged Blackbird	*Agelaius phoeniceus*	37
	Common Grackle	*Quiscalus quiscula*	21
	Brown-headed Cowbird	*Molothrus ater*	2
	Baltimore Oriole	*Icterus galbula*	27
Finches	Purple Finch	*Carpodacus purpureus*	5
	American Goldfinch	*Carduelis tristis*	15

[a]% – Percent of surveyed sample sites in which a bird species occurred (N=62)

Bird Species Richness

Objectives

1. Calculate and map bird richness around the shoreline of Long 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.

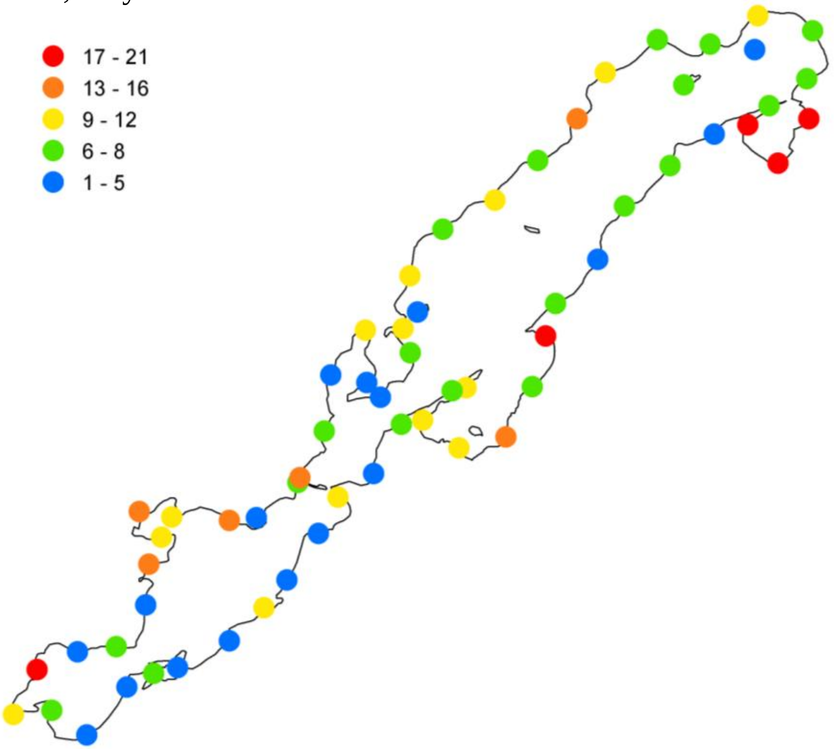
Methods

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

One sampling station on Long Lake contained 21 bird species. Six additional sampling stations contained at least 15 species each. The minimum number of species found at a sampling site was one, and seven sites contained three or fewer bird species. The number of species of greatest conservation need at a single station ranged from 0 to 6. Sites with the greatest number of species were located within the bays (Figure 56).

Figure 56. Bird species richness (number of species per sample site) in Long 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

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.

Loon pair with chick

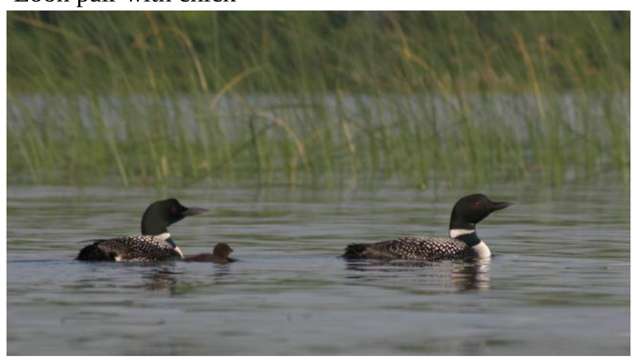


Photo by: Paul Bolstad

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

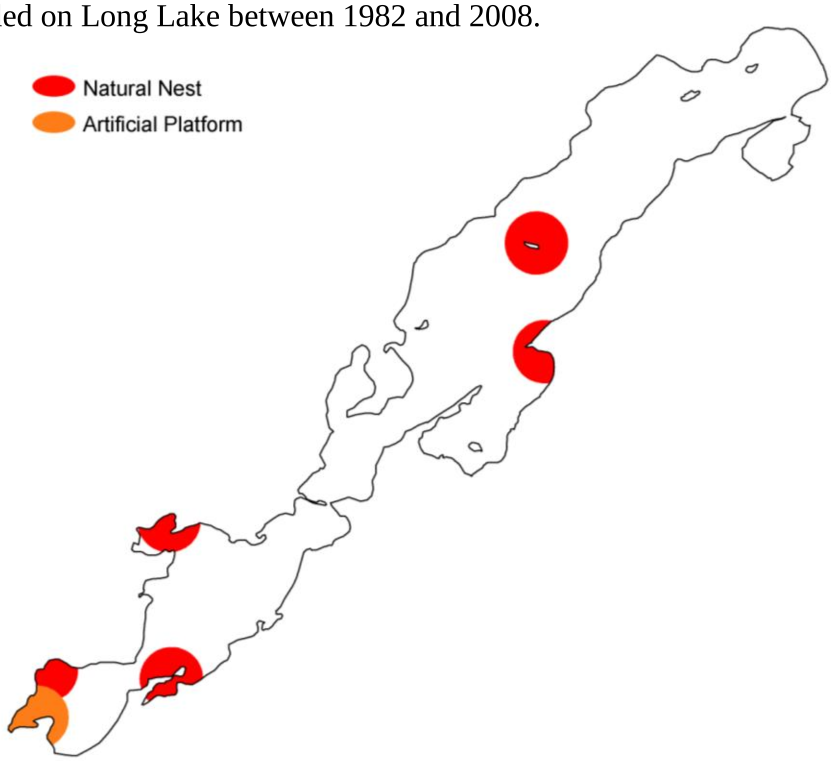
Methods

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

Results

Between 1981 and 2008, six probable nesting areas were identified on Long Lake (Figure 57). Of these, five were natural loon nests and one was an artificial platform. Three of the natural nests were in the southwest basin of Long Lake, one was in the non-isolated bay on the eastern edge of the lake, and one was on the Long Lake island. In 2008, four natural loon nests (active) on Long Lake were identified. In addition, two artificial nesting platforms were established; one of these was utilized by nesting loons.

Figure 57. Location of natural loon nests and manmade loon platforms recorded on Long Lake between 1982 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 58. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

Mink frogs (Figure 58) 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 59. Green frog

Photo by: Jeff LeClere, www.herpnet.net

Green frogs (Figure 59) 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
Surveyors heard both mink frogs and green frogs on Long Lake. Mink frogs were heard infrequently; surveyors detected them at three stations along the lakeshore. Fewer than 10 males were heard calling at each of these stations (Figure 60). Green frogs were heard more often on Long Lake; surveyors heard green frog males calling at 15 different stations. Frog abundance values ranged from fewer than 10 males per station to up to 100 males per station (Figure 61). All three stations along the lakeshore that had mink frogs also had green frogs (Figure 62).

Other species
Two additional frog species were heard during the Long Lake surveys. Spring peepers (*Pseudacris crucifer*) were heard at one station in a large bay on the northern half of Long Lake. Gray treefrogs (*Hyla versicolor*) were heard at fifteen different stations. Only one gray treefrog location was on the northern half of the lake; fourteen of the locations were on the southern part of the lake. Index values for gray treefrogs ranged from 1 (distinct individual frogs could be counted, with silence between calls) to 2 (calls of individual frogs could be distinguished, but calls did overlap). While conducting nongame fish surveys, surveyors also captured one northern leopard frog (*Rana pipiens*). Other frog or toad species that may be found near Long Lake, such as the wood frog (*Rana sylvatica*), chorus frog (*Pseudacris triseriata*), and American toad (*Bufo americanus*), breed earlier in the year and are not strongly associated with larger lakes.

Figure 60. Abundance of mink frogs heard during Long Lake frog surveys, June 2007.

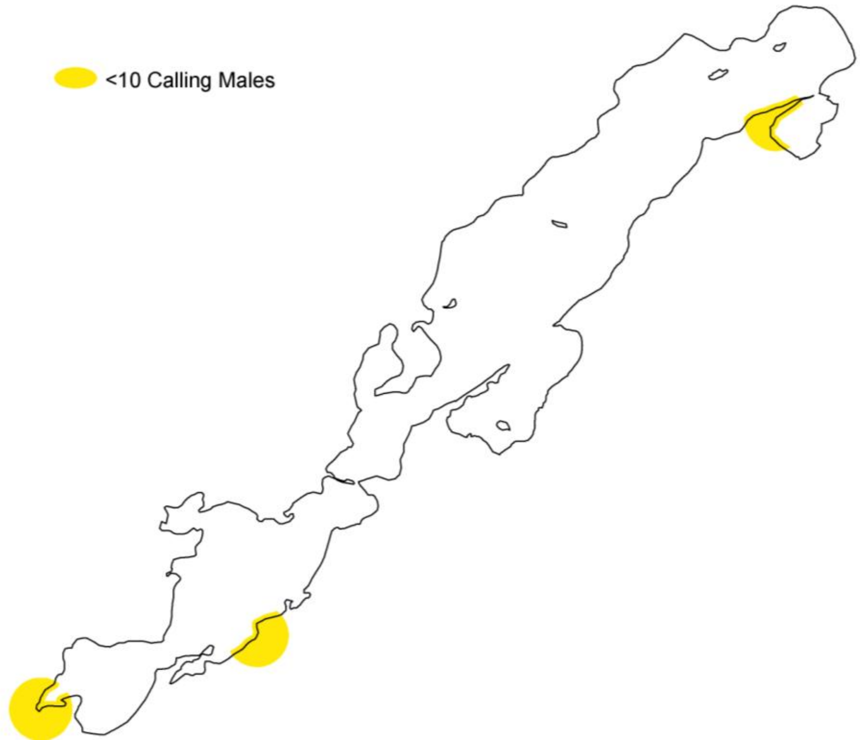


Figure 61. Abundance of green frogs heard during Long Lake frog surveys, June 2007.

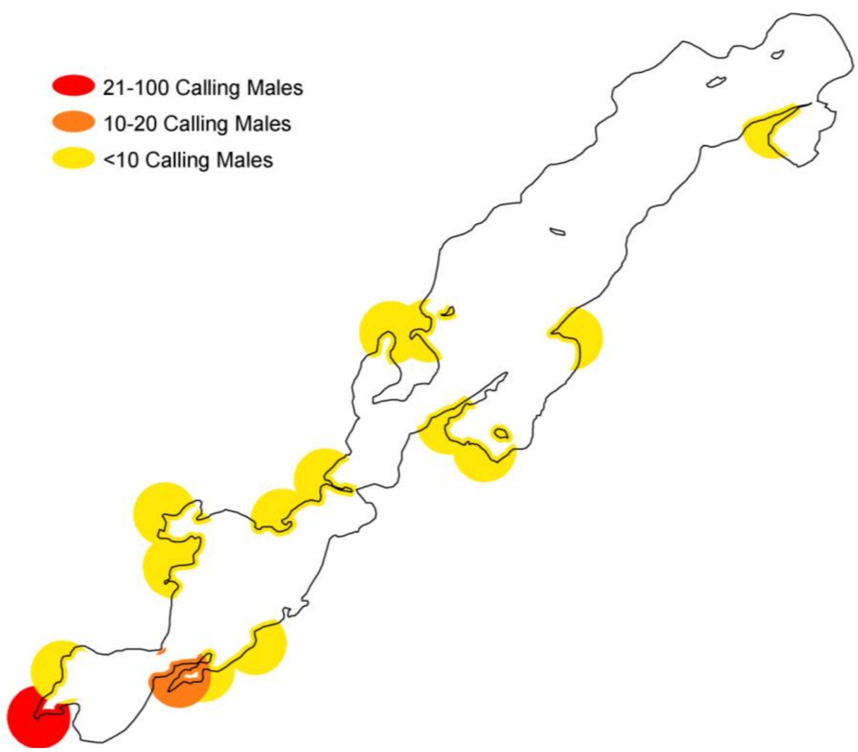
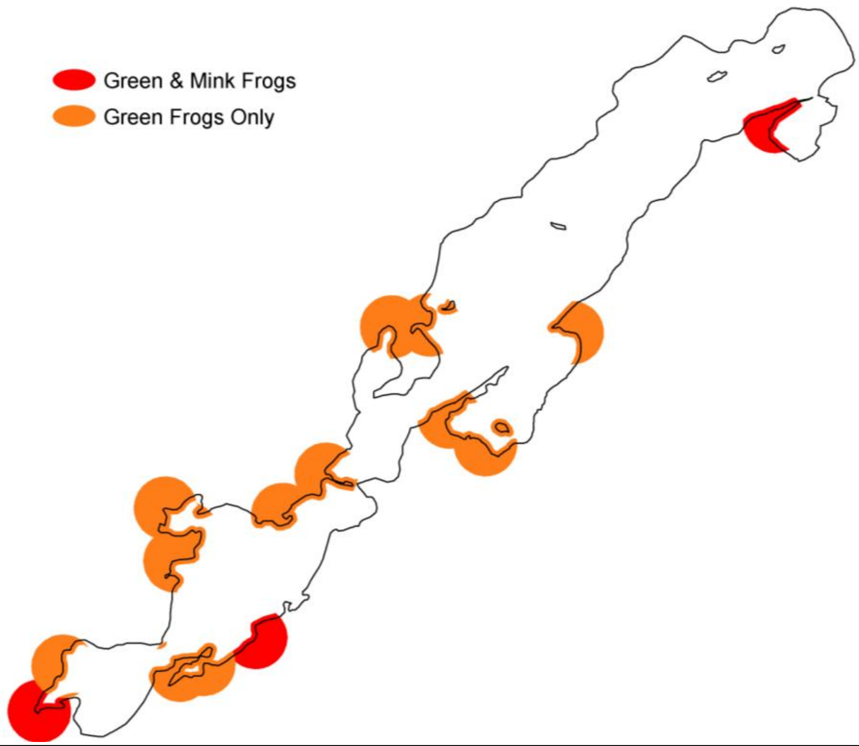


Figure 62. Distribution of mink and green frogs heard during Long Lake frog surveys, June 2007.



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

Figure 63. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (*Etheostoma microperca*; Figure 64) 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 64. Least darter

Photo by: Konrad Schmidt

Longear sunfish (*Lepomis megalotis*; Figure 65) 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 65. 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 66) 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 66. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (*Notropis heterolepis*; Figure 67) 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 67. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 68) 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 68. 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 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 in Long Lake. Surveyors did identify all three proxy species during the surveys (Figure 69). However, abundance of these species was low. Surveyors found five banded killifish at three different sampling locations. Blacknose shiners and blackchin shiners were found at two sampling stations each (total abundance for these species was eight and two, respectively). Most proxy species were found at sites with soft bottom substrates, including silt and muck. Several specimens were also found in locations with sandy substrates. Biovolume (i.e., amount of submerged aquatic vegetation) was virtually identical between sites containing proxy species (average biovolume ~30 percent) and those without.

The presence of several sensitive fish species (blackchin shiner, blacknose shiner, banded killifish) indicates minimal disturbance in several areas of the lake. However, because populations of these species are vulnerable across their ranges, continued monitoring and maintenance of these shoreline habitats is necessary to ensure continued existence of these populations. Limiting macrophyte removal, pesticide and herbicide use, and modification of the riparian zone will help maintain good water quality and a healthy aquatic plant community. These conditions will also benefit multiple game fishes, including bass, muskellunge, and northern pike.

Twenty-two different species of fish were identified during the surveys at Long Lake (Table 4). Bluegills were by far the most abundant; they were documented at every one of the 43 sampling stations, and numbered over 5000. One single station yielded over 350 bluegills. Largemouth bass, rock bass, and pumpkinseed were also found regularly; surveyors captured them at over 75 percent of the survey stations. Abundances for these species were much lower, however, and totaled less than 150 each.

Nine species previously undocumented at Long Lake were identified during this study. These newly documented species were blackchin shiner, banded killifish, bluntnose minnow, blacknose shiner, central mudminnow, Iowa darter, johnny darter, mimic shiner, and tadpole madtom.

Maximum species richness was 10 species at a sample site. Less than 20 percent of the sites contained fewer than five species.

Figure 69. Distribution of fish proxy species in Long Lake, June – August 2007.

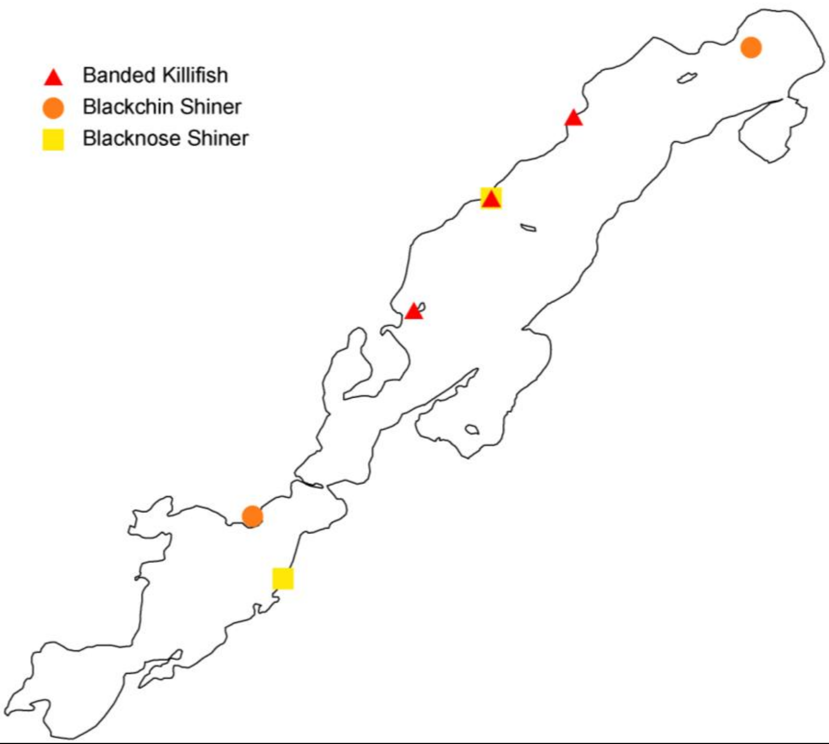


Table 4. Abundance and frequency of fish species identified during Long Lake fish surveys, June – August 2007.

Description	**Common Name**	**Scientific Name**	**#** [a]	**%** [b]
Minnows/carps	Blackchin shiner	*Notropis heterodon*	2	5
	Blacknose shiner	*Notropis heterolepis*	8	5
	Mimic shiner	*Notropis volucellus*	13	2
	Bluntnose minnow	*Pimephales notatus*	17	19
Suckers	White sucker	*Catostomus commersonii*	1	2
North American freshwater catfishes	Black bullhead	*Ameiurus melas*	5	9
	Yellow bullhead	*Ameiurus natalis*	39	47
	Brown bullhead	*Ameiurus nebulosus*	6	9
	Tadpole madtom	*Noturus gyrinus*	3	7
Pikes	Northern pike	*Esox lucius*	17	33
Mudminnows	Central mudminnow	*Umbra limi*	5	12
Killifishes	Banded killifish	*Fundulus diaphanus*	5	7
Sunfishes	Rock bass	*Ambloplites rupestris*	107	79
	Green sunfish	*Lepomis cyanellus*	13	23
	Pumpkinseed	*Lepomis gibbosus*	79	77
	Bluegill	*Lepomis macrochirus*	~5100	100
	Largemouth bass	*Micropterus salmoides*	128	81
	Black crappie	*Pomoxis nigromaculatus*	40	51
Perches	Iowa darter	*Etheostoma exile*	5	7
	Johnny darter	*Etheostoma nigrum*	7	12
	Yellow perch	*Perca flavescens*	33	42
	Walleye	*Sander vitreus*	1	2

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

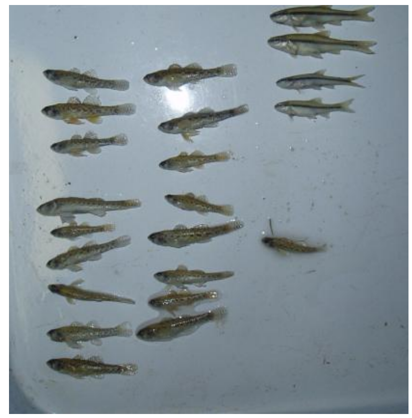
[b]% – Percent of surveyed sample sites in which a species occurred (N=43)

Aquatic Vertebrate Richness

Objectives

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

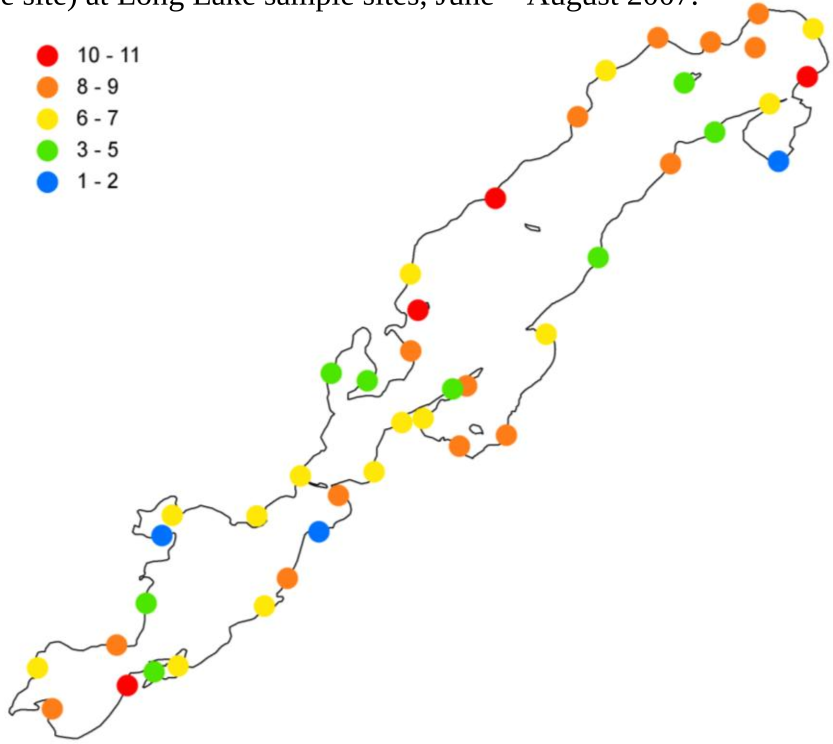
Methods

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

Species richness varied among the sites. Maximum species richness at a sampling station was 11 species, and three additional stations had 10 species (Figure 70). All stations that were sampled contained at least one aquatic vertebrate species. The majority of the documented species were fish, although painted turtles, snapping turtles, mink frogs, green frogs, and northern leopard frogs were also identified. All of the aquatic vertebrate species identified during the nongame fish surveys were native.

Figure 70. Aquatic vertebrate species richness (number of species per sample site) at Long Lake sample sites, June – August 2007.



Other Rare Features

Objectives

1. Map rare features occurring within the extended state-defined shoreland area of Long 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

Four rare features were documented near the shoreline of Long Lake (Figure 71). These include two aquatic plant species of Special Concern status and two locations of a bird species 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 Long Lake, practices that maintain good water quality and the integrity of the shoreline will be beneficial to all species involved.

Figure 71. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Long 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.

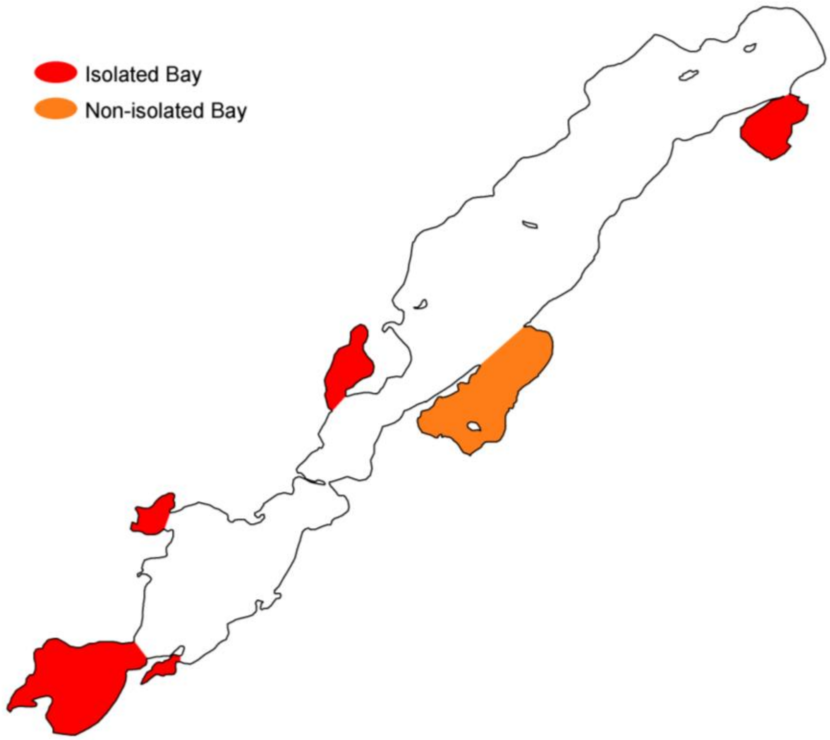
Methods

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

Five isolated bays and one non-isolated bay were identified on Long Lake (Figure 72). Field surveys documented several species mainly within these bays. The sampling stations with the greatest diversity of bird species were located within bays, and nearly all of the sampling stations that contained mink and green frogs were located in or near delineated bays. The most substantial waterlily beds were also located within these protected areas.

Figure 72. Location of isolated and non-isolated bays in Long Lake.



II. Ecological Model Development

The second component of the sensitive lakeshore protocol involved the development of an ecological model. The model scored lakeshores 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 73). 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 74). 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 75).

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

Variable	Score	Criteria
Wetlands	3	> 25% of analysis window is wetlands
	2	12.5 – 25% is wetlands
	1	< 12.5% is 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 survey 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 SGCNs 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 73. Total score layer created by summing scores of all 15 variables. Highest total scores represent the most sensitive areas of shoreline.

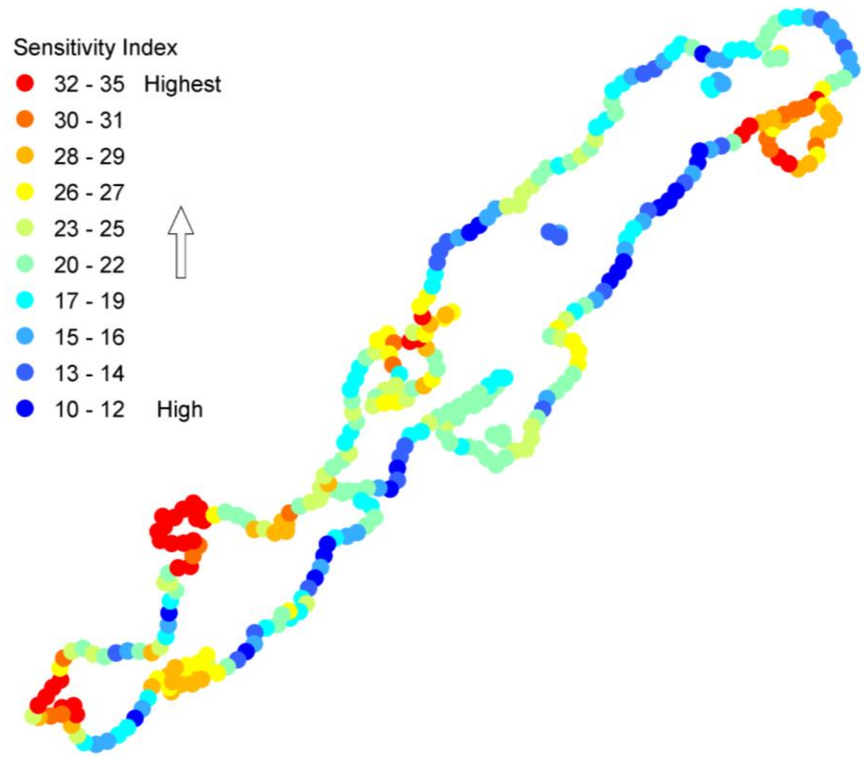


Figure 74. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland)

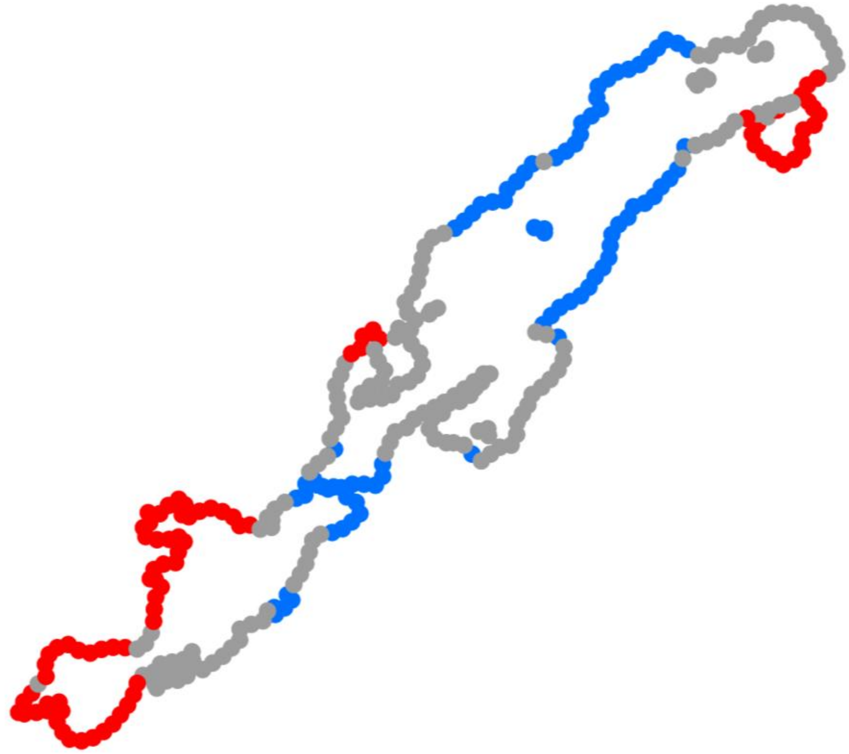
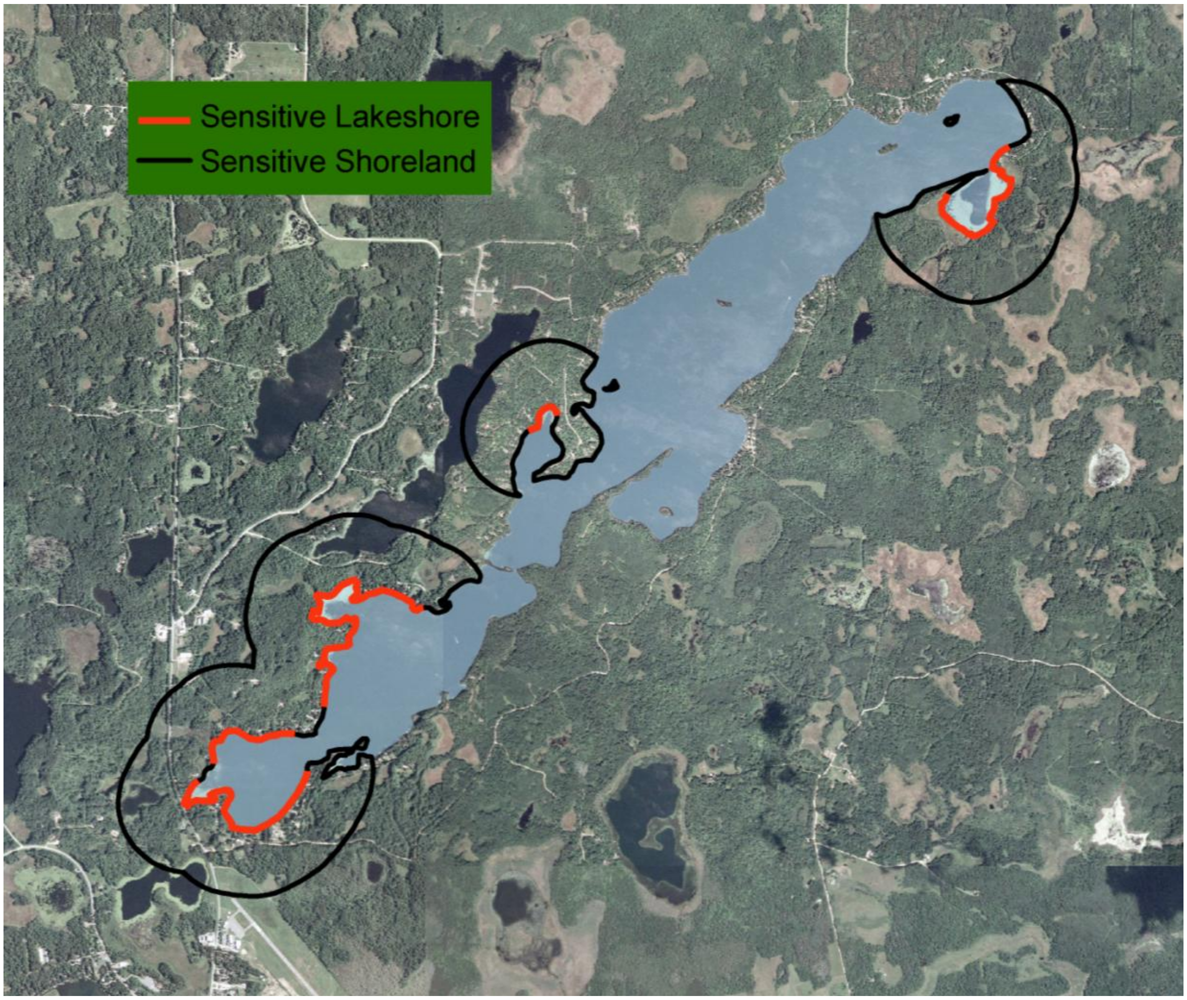


Figure 75. The Long Lake sensitive lakeshore areas identified by the ecological model.



Habitat Connectivity
In addition to the sensitive shorelands identified through the GIS model, surveyors considered adjacent river shorelines that provide habitat connectivity to and from the lake shorelands. There were no ecological connections identified at Long Lake.

Other Areas of Ecological Significance
There are additional aquatic areas of ecological significance in Long Lake that contain important aquatic plant communities but these sites are not necessarily associated with priority shoreland features. These are also sites that may not typically be associated with abundant aquatic plants or certain rare fish because they occur along less protected / higher energy shorelines (not bays) and are dominated by hard substrates. 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.

On Long Lake, sites containing the unique aquatic plant species, leafless watermilfoil and creeping spearwort, are considered sites of ecological significance. The characteristics that make these sites suitable for these unique species (shallow, sandy shorelines), are also features that many riparian owners find valuable from a recreational viewpoint. Protection of these sites, and sites with similar characteristics that may be potential habitat for these species, is important.

Other Long Lake sites of ecological significance are emergent plant beds of hardstem bulrush and spikerush. While these plant may be common in other lakes, only isolated patches occurred in Long Lake, and they covered only three acres (less than one percent of the littoral zone). Destruction of these emergent beds would be particularly detrimental because attempts to restore these types of plants have had limited success.

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

Sensitive Lakeshore

As the field surveys documented, the bays supported the greatest diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such emergent and floating-leaf vegetation, was also present in the highest quantities near the bays. The ecological model displays these areas both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby have significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. 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 Long Lake, and the value of the lake itself.

References

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

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

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

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

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

Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford.

Gleason, H.A., and A. Cronquist. 1991. Manual of vascular plants of Northeastern United States and adjacent Canada (2nd ed.). New York Botanical Garden, Bronx. 910 pp.

Magurran, A.E. 2004. Measuring biological diversity. Blackwell Science, Oxford. 260 pp.

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

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

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

Minnesota Department of Natural Resources. 2004. Lake information report. Minnesota Department of Natural Resources, Division of Fish and Wildlife. http://www.dnr.state.mn.us/lakefind/index.html

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

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

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

Minnesota Department of Natural Resources. 2008b. 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. 2002. Status and Trend Assessment: 2001 Long and Stony Lakes, Cass County, Minnesota (ID # 11-0142 & 11-0371). Minnesota Pollution Control Agency. Environmental Outcomes Division. St. Paul, MN. 22 pp. http://www.pca.state.mn.us/publications/reports/lar-11-0142-11-0371.pdf

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.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer (Accessed: January 2009).

Newmaster, S.G., A.G. Harris, and L.J. Kershaw. 1997. Wetland plants of Ontario. Lone Pine Publishing, Edmonton, Alberta. 241 pp.

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. 2008. Aquatic vegetation of Long Lake (DOW 11-0142-00), Cass County, Minnesota, 2007. Division of Ecological Resources, Minnesota Department of Natural Resources, Brainerd. 24 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.

Skon, P. 2005. Lake assessment program 1993, Long Lake (11-0142). Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division. http://www.pca.state.mn.us/publications/reports/lar-11-0142.pdf

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 plants found in Long Lake, 2007.

Description	**Common Name**	**Scientific Name**
Grasses and sedges	Sedges	*Carex* spp.
	Wool-grass	*Scirpus cyperinus*
	Reed canary grass	*Phalaris arundinacea**
	Soft rush	*Juncus effusus*
	Kentucky bluegrass	*Poa pratensis**
Forbs	Sweet flag	*Acorus americanus*
	Purple foxglove	*Agalinis purpurea*
	Swamp milkweed	*Asclepias incarnata*
	Beggarticks	*Bidens* sp.
	Thistle	*Cirsium* sp.
	Common boneset	*Eupatorium perfoliatum*
	Jewelweed	*Impatiens capensis*
	Blue-flag iris	*Iris versicolor*
	Yellow iris	*Iris pseudacorus**
	Water pepper	*Persicaria hydropiperoide*
	Smartweed	*Persicaria* sp.
	Forget-me-nots	*Myosotis* sp.*
	Water parsnip	*Sium suave*
	Marsh skullcap	*Scutellaria galericulata*
	Dandelion	*Taraxacum* sp.*
	St. John's wort	*Triadenum fraseri*
	Blue vervain	*Verbena hastata*
Shrubs	Alder	*Alnus incana*

*Indicates plant is not native to Minnesota.

Nomenclature follows MNTaxa 2009.

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

Common Name	Scientific Name
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Ruffed Grouse	*Bonasa umbellus*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Broad-winged Hawk	*Buteo platypterus*
Sora	*Porzana carolina*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Sterna caspia*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Barred Owl	*Strix varia*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-throated Vireo	*Vireo flavifrons*
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*

Appendix 2, continued.

Common Name	**Scientific Name**
Ruby-crowned Kinglet	*Regulus calendula*
Veery	*Catharus fuscescens*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-throated Green Warbler	*Dendroica virens*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Purple Finch	*Carpodacus purpureus*
American Goldfinch	*Carduelis tristis*