Final Report
Sensitive Lakeshore Survey
Little Boy Lake (11-0167-00)
Wabedo Lake (11-0171-00)
Louise Lake (11-0573-00)
Cass County, Minnesota

May 2009

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES

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

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

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

Project manager
Paul Radomski

Surveys conducted by
Donna Perleberg, Aquatic Plant Ecologist
Pam Perry, Nongame Wildlife Biologist
Paul Radomski, Project Manager
Kristin Thompson, Nongame Wildlife Biologist
Kevin Woizeschke, Nongame Wildlife Technician
Andrea Lambrecht, Bird Survey Specialist
Stephanie Loso, Aquatic Biologist/Intern
Ken Perry, Bird Survey Specialist
Lucas Wandrie, Natural Resources Specialist /Intern
Jesse Amo, Intern
Matthew Brinkman, Intern
Rachel Bulman, Intern
Corey Carpentier, Intern
Bethany Galster, Intern
Brent Vacinek, Intern

GIS technical guidance
Kevin Woizeschke, Nongame Wildlife Technician

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Alternative format available upon request.

Executive Summary

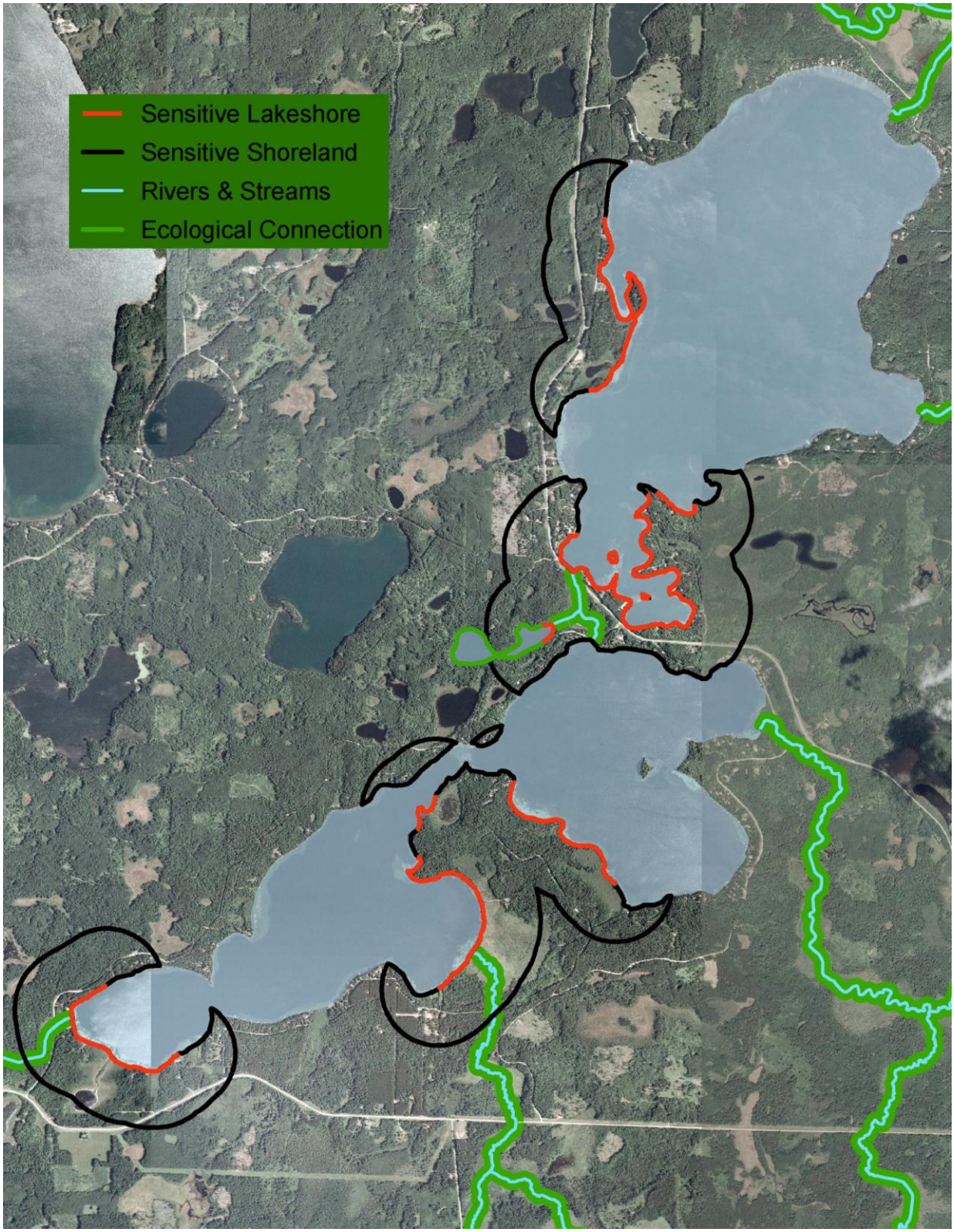
Plant surveyors recorded a total of 39 aquatic plant taxa in Little Boy, Wabedo, and Louise Lakes. Plants occurred to a maximum depth of 19 feet (in Louise Lake), but were most common in the shore to 10 feet depth zone, where 90 percent of the sample sites contained vegetation. Common submerged aquatic plants included large algae and several pondweed species. Surveyors also mapped approximately 308 acres of emergent and floating-leaf plants and common plants were bulrush, wild rice and waterlilies. Unique plant species included both submerged and emergent aquatic plants.

Two fish species of greatest conservation need, the pugnose shiner and greater redhorse, were identified on this group of lakes. A number of previously undocumented fish species were identified at each of the lakes; surveyors documented 11 new species at Little Boy Lake and 8 new species at Wabedo Lake. The nongame fish surveys conducted on Louise Lake were the first fish surveys on that lake, and surveyors documented 11 species. In total, 35 fish species were documented during the nongame fish surveys. Green frogs were identified at numerous locations on both Little Boy and Wabedo Lakes.

Surveyors documented 87 species of birds on the three lakes, including 19 species of greatest conservation need. Wabedo Lake had the highest species count (80 species), followed by Little Boy Lake (64 species) and Louise Lake (34 species). Ovenbirds were the most commonly detected species of greatest conservation need, whereas red-eyed vireos were most abundant overall.

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

The ecological model identified four primary sensitive lakeshore areas to be considered for potential resource protection districts by Cass County. The major inlets and outlets, as well as Louise Lake and the channel connecting the three lakes, were identified as important ecological connections. The County may use this objective, science-based information in making decisions about districting and reclassification of lakeshore areas. The most probable highly sensitive lakeshore areas and the recommended resource protection districts are:


Sensitive Lakeshore
Sensitive Shoreland
Rivers & Streams
Ecological Connection

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 of greatest conservation need.

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

Lake Description

Figure 1. Location of Little Boy, Wabedo, and Louise Lakes in Cass County, MN.

Little Boy Lake, Wabedo Lake, and Louise Lake are located near the city of Longville, in Cass County, north-central Minnesota (Figure 1). These lakes occur in the southeast corner of the Leech Lake Watershed and are connected to the Boy River, which drains the watershed to the north. Water flows north from Wabedo Lake into a navigable channel that connects to the eastern end of Louise Lake, and continues north as it enters and then leaves Little Boy Lake (Figure 2).

Little Boy Lake is the largest of the three lakes, and the 10th largest in the Leech Lake Watershed. It has a surface area of about 1,400 acres and 11 miles of shoreline. Wabedo Lake is slightly smaller, with a surface area of approximately 1,200 acres and ten shoreline miles. The waterbody between the two lakes, which includes the channel and Louise Lake, is about 33 acres in size. Wabedo Lake has two distinct basins: a southwest basin with a maximum depth of 95 feet and a northeast basin with a maximum depth of 50 feet (Figure 3). Little Boy Lake has a maximum depth of 74 feet. About 65 percent of Louise Lake and 45 percent of Little Boy and Wabedo Lakes are shallow with water depths of 20 feet or less.

The Minnesota DNR has classified Little Boy Lake as a Class 22 lake; these lakes are generally clear, very large and deep, have a low percentage of shallow water, and have an irregularly shaped shoreline (MN DNR 2005). Between 1989 and 2008, the average Secchi depth (which measures water transparency) for Little Boy Lake was 10 feet (MPCA 2008). Based on this and other measurements, Little Boy Lake is described as mesotrophic, or moderately nutrient-

enriched. The Minnesota DNR Section of Fisheries manages Little Boy Lake primarily for muskellunge, walleye, and northern pike (MN DNR 2005).

Wabedo Lake is also classified as a Class 22 lake. The average Secchi depth for the northeast basin between 1980 and 2008 was 9 feet; the average Secchi depth for the southwest basin between 1993 and 2008 was 10 feet (MPCA 2008). The northeast basin is described as mesotrophic, while the southwest basin is considered eutrophic, and is slightly more nutrient-rich. Wabedo Lake is managed by the MN DNR Section of Fisheries primarily for muskellunge, black crappie, and walleye (MN DNR 2005).

Figure 2. Features of Little Boy, Wabedo, and Louise Lakes.

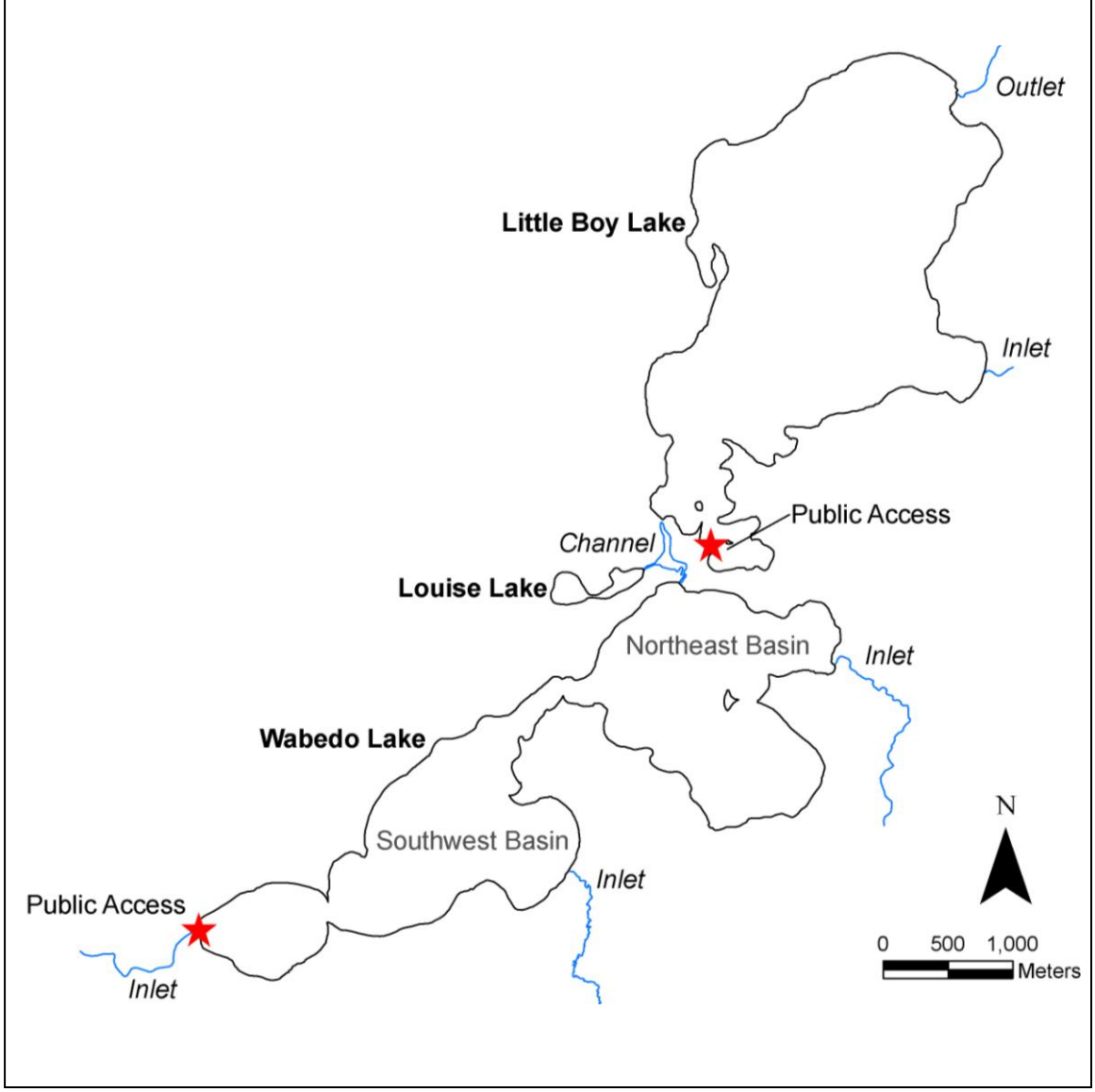
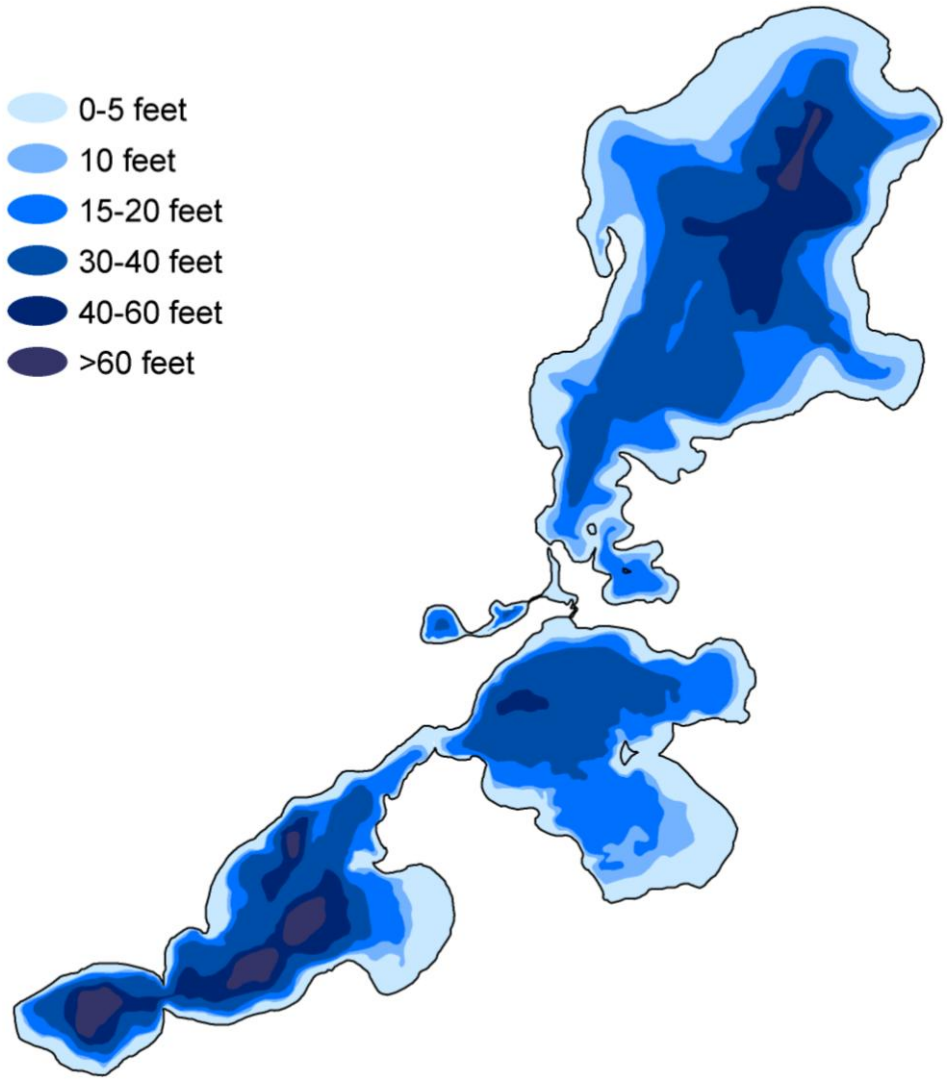


Figure 3. Depth contours of Little Boy, Wabedo, and Louise Lakes.



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 Little Boy, Wabedo, and Louise Lakes

Introduction

Wetland in the channel between Little Boy and Wabedo Lakes

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

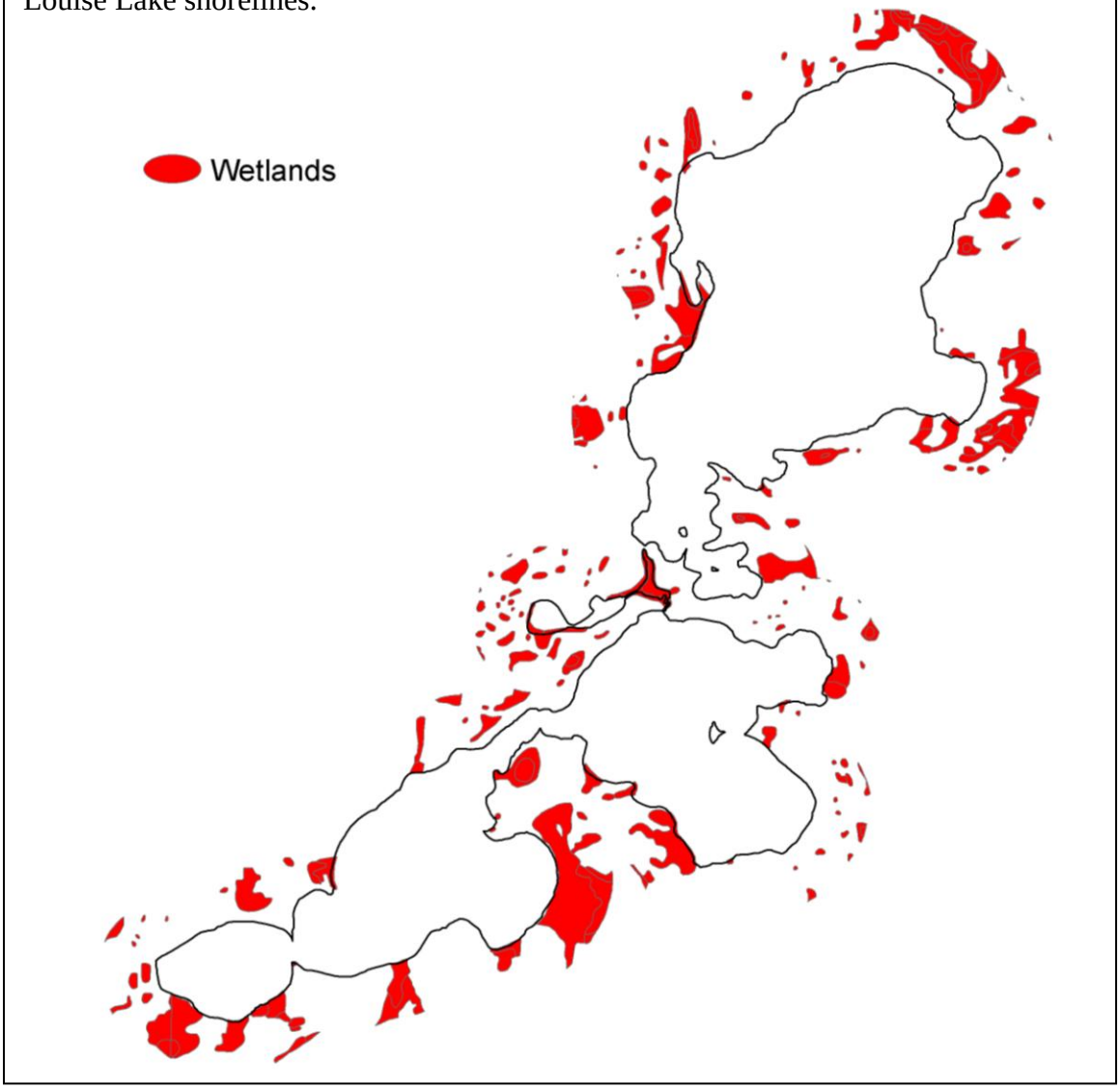
Wetland data were obtained from the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS). The NWI project was conducted between 1991 and 1994 using aerial photography from 1979 – 1988. Wetland polygons obtained from the NWI were mapped in a Geographic Information System (GIS) 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 ordinary high water mark were excluded from this analysis.

Results

Approximately 630 acres within the shoreland area of Little Boy, Wabedo, and Louise Lakes are described as wetlands by NWI (Figure 4). These wetlands comprise 19 percent of the Little Boy Lake shoreland district (~270 acres) and 18 percent of the Wabedo Lake shoreland district (~310 acres). The dominant wetland types included emergent wetland (Cowardin et al. 1979) or marsh (MN DNR 2003) systems, characterized by herbaceous, emergent wetland vegetation; palustrine scrub-shrub (Cowardin et al. 1979) or wetland shrubland systems (MN DNR 2003), dominated by deciduous or evergreen shrubs, or unconsolidated bottom wetlands (Cowardin et al. 1979), characterized by sparse vegetative cover. The water regime varied among wetlands, and included saturated, seasonally flooded, and intermittently exposed soils.

Figure 4. Distribution of wetlands within 1320 feet of Little Boy, Wabedo, and Louise Lake shorelines.



Hydric Soils

Objectives

1. Map hydric soils within the extended state-defined shoreland area of Little Boy, Wabedo, and Louise Lakes

Introduction

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

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

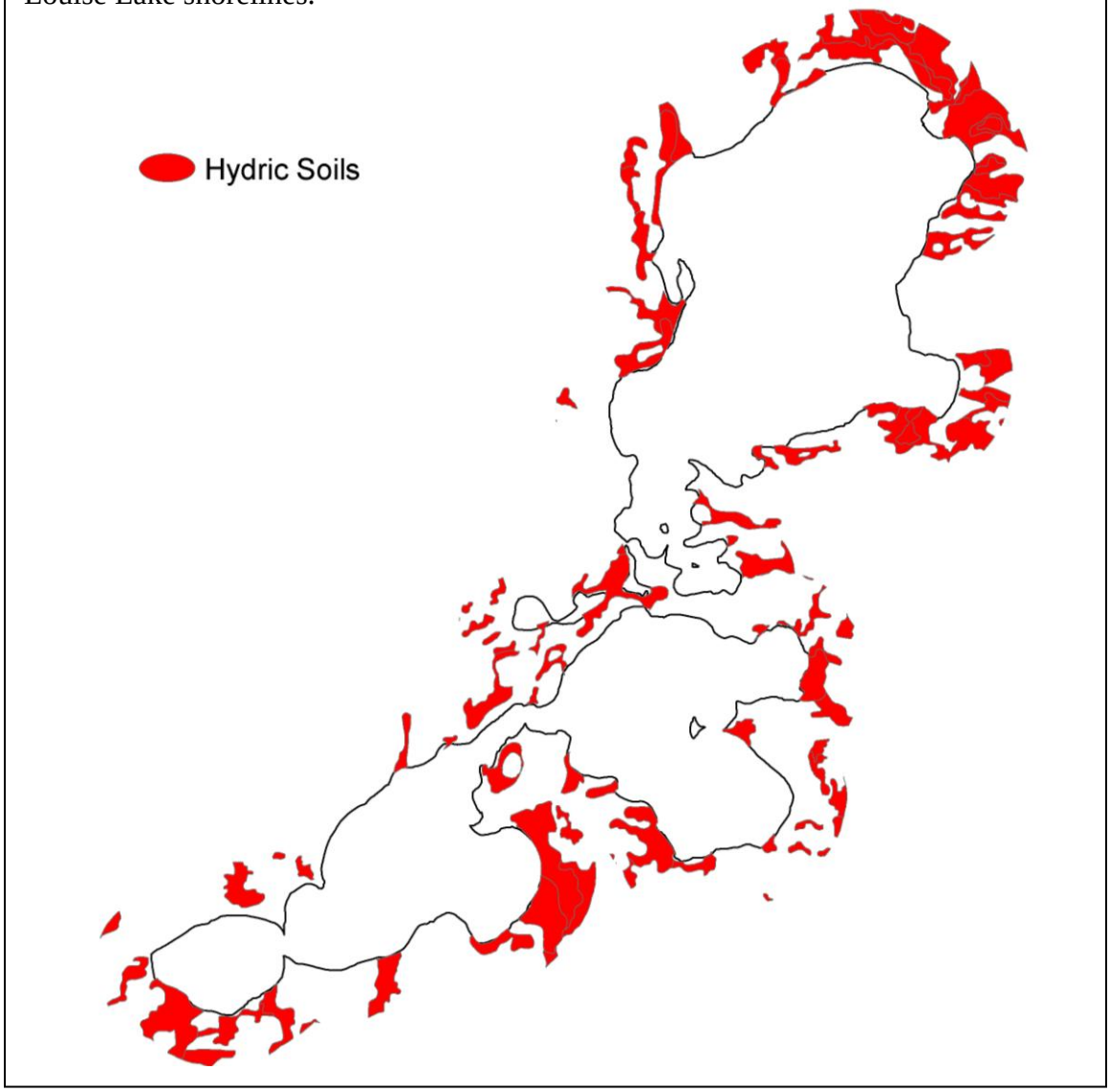
Methods

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

Results

Nearly 850 acres of the shoreland area around Little Boy, Wabedo, and Louise Lakes are comprised of hydric soils (Figure 5). Approximately 400 of those acres surround Little Boy Lake, and make up 29 percent of the shoreland district. Twenty-two percent (slightly under 400 acres) of the shoreland area around Wabedo Lake is comprised of hydric soils. Approximately 50 acres of hydric soils occur within the Louise Lake shoreland district. The major soil types are identified as muck, peat, and loamy sand. These soils are very poorly drained, and have high to very high organic matter content.

Figure 5. Distribution of hydric soils within 1320 feet of Little Boy, Wabedo, and Louise Lake shorelines.



Plant Surveys

Objectives

1. Describe distribution of vegetation in Wabedo, Little Boy, and Louise Lakes
    a. Estimate maximum depth of plant colonization
    b. 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

Surveyors recorded 39 aquatic plant taxa and mapped about 308 acres of emergent and floating-leaf plants. Extensive bulrush stands occurred around Little Boy Lake and smaller beds of bulrush, waterlilies and wild rice were common in protected bays. Submerged plants were found to a depth of 16 feet in Little Boy Lake, 18 feet in Wabedo Lake, and 19 feet in Louise Lake. In all three lakes, vegetation was most common from shore to the 10 feet depth where about 90 percent of the sample sites contained vegetation. Few plants occurred beyond the 15 feet depth.

The large algae muskgrass (*Chara* sp.) was the most frequently found submerged plant, and occurred in one-third of the sample sites. This low-growing plant is common in hardwater lakes of northern Minnesota. Other native submerged taxa included coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*) and several broad-leaf pondweeds (*Potamogeton* spp.).

Within the shore to seven feet depth zone, 30 percent of the sample sites contained at least one emergent or floating-leaf plant. Floating-leaf plants, including white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*), covered about 39 acres in Little Boy Lake, 52 acres in Wabedo Lake, and 12 acres in Lake Louise. Hard-stem bulrush (*Schoenoplectus acutus*) was found primarily on sand substrates and occupied about 169 acres in Little Boy Lake and 43 acres in Wabedo Lake.

Unique submerged and emergent aquatic plants documented during the surveys were pipewort (*Eriocaulon aquaticum*) and three-way sedge (*Dulichium arundinaceum*).

Introduction

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

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

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

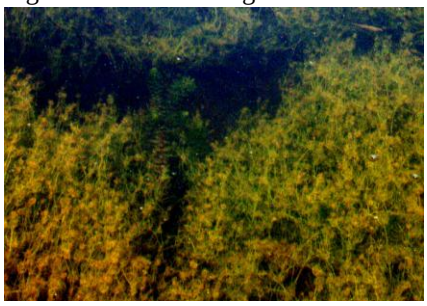
Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant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

Submerged plants

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

Muskgrass (*Chara* sp.; Figure 6) is a large algae that is common in many hardwater Minnesota lakes. This plant resembles higher plants but does not form flowers or true leaves, stems and roots. Muskgrass grows entirely submerged, is often found at the deep edge of the plant zone (Arber 1920), and may form thick "carpets" on the lake bottom. These beds provide important habitat for fish spawning and nesting. Muskgrass has a brittle texture and a characteristic "musky" odor. It is adapted to a variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer.

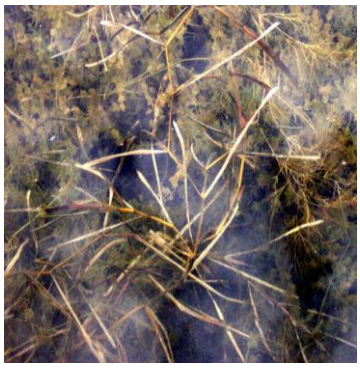
Figure 6. Bed of muskgrass



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

species differ in their water chemistry and substrate preferences and tolerance to turbidity. There are over 35 species of pondweeds in Minnesota and they vary in leaf shapes and sizes.

Figure 7. Flat-stem pondweed



Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 7) is a perennial plant that is anchored to the lake bottom by underground rhizomes. It is named for its flattened, grass-like leaves. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. These pondweeds are anchored to the lake bottom by rhizomes and over-winter by winter buds.

Figure 8. Clasping-leaf pondweed

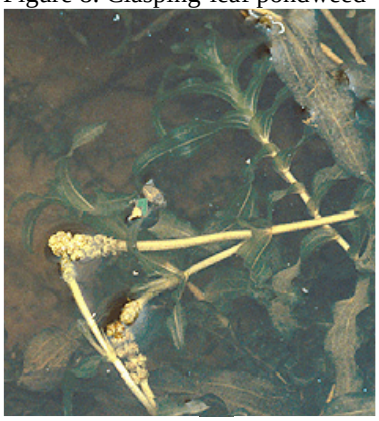


Photo by Vic Ramey: ©2001 Univ of Florida/ IFAS Center for Aquatic and Invasive Plants

Broad-leaf pondweeds are rooted, perennial plants with broad leaves and are often called "cabbage" plants by anglers. All species of broad-leaf pondweeds form submerged leaves and some may also form floating leaves. The foliage provides food and shelter for fish and seeds and tubers are eaten by waterfowl. Clasping-leaf pondweed (*Potamogeton richardsonii*) is a species that can be found throughout Minnesota (Ownbey and Morley 1991). It receives its name because its broad leaves "clasp" around the stem (Figure 8).

Figure 9. Coontail

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

Figure 10. Northern watermilfoil

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 10) is a rooted, perennial submerged plant with finely dissected leaves. It may reach the water surface, particularly in depths less than ten feet and its flower stalk extends above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. This native plant provides fish shelter and insect habitat and the extensive root systems help stabilize near-shore substrates.

Floating-leaf and emergent plants

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

Figure 11. White waterlily

Figure 12. Yellow waterlily

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

Figure 13. Bulrush plant in flower

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

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

Figure 14. Wild rice

Wild rice (*Zizania palustris*; Figure 14) is an emergent annual plant that reproduces each year from seed set in the previous fall. Wild rice is most commonly found in lakes of central and northern Minnesota. Cass County is one of five Minnesota counties with the highest concentration of lakes supporting natural wild rice stands (MN DNR 2008b). Wild rice generally requires habitat with some water flow, such as lakes with inlets and outlets. This plant is most often found in

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

Unique aquatic plants

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

- Plant species that are not listed as rare but are uncommon in the state or locally. These may include species that are proposed for rare listing.
- 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.

Pipewort (*Eriocaulon aquaticum*) is a perennial plant that begins as an underwater plant and sends up a small white-capped flower stalk at the end of summer (Figure 15). The fruits on this plant are small capsules with oval seeds (Newmaster et al. 1997). Pipewort is found in acidic lakes along sandy shorelines and on floating fen mats (Newmaster et al. 1997) throughout northeastern Minnesota (Ownbey and Morley 1991).

Figure 15. Pipewort

Three-way sedge (*Dulichium arundinaceum*; Figure 16) 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 an airplane propeller from above (Newmaster et al. 1997). Three-way sedge is found along shores of lower alkalinity lakes (Nichols 1999b) throughout central and northern Minnesota (Ownbey and Morley 1991).

Figure 16. Three-way sedge

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

Species richness

Species richness is defined as the number of species present in a community and is often used as a simple measure of biodiversity (Magurran 2004). In aquatic plant communities, species richness is influenced by many complex factors (Pip 1987) including water chemistry, transparency, habitat area and habitat diversity (Vestergaard and Sand-Jensen 2000, Rolon et al. 2008). In Minnesota, water chemistry strongly influences which plant species can potentially occur in a lake (Moyle 1945), and thus, indirectly influences lakewide species richness. The trophic status of a lake further influences plant species richness and eutrophic and

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 Little Boy, Wabedo, and Louise Lakes 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 Little Boy Lake on July 3, 5, and 11, 2007. Wabedo Lake was surveyed on July 27 – 29, 2007, and Louise Lake was surveyed on August 9, 2007 (Perleberg 2008). A GIS computer program was used to establish aquatic plant survey points that were established throughout the littoral (i.e., vegetated) zone of the lake to a depth of 20 feet. Points were spaced 65 meters apart on Little Boy and Wabedo Lakes. Survey points were spaced closer (30 meters) on Louise Lake to ensure that sufficient sample points were included in the vegetated zone (Perleberg 2008). In total, 1172 sites were sampled within the shore to 20 feet depth interval. An additional 31 sites were surveyed in the 21 to 30 feet depth zone but since no vegetation was found, these deeper water sites were not used in analyses. Surveyors navigated to each site using a handheld Global Positioning System (GPS) unit. At each sample site, water depth and all vegetation within a one-meter squared sample area were sampled using a double-headed garden rake. All aquatic plant species present within the sample plot were recorded and frequency of occurrence was calculated for each species. Any additional species found outside the sample plots were recorded as present in the lake. Voucher specimens were collected for most species and were submitted to The Herbarium at the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Emergent and floating-leaf bed delineation

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

Near-shore vegetation survey
Near-shore vegetation surveys were conducted at six plots on Little Boy Lake and six plots on Wabedo Lake. 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
Prior to fieldwork, surveyors obtained known locations of state and federally listed rare plants within one mile of Little Boy, Wabedo, and Louise lakes from the Rare Features Database of the Minnesota DNR Natural Heritage Information System. Surveyors also queried the University of Minnesota Herbarium Vascular Plant Collection database and DNR Fisheries Lake Files to determine if certain plant species had previously been documented in or near Little Boy, Wabedo, and Louise Lakes.

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

A targeted search for rare aquatic vascular plants in Little Boy Lake was conducted by the Minnesota County Biological Survey Program on August 29, 2008 (Myhre 2008). This search focused on sites that were most likely to contain rare plant species. Botanists used professional experience to select rare species search sites and included factors such as shoreline development, substrate type, water depth, and native plant communities type in their site selection. To gain access to shallow vegetated areas, searches were conducted by slowly kayaking, canoeing and/or wading through the site.

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

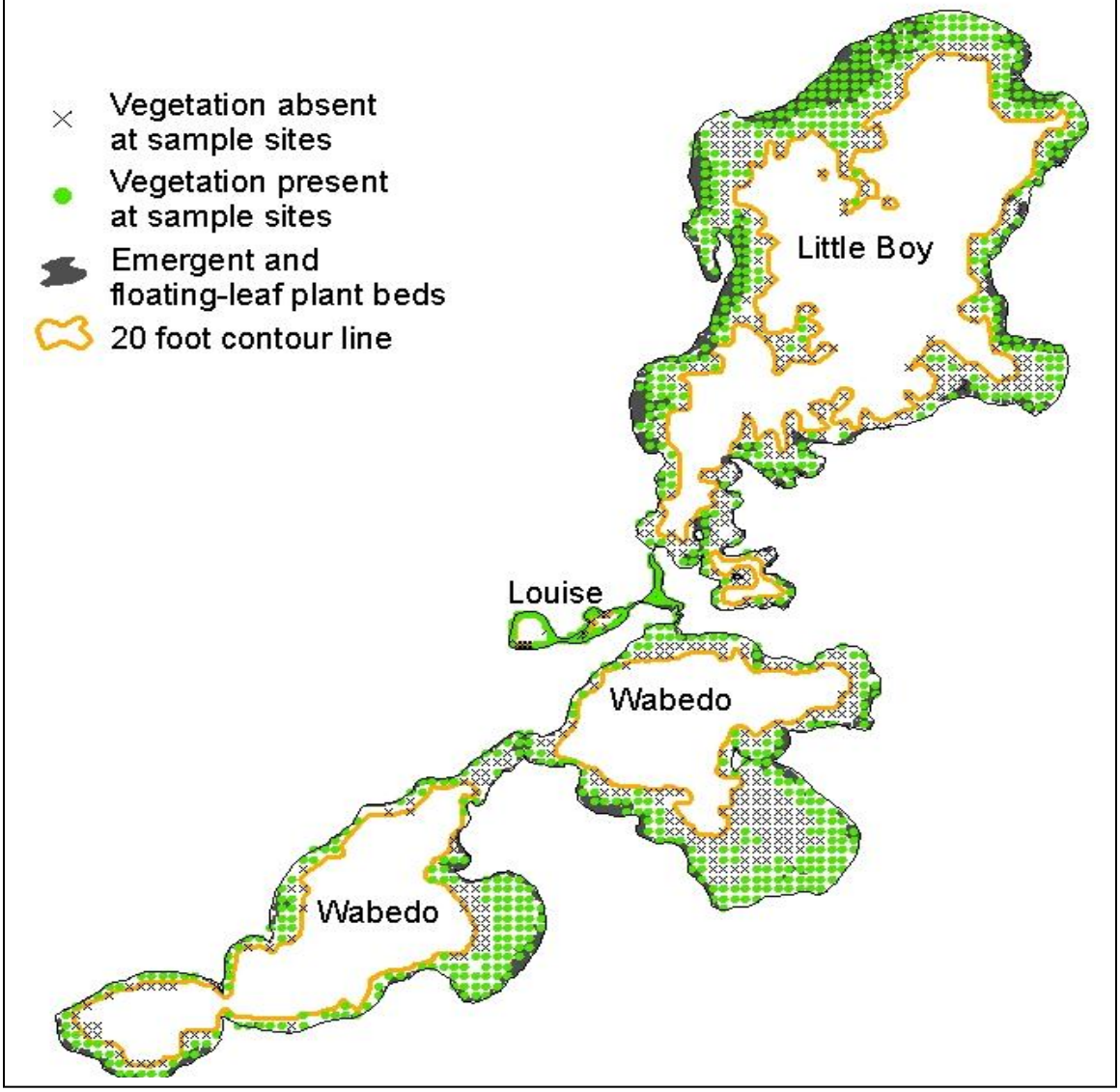
Results

Distribution of plants by water depth
Aquatic plants occurred around the entire perimeter of each lake and in some areas extended lakeward as much as 900 feet (Figure 17). Approximately 308 acres of emergent and floating-leaf beds were mapped and the largest beds occurred along the west and northeast shores of Little Boy Lake. Submerged plants occurred along shore as well as in offshore shallow areas.

Plants were found to a water depth of 16 feet in Little Boy Lake, 18 feet in Wabedo Lake, and 19 feet in Louise Lake. This vegetated zone includes about 845 acres, or about one-third of the

lakes. Within this area, nearly 80 percent of the survey sites contained vegetation. Beyond depths of 15 feet, only one or two sites in each lake contained vegetation

Figure 17. Aquatic plant distribution in Little Boy, Wabedo, and Louise Lakes, 2007.



Aquatic plant species observed

A total of 39 aquatic plant taxa were recorded in Little Boy, Wabedo, and Louise Lakes. These included 22 submerged, three free-floating (Table 1), five floating-leaved and nine emergent taxa (Table 2). Additional shoreline emergent plants were also documented (Appendix 1).

Table 1. Submerged and free-floating aquatic plants recorded in Little Boy, Wabedo and Louise Lakes, 2007 and 2008.

Description	Common Name	Scientific Name	Frequency of Occurrence[a]		
			Wabedo N =526	Little Boy N=577	Louise N=85
Algae	Muskgrass	*Chara* sp.	32	33	27
	Stonewort	*Nitella* sp.	---	<1	---
Grass-leaf plants	Flat-stem pondweed	*Potamogeton zosteriformis*	26	15	18
	Ribbon pondweed	*Potamogeton epihydrus*	---	---	P[bc]
	Water stargrass	*Zosterella dubia*	1	3	1
	Wild celery	*Vallisneria americana*	2	3	5
Dissected-leaf plants	Coontail	*Ceratophyllum demersum*	27	11	36
	Northern watermilfoil	*Myriophyllum sibiricum*	14	6	5
	Greater bladderwort	*Utricularia vulgaris*	2	5	11
	Water marigold	*Bidens beckii*	1	P[b]	---
Bushy-leaf plants	Canada waterweed	*Elodea canadensis*	17	4	6
	Bushy pondweed	*Najas flexilis*	3	3	33
Broad-leaf plants	Clasping-leaf pondweed	*Potamogeton richardsonii*	6	3	4
	Large-leaf pondweed	*Potamogeton amplifolius*	5	2	4
	White-stem pondweed	*Potamogeton praelongus*	3	3	---
	Illinois pondweed	*Potamogeton illinoensis*	1	2	1
	Variable pondweed	*Potamogeton gramineus*	---	2	---
Fine-leaf plants	Sago pondweed	*Stuckenia pectinata*	---	3	1
	Fries' pondweed	*Potamogeton friesii*	2	2	4
	Small pondweed	*Potamogeton pusillus*	---	P[c]	---
	Straight-leaved pondweed	*Potamogeton strictifolius*	---	P[c]	---
	Narrow-leaf pondweed	*Potamogeton* sp.[d]	1	2	5
	Pipewort	*Eriocaulon aquaticum*	---	---	P[b]
Free-floating duckweed	Lesser duckweed	*Lemna minor*	---	<1	---
	Star duckweed	*Lemna trisulca*	6	<1	9
	Greater duckweed	*Spirodela polyrhiza*	---	<1	27

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

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

[c]P = Located only during Minnesota County Biological Survey, 29 August 2008.

[d]Some specimens of "narrow-leaved pondweeds" were positively identified as Potamogeton friesii (Fries' pondweed). However, it is not known whether other "look-a-like" narrow-leaf pondweed species occurred in the lake. Therefore, a separate group of unidentified narrow-leaf pondweeds (Potamogeton sp.) are reported here but not counted in the species tally.

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaf and emergent aquatic plants recorded in Little Boy, Wabedo, and Louise Lakes, 2007.

Description	Common Name	Scientific Name	Frequency of Occurrence[a]		
			Wabedo N = 526	Little Boy N=577	Louise N=85
Floating-leaf	Yellow waterlily	*Nuphar variegata*	7	4	15
	White waterlily	*Nymphaea odorata*	3	2	31
	Floating-leaf pondweed	*Potamogeton natans*	<1	1	4
	Floating-leaf burreed	*Sparganium* sp.	P[b]	P[b]	---
	Water smartweed	*Polygonum amphibium*	P[b]	---	---
Narrow-leaf emergent	Bulrush	*Schoenoplectus acutus*	6	19	2
	Spikerush	*Eleocharis* sp.	---	<1	---
Leafy Emergent	Three-way sedge	*Dulichium arundinaceum*	---	P[b]	---
	Giant cane	*Phragmites australis*	P[b]	P[b]	---
	Arrowhead	*Sagittaria latifolia*	1	1	1
	Giant burreed	*Sparganium eurycarpum*	<1	1	---
	Narrow-leaf cattail	*Typha* sp.	---	1	1
	Broad-lead cattail	*Typha latifolia*	---	P[b]	---
	Wild rice	*Zizania palustris*	1	4	38

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

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

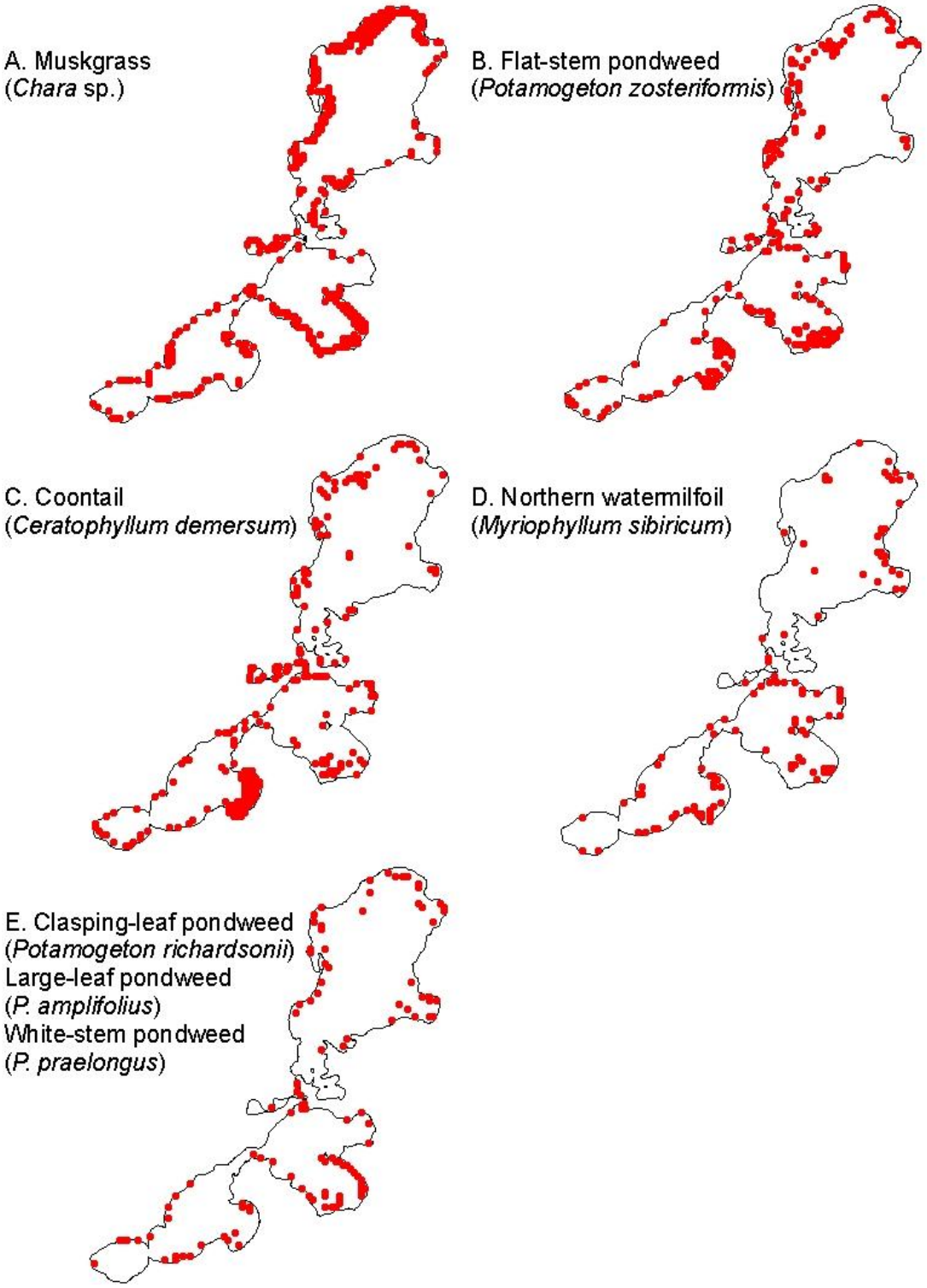
Submerged plants

Within the shore to 20 feet depth zone, submerged plants occurred in 78 percent of the Louise Lake sites, 65 percent of the Wabedo Lake sites and 57 percent of the Little Boy Lake sites. A mixture of submerged plant types were found and the most commonly occurring taxa were muskgrass, coontail, flat-stem pondweed, broad-leaf pondweeds (*Potamogeton* spp.), Canada waterweed, and northern watermilfoil. These taxa accounted for at least 85 percent of the plant occurrences in Little Boy and Wabedo Lakes. In Louise Lake, bushy pondweed was also an important submerged species.

Muskgrass was found in about 30 percent of the sites in each lake (Table 1). It was widespread around the vegetated zones of each lake (Figure 18A) and was found both growing in thick beds with no other vegetation and within mixed beds of pondweeds and other submerged plants. In Little Boy Lake, muskgrass was common within the extensive bulrush stands along the west shore. Muskgrass was most often found in depths less than eight feet and was the most common submerged plant found in depths less than five feet.

Eleven different submerged pondweed species (*Potamogeton* and *Stuckenia*) were found in these lakes and were most common in depth of ten feet and less. The most common species was flat-stem pondweed, which occurred with a frequency of 26 percent in Wabedo Lake, 15 percent in Little Boy Lake and 18 percent in Louise Lake (Table 1). Flat-stem pondweed had a widespread distribution (Figure 18B) and often co-occurred with muskgrass and coontail.

Figure 18. Distribution of common aquatic plants in Little Boy, Wabedo, and Louise Lakes, 2007.



Broad-leaf pondweeds were scattered around the lakes and included clasping-leaf, large-leaf, white-stem, Illinois, and variable pondweeds (Figure 18E)

Two submerged plants with finely dissected leaves were common in these lakes. Coontail was the most common species in Louise Lake, where it was found in 37 percent of the sample sites. It occurred with a frequency of 27 percent in Wabedo Lake and 11 percent in Little Boy Lake (Figure 18C). Coontail was one of the few species found in depths greater than ten feet. Northern watermilfoil occurred with a frequency of 14 percent in Wabedo Lake, 6 percent in Little Boy, and 5 percent in Louise Lake (Figure 18D). It was most common in depths less than ten feet.

Floating-leaf and emergent plants

Emergent and floating-leaf plants occurred in water depths of seven feet and less. Common floating-leaf plants were white and yellow waterlilies. Beds of waterlilies often included submerged plants and scattered emergents and were usually associated with muck substrates. A total of 105 acres of waterlily beds were mapped and the largest beds occurred in Wabedo Lake (Figure 19).

Waterlilies in Wabedo Lake, 2007

Surveyors delineated approximately 212 acres of emergent plants and the most common taxa were wild rice and bulrush.

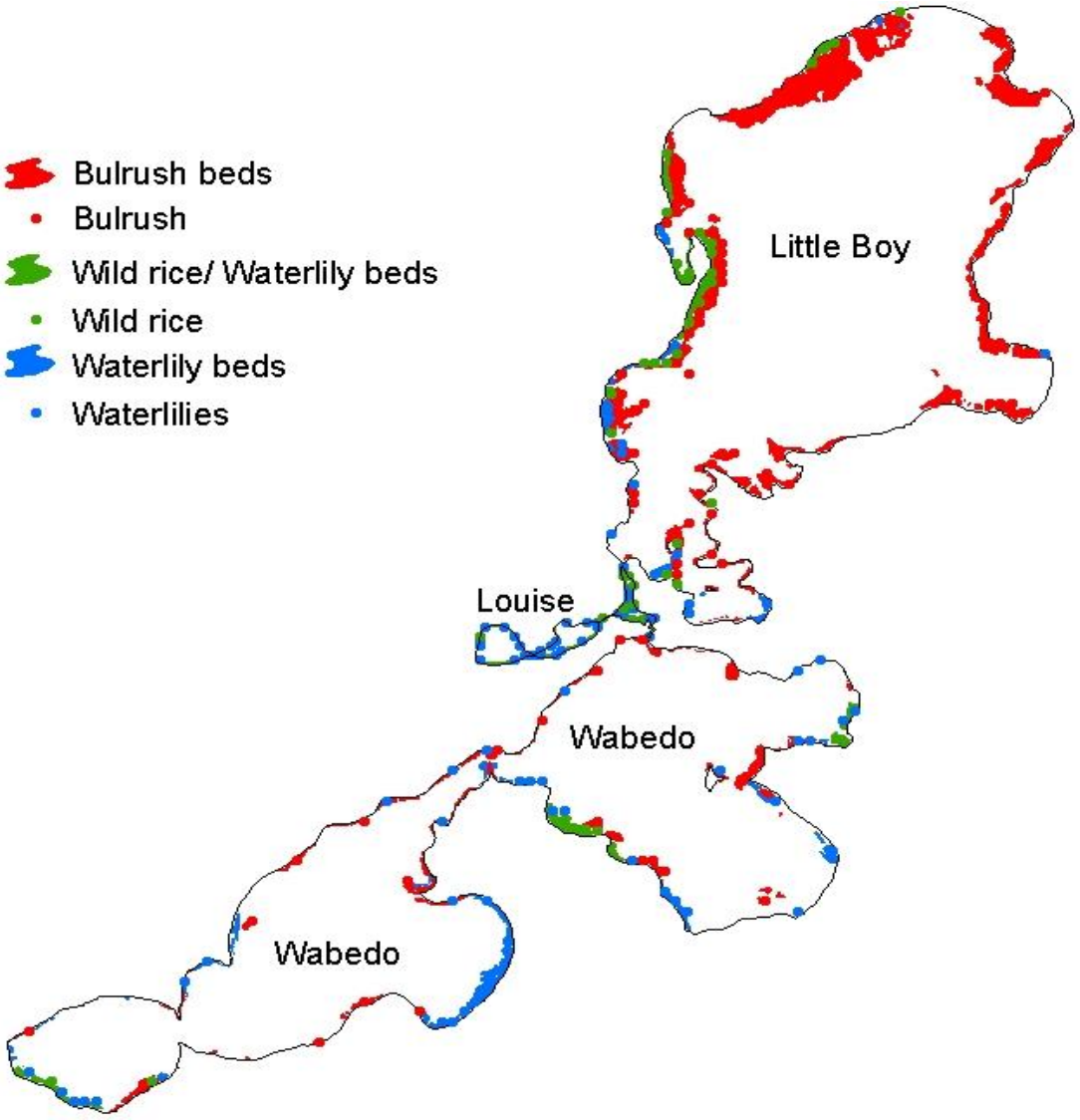
Wild rice was found in soft substrates and often co-occurred within waterlilies. Approximately 49 acres of wild rice mixed with waterlilies were mapped and the largest beds occurred along the west shore of Little Boy Lake and the south shores of Wabedo Lake (Figure 19). Bulrush occupied about 203 acres and the largest stands occurred in Little Boy Lake (Figure 19).

Wild rice-waterlily bed in Little Boy Lake, 2007

Other emergent plants occurred at scattered locations around the lake and included arrowhead and burreed. Many of these emergent plants occupied the transitional zone between the lake and adjacent wetlands. Numerous additional native emergents occurred in these adjacent wetlands but this survey did not include an exhaustive wetland species inventory. Frequency values for floating-leaf taxa represent the occurrence of these taxa only within the sites that were surveyed.

Bulrush on sand-rock shore, Little Boy Lake, 2007

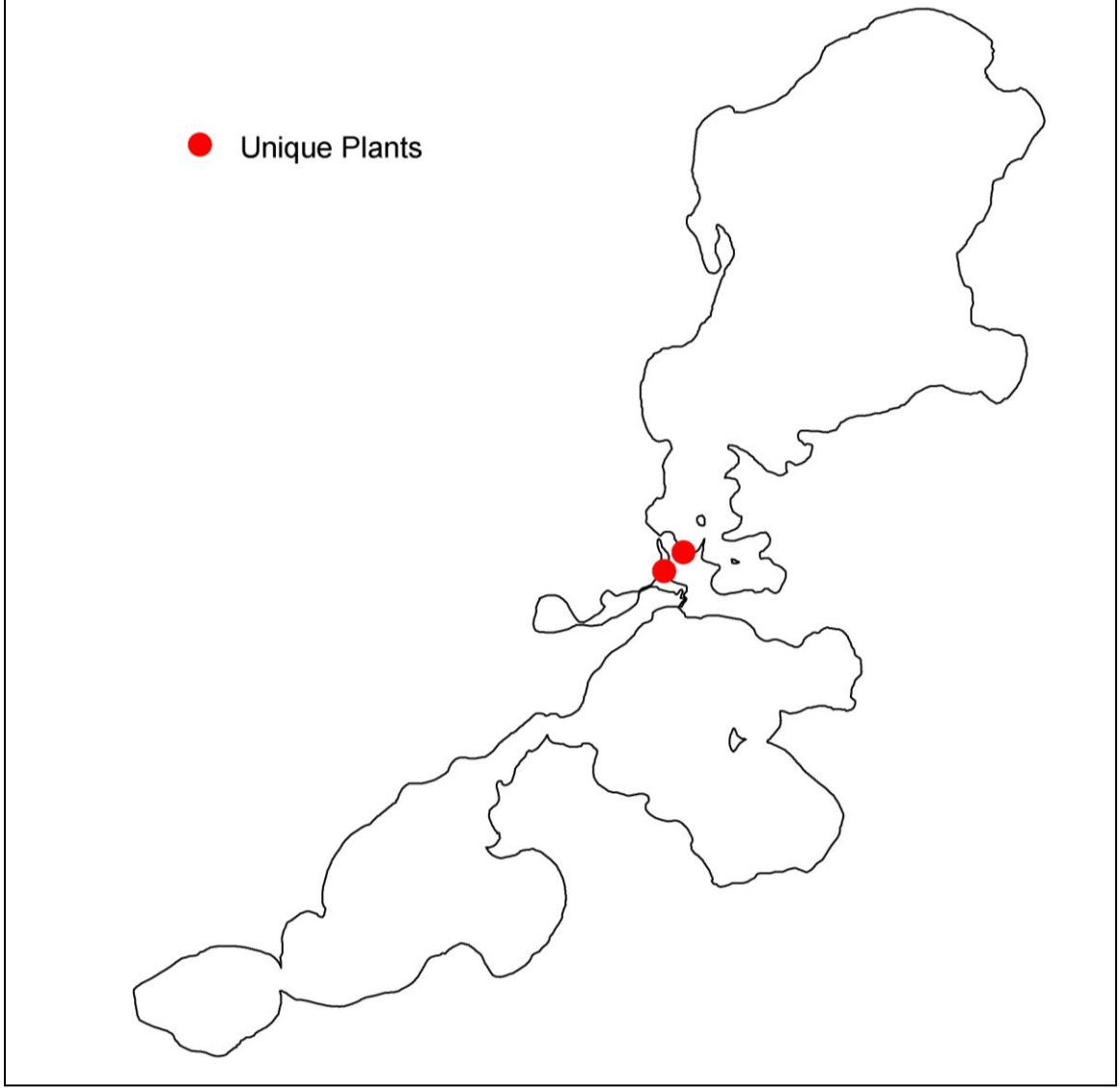
Figure 19. Distribution of emergent and floating-leaf plant beds in Little Boy, Wabedo, and Louise Lakes, 2007.



Unique plants

In addition to the commonly occurring plants in Little Boy, Wabedo, and Louise Lakes, two unique plant species were documented at two locations during the survey (Figure 20). These species are not widespread in Minnesota but their presence is indicative of relatively undisturbed native plant communities in the lakes. Unique submerged aquatic plants included pipewort and three-way sedge. Three-way sedge was located in the south bay of Little Boy Lake and pipewort was located in the channel between Little Boy and Wabedo Lakes.

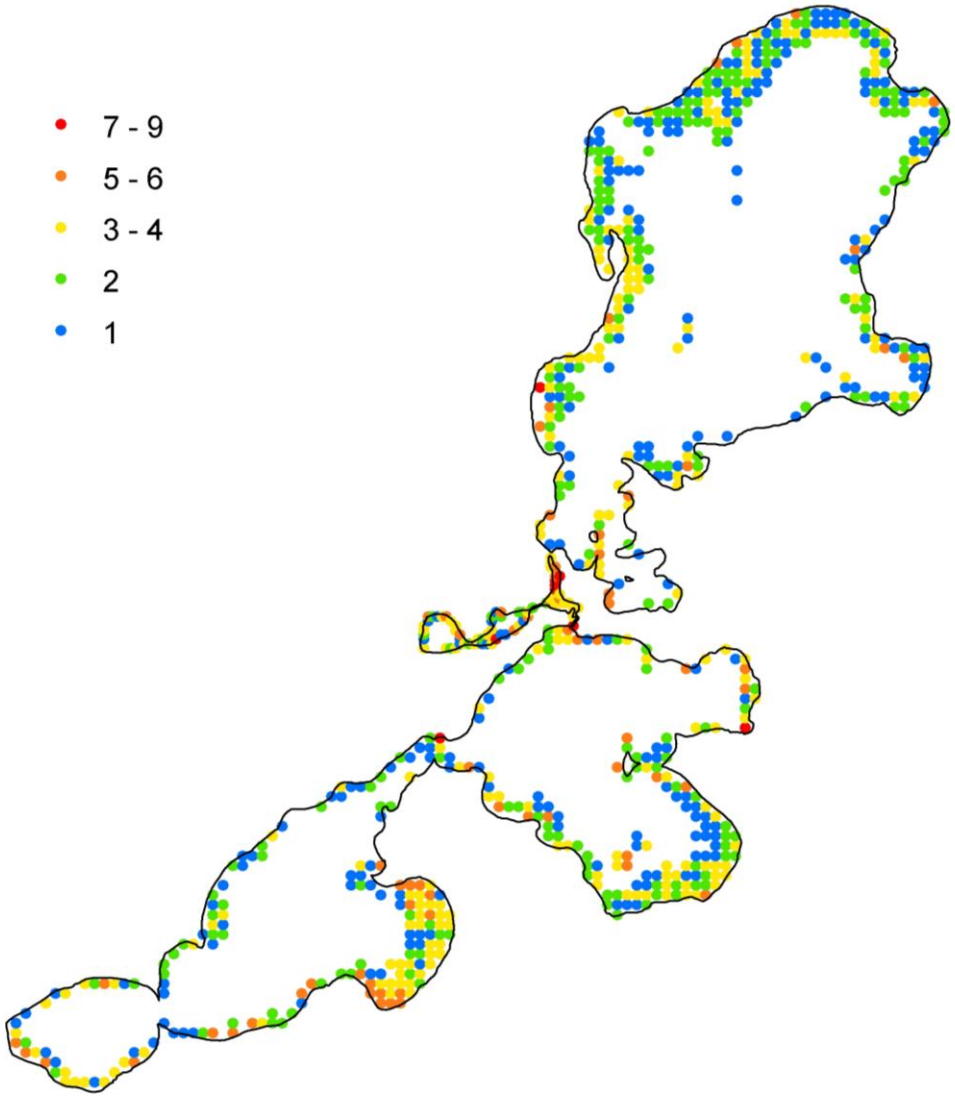
Figure 20. Unique aquatic plants in Little Boy, Wabedo, and Louise Lakes, 2007.



Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to nine (Figure 21). Sites with the highest number of taxa occurred near shore, within mixed beds of emergent, floating-leaved and submerged plants. These sites included the channel leading from Louise Lake to Little Boy Lake and the east bay of the south Wabedo basin. In depths greater than ten feet most sites contained fewer than three taxa.

Figure 21. Aquatic plant richness (number of taxa per sampling station) in Little Boy, Wabedo, and Louise Lakes, 2007.



Near-shore Substrates

Objectives

1. Describe and map the near-shore substrates of Little Boy, Wabedo, and Louise Lakes

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

Methods

Near-shore substrate in Little Boy, Wabedo, and Louise Lakes was evaluated at a total of 739 sampling stations set up in the grid point-intercept aquatic plant survey and near-shore fish surveys. Plant point-intercept sample stations were spaced 65 meters apart on Little Boy and Wabedo Lakes, and 30 meters apart on Louise Lake. Surveyors described substrate at 649 of these sites that were located between the shore and the seven foot water depth. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore fish sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 90 of these stations. In total, substrate was described at 347 sites on Little Boy Lake, 337 sites on Wabedo Lake, and 55 sites on Louise Lake.

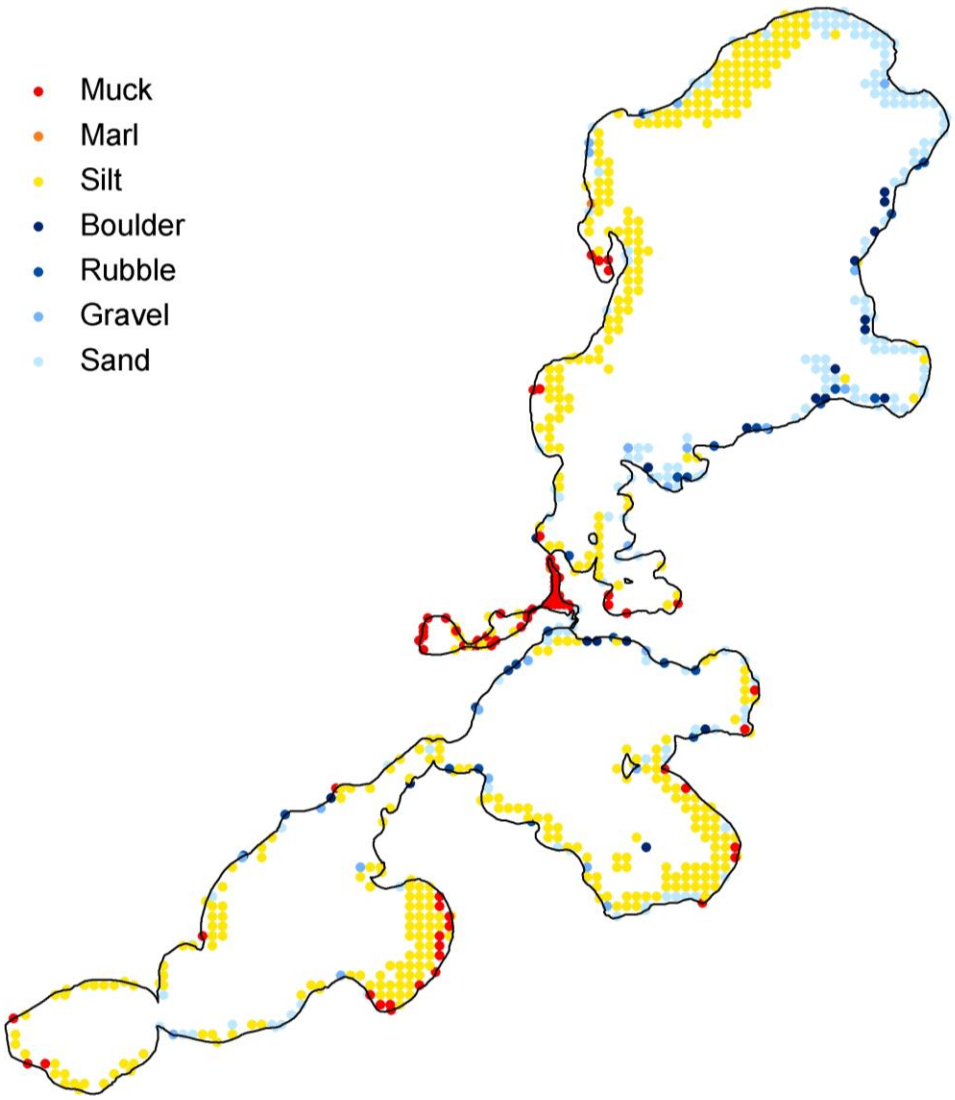
Surveyors evaluated substrate by tapping a pole into the lake bottom; soft substrate could usually be brought to the surface on the pole or sampling rake for evaluation. If this method was not feasible, substrate was evaluated by visual observation of the lake bottom. Standard lake substrate classes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

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

Results

Substrate type varied somewhat between the lakes (Figure 22). Little Boy Lake had a mix of sand and silt substrates, with the sandy substrates occurring primarily on the eastern shoreline and the silt substrates along the western shoreline. Boulders and rubble were also scattered along the eastern shore. Wabedo Lake was dominated by silt substrates, particularly in the broad, shallow eastern bays. Although a small section of the channel between Wabedo Lake and Louise Lake had a sand bottom, most of Louise Lake had a muck substrate. Overall, the dominant near-shore substrate type was silt, which occurred at nearly 60 percent of the sampling sites.

Figure 22. Distribution of near-shore substrates in Little Boy, Wabedo, and Louise Lakes, 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 (MN DNR 2006). Nineteen of these species were identified at Little Boy, Wabedo, and Louise Lakes.

Figure 23. American bittern

Photo by: Dave Herr

American bitterns (*Botaurus lentiginosus*; Figure 23) are medium-sized wading birds. The upperparts are dark brown, while the neck and body are streaked with brown. Adults have a black patch on either side of the throat. When disturbed, bitterns "freeze" with their bills pointed upward, allowing them to blend into the reeds. Habitat includes shallow, densely vegetated shorelines and marshes. Habitat loss has been a major factor in the decline of American bittern populations. Habitat degradation and pesticide contamination have also negatively affected bittern numbers.

American white pelicans (*Pelecanus erythrorhynchos*; Figure 24) are one of the largest birds in North America. These white waterbirds have a wingspan of nearly 10 feet, and weigh up to 30 pounds. They have black wingtips and an orange bill with a pouch. Unlike some pelicans, American white pelicans do not dive for their food, but feed while swimming. They nest in colonies on remote freshwater lakes, and depend on wetlands for many stages of their life cycle. Habitat loss is the largest known cause of nesting failure, although predation and boating disturbance can also be factors.

Figure 24. American white pelican

Photo by: Carrol Henderson

Bald eagles (*Haliaeetus leucocephalus*; Figure 25) 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. Bald eagles are found in forested areas near large, open bodies of water. Although their 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 25. Bald eagle

Photo by: Carrol Henderson

Black terns (*Chlidonias niger*; Figure 26) are distinguished by a black head and chest with gray wings, back, and tail. The nonbreeding plumage is lighter in color, and much of the black is replaced with white or gray. The bill is long, dark, and slightly curved. Black terns are loosely colonial, and often are found in freshwater marshes or wetlands. They may also occur along lake margins with abundant emergent vegetation. Black tern populations have declined dramatically since the 1960s. Habitat loss, environmental contamination, and human disturbance are often cited as causes of the decline.

Figure 26. Black tern

Photo by: Carrol Henderson

Common loons (*Gavia immer*; Figure 27) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. This large diving bird possesses red eyes and a large, dark pointed bill that is well-adapted for catching fish. Loons spend most of their time in the water, and come ashore only to breed and lay 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 27. Common loon

Photo by: Carrol Henderson

Common nighthawks (*Chordeiles minor*; Figure 28) 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 turning quickly 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 28. Common nighthawk

Photo by: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 29) 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. Deer browse and decrease the lower-canopy foraging area available to the pewee.

Figure 29. Eastern wood-pewee

Photo by: J.A. Spendelow

Golden-winged warblers (*Vermivora chrysoptera*; Figure 30) 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. They are active in their foraging, and may hang upside down from tree branches. 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 30. Golden-winged warbler

Photo by: Carrol Henderson

Least flycatchers (*Empidonax minimus*; Figure 31) 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 by their call, a harsh "che-bek." These birds are often found along water edges in mature, open woods, where they forage anywhere from the shrub layer to high in the canopy. 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 31. Least flycatcher

Photo by: J.A. Spendelow

Northern rough-winged swallows (*Stelgidopteryx serripennis*; Figure 32) are small, fairly common songbirds. They are brown on the head and back with a pale brown throat and white belly. The outer wing feathers, or primaries, have "hooks" on the edge, giving them a rough feel. These swallows are insectivorous and feed in the air, often over water. They will nest either singly or colonially near rocky or exposed banks of clay or sand. Open habitat is preferred for breeding. Northern rough-winged swallows are fairly adaptable and are even increasing in parts of their range. Continued monitoring is important to help maintain this trend.

Figure 32. Northern rough-winged swallow

Photo by: Dave Herr

Ovenbirds (*Seiurus aurocapillus*; Figure 33) 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 forage on the ground, looking for insects. Ovenbird numbers appear to be stable, but the birds are vulnerable to forest fragmentation and parasitism by brown-headed cowbirds (*Molothrus ater*).

Figure 33. Ovenbird

Photo source: U.S. Fish and Wildlife Service

Rose-breasted grosbeaks (*Pheucticus ludovicianus*; Figure 34) are occasional visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes, meadows and woodlands, and suburban parks and gardens. The winter range spans from southern Mexico to South America and the Caribbean. Significant regional declines in rose-breasted populations have been noted.

Figure 34. Rose-breasted grosbeak

Photo by: J.A. Spendelow

Sedge wrens (*Cistothorus platensis*; Figure 35) are small, brown wrens with buffy underparts and white streaks on the back and crown. They have an indistinct white eye stripe, and often hold their short tails in a cocked, upright position. As their name implies, they prefer marshes and meadows with abundant dense sedges and grasses. The nest is often made of sedges, as well. Sedge wrens are unpredictable in their migration patterns, and may be abundant in an area one year and completely absent the next. Human development of wetlands is the primary reason for the recent notable declines in sedge wren populations.

Figure 35. Sedge wren

Photo by: Berlin Heck

The swamp sparrow's (*Melospiza georgiana*; Figure 36) 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 36. Swamp sparrow

Photo by: Jim Stasz

The veery (*Catharus fuscescens*; Figure 37) 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. It forages mainly on the forest floor, flipping over dead leaves to find insects. 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 37. Veery

Photo by: Deanna Dawson

White-throated sparrows (*Zonotrichia albicollis*; Figure 38) are common in Minnesota during their spring and fall migrations. They are recognizable by the white patch on the throat and their characteristic "Old Sam Peabody Peabody Peabody" song. The head is striped with black and tan or white, and has a yellow spot above the eye. The chest is gray and the back is streaked with brown and black. They inhabit coniferous or mixed forests, and prefer areas with multiple openings and abundant low-growing vegetation. During winter and migration, they may also be found in woodlots, city parks, and backyards.Nests are often build on or near the ground. Although white-throated sparrows are widespread, they are declining over portions of their breeding range.

Figure 38. White-throated sparrow

Photo by: Dave Herr

The loud, bubbly song of the winter wren (*Troglodytes troglodytes*; Figure 39) belies its small size. At four inches in length, the winter wren is the smallest of the North American wrens. Winter wrens are dark brown in color and have fine barring on the wings, tail, and underparts. They often hold their short tail in an upright position. Winter wrens are sometimes described as "mouse-like" because of their small stature and tendency to stay near the ground, foraging around like a rodent. The winter wren inhabits a variety of habitats, including conifer forests and riparian areas. They nest in cavities, and may build several nests each breeding season. Loss of forested habitat may pose a threat to the winter wren.

Figure 39. Winter wren

Photo source: U.S. Fish and Wildlife Service

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

Figure 40. Wood thrush

Photo source: U.S. Fish and Wildlife Service

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

Figure 41. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Surveyors used several techniques to collect information on bird species. Point counts were conducted at 92 stations (41 stations at Little Boy Lake, 46 stations at Wabedo Lake, 5 stations at Louise Lake), 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 birds were most likely to be singing. Call-playback surveys were conducted at survey stations that had appropriate habitat. At each station, surveyors played a tape that included the calls of six marsh birds (least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), American bittern (*Botaurus lentiginosus*), and pied-billed grebe (*Podilymbus podiceps*)) and listened for a response. Call-playback surveys generally took place in the early evening. Both survey techniques were dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or on the lakeshore were also recorded.

Results

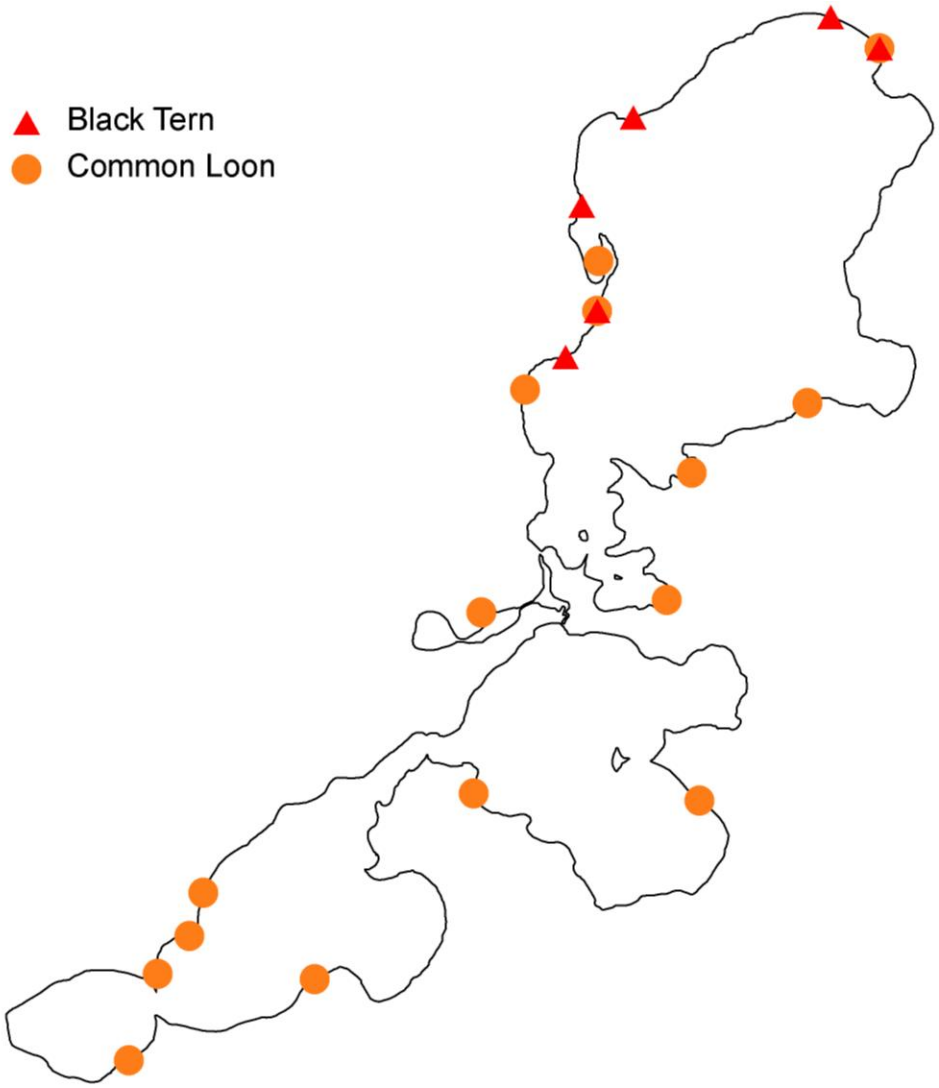
Nineteen bird species of greatest conservation need were identified on Little Boy, Wabedo, and Louise Lakes. Eighteen of these species were documented during the point count or call-playback surveys, and one (American white pelican) was documented while casually observing the lake. Ovenbirds were the most frequently heard species of greatest conservation need, documented at 35 sample stations. They were most common on Wabedo Lake, where surveyors heard them at nearly half of the stations (N=22). This species was also heard at nine stations on Little Boy Lake and at four stations on Louise Lake. Swamp sparrows and the veery were also heard regularly. The veery was heard at 24 total stations (16 on Wabedo Lake, six on Little Boy Lake, and two on Louise Lake), and the swamp sparrow was heard at 22 stations (13 on Wabedo Lake, five on Little Boy Lake, and four on Louise Lake). The common loon and bald eagle were also documented at ten or more stations.

Not all species of greatest conservation need were documented on all three lakes. Several wetland-dwelling species, the American bittern and sedge wren, were heard only on Wabedo Lake, as were the American white pelican and white-throated sparrow. The black tern, eastern wood-pewee, and northern rough-winged swallow were documented only on Little Boy Lake. Overall, surveyors recorded 15 species of greatest conservation need on Wabedo Lake, 14 species of greatest conservation need on Little Boy Lake, and eight species of greatest conservation need on Louise Lake.

Eighty bird species were recorded during the Little Boy, Wabedo, and Louise Lake point count and call-playback surveys (Table 3). An additional seven species were documented during casual observation of the lakes, for a total of 87 species (Appendices 2 – 4). The red-eyed vireo was the most commonly heard species at each of the three lakes, and overall; surveyors documented red-eyed vireos at nearly 75 percent of sample stations. Song sparrows were second in overall abundance, and were identified at 58 of 92 stations. This was the second most common species at Wabedo Lake, and the third most common species at Little Boy Lake. The red-winged blackbird, American robin, and American crow rounded out the top five most common species list at Little Boy Lake, while the American crow, ovenbird, and blue jay were on the top five list at Wabedo Lake. Surveyors identified a total of 64 species at Little Boy Lake, 80 species at Wabedo Lake, and 34 species at Louise Lake.

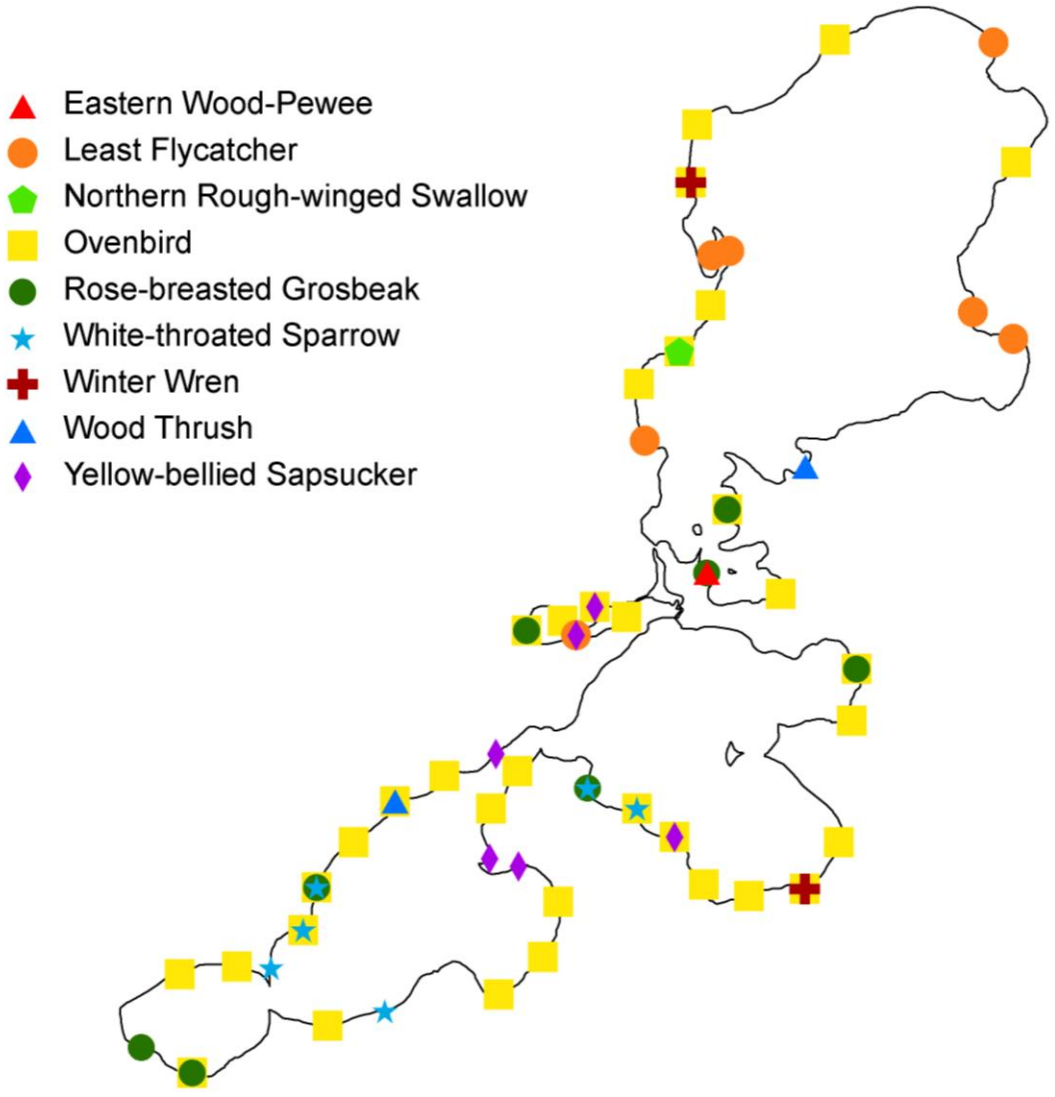
One of the aquatic habitat-dependent species of greatest conservation need, the common loon, was found on all three study lakes (Figure 42). This species was sighted not only in the protected bays, but also along the shoreline of the main lakes. The black tern was documented only in Little Boy Lake, along the northern and western shorelines.

Figure 42. Distribution of aquatic habitat-dependent bird species of greatest conservation need at Little Boy, Wabedo, and Louise Lakes, May – June 2008.



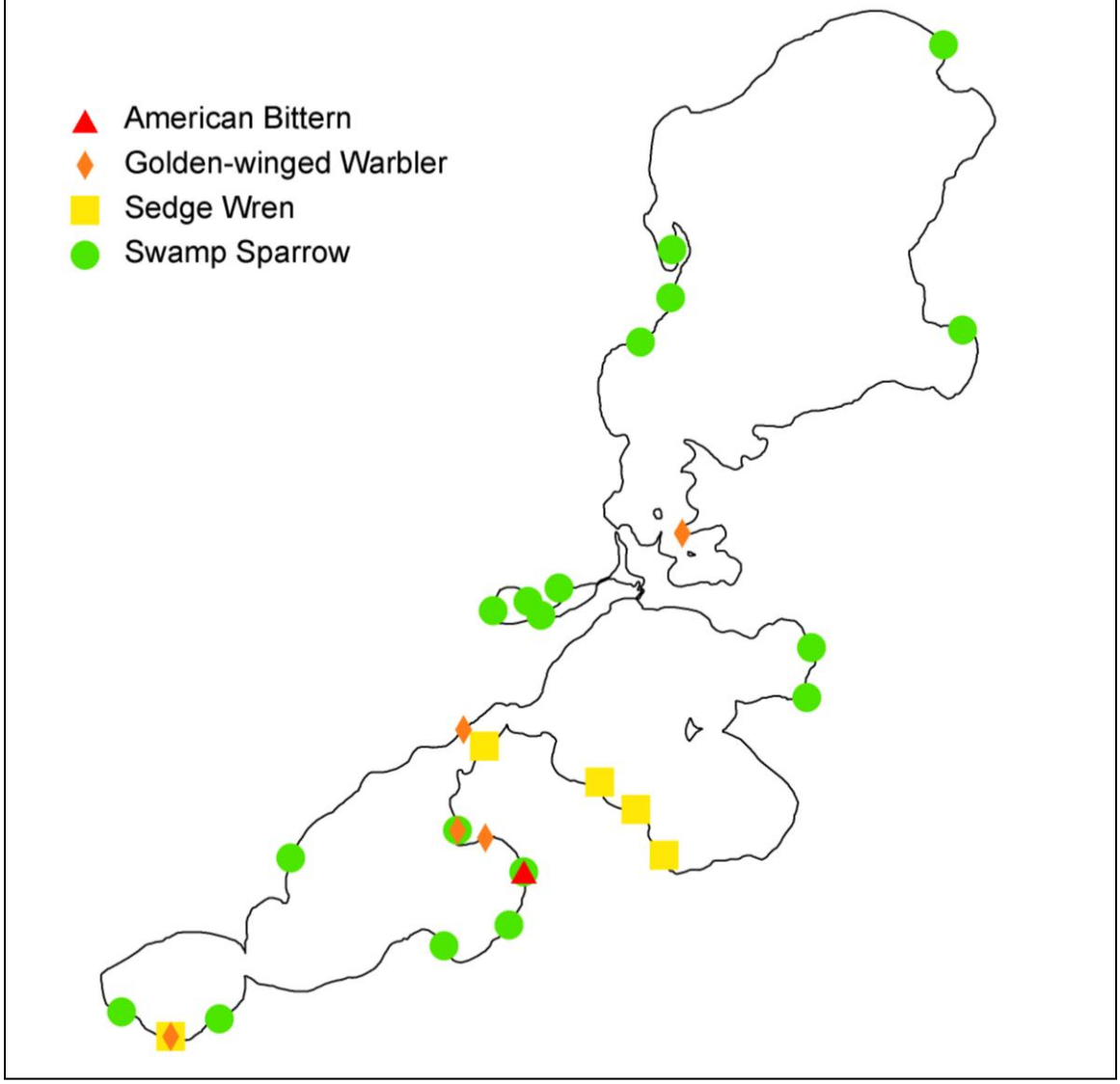
Forest habitat-dependent species of greatest conservation need were found at various locations along the shorelines of all three study lakes (Figure 43). Several species, like the ovenbird and rose-breasted grosbeak, were scattered along much of the shoreline. Other species, like the eastern wood-pewee, were limited to small, protected bays.

Figure 43. Distribution of forest habitat-dependent bird species of greatest conservation need at Little Boy, Wabedo, and Louise Lakes, May – June 2008.



With the exception of the swamp sparrow, which was found regularly on all three study lakes, most of the wetland-dwelling species of greatest conservation need were found on Wabedo Lake (Figure 44). One golden-winged warbler was documented in an isolated bay at the southern tip of Little Boy Lake; this species was identified at four sites on Wabedo Lake.

Figure 44. Distribution of wetland habitat-dependent bird species of greatest conservation need at Little Boy, Wabedo, and Louise Lakes, May – June 2008.



Bald eagles and common nighthawks occupy a variety of habitats, and were found at multiple sampling stations both within the bays and along the main shoreline (Figure 45).

Figure 45. Distribution of bird species of greatest conservation need that occupy a variety of habitats at Little Boy, Wabedo, and Louise Lakes, May – June 2008.

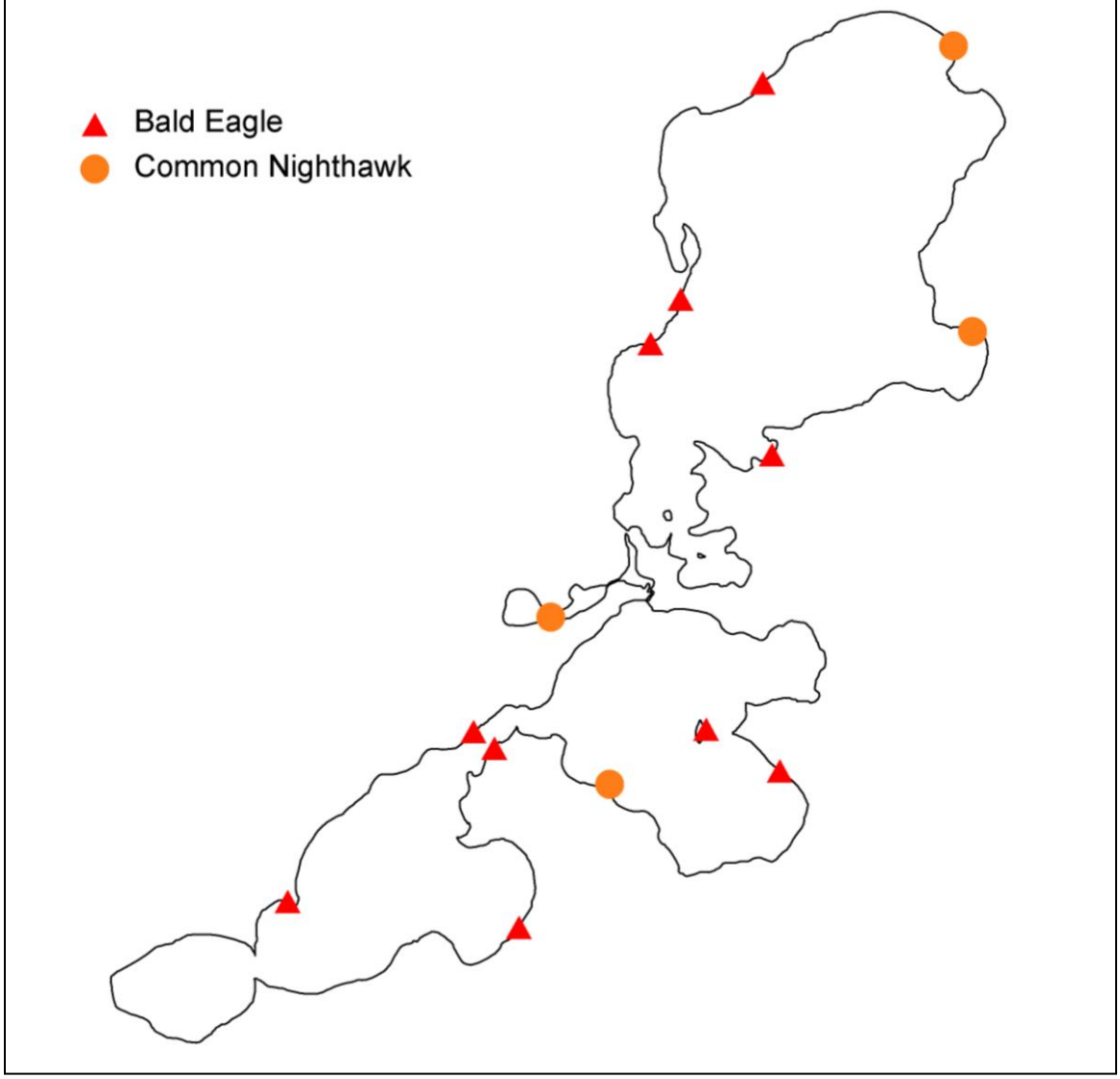


Table 3. Species list and frequency of occurrence of bird species identified during point count and call-playback surveys, May – June 2008. * denotes a species of greatest conservation need.

Description	Common Name	Scientific Name	Frequency of occurrence[a]			
			Total N=92	L. Boy N=41	Wab N=46	Lou N=5
Waterfowl	Canada goose	*Branta canadensis*	2	0	4	0
	Wood duck	*Aix sponsa*	8	7	9	0
	Mallard	*Anas platyrhynchos*	16	20	13	20
	Ring-necked duck	*Aythya collaris*	1	0	2	0
	Common goldeneye	*Bucephala clangula*	10	17	4	0
	Hooded merganser	*Lophodytes cucullatus*	2	2	2	0
Grouse/turkeys	Ruffed grouse	*Bonasa umbellus*	1	0	2	0
Loons	Common loon*	*Gavia immer*	16	17	15	20
Herons/bitterns	American bittern*	*Botaurus lentiginosus*	1	0	2	0
	Great blue heron	*Ardea herodias*	10	1	9	20
	Green heron	*Butorides virescens*	5	2	9	0
Hawks/eagles	Osprey	*Pandion haliaetus*	3	0	7	0
	Bald eagle*	*Haliaeetus leucocephalus*	11	10	13	0
	Broad-winged hawk	*Buteo platypterus*	1	0	2	0
Falcons	Merlin	*Falco columbarius*	1	0	2	0
Sandpipers	Wilson's snipe	*Gallinago delicata*	1	0	2	0
Gulls/terns	Ring-billed gull	*Larus delawarensis*	3	0	7	0
	Black tern*	*Chlidonias niger*	7	15	0	0
Pigeons/doves	Mourning dove	*Zenaida macroura*	1	0	2	0
Goatsuckers	Common nighthawk*	*Chordeiles minor*	4	5	2	20
Hummingbirds	Ruby-throated hummingbird	*Archilochus colubris*	4	5	4	0
Kingfishers	Belted kingfisher	*Megaceryle alcyon*	20	17	22	20
Woodpeckers	Red-bellied woodpecker	*Melanerpes carolinus*	12	5	17	20
	Yellow-bellied sapsucker*	*Sphyrapicus varius*	7	0	9	40
	Downy woodpecker	*Picoides pubescens*	4	0	9	0
	Hairy woodpecker	*Picoides villosus*	9	12	7	0
	Northern flicker	*Colaptes auratus*	9	2	15	0
	Pileated woodpecker	*Dryocopus pileatus*	13	10	15	20
Flycatchers	Eastern wood-pewee*	*Contopus virens*	1	2	0	0
	Alder flycatcher	*Empidonax alnorum*	5	0	7	40
	Least flycatcher*	*Empidonax minimus*	8	15	0	20
	Eastern phoebe	*Sayornis phoebe*	20	15	24	20
	Great crested flycatcher	*Myiarchus crinitus*	14	5	15	80
	Eastern kingbird	*Tyrannus tyrannus*	2	2	2	0
Vireos	Yellow-throated vireo	*Vireo flavifrons*	3	0	7	0
	Warbling vireo	*Vireo gilvus*	5	10	2	0
	Red-eyed vireo	*Vireo olivaceus*	73	66	76	100

Table 3, continued.

Description	Common Name	Scientific Name	Frequency of occurrence[a]			
			Total	L. Boy	Wab	Lou
Jays/crows	Blue jay	*Cyanocitta cristata*	35	24	43	40
	American crow	*Corvus brachyrhynchos*	50	41	61	20
	Common raven	*Corvus corax*	2	0	4	0
Swallows	N. rough-winged swallow*	*Stelgidopteryx serripennis*	1	2	0	0
	Tree swallow	*Tachycineta bicolor*	21	22	22	0
	Barn swallow	*Hirundo rustica*	10	10	11	0
Chickadees	Black-capped chickadee	*Poecile atricapilla*	20	17	22	20
Nuthatches	Red-breasted nuthatch	*Sitta canadensis*	8	2	11	20
	White-breasted nuthatch	*Sitta carolinensis*	13	10	17	0
Wrens	House wren	*Troglodytes aedon*	1	0	2	0
	Winter wren*	*Troglodytes troglodytes*	2	2	2	0
	Sedge wren*	*Cistothorus platensis*	5	0	11	0
Kinglets	Golden-crowned kinglet	*Regulus satrapa*	1	0	2	0
Thrushes	Veery*	*Catharus fuscescens*	26	15	35	40
	Wood thrush*	*Hylocichla mustelina*	2	2	2	0
	American robin	*Turdus migratorius*	39	46	35	20
Mockingbirds	Gray catbird	*Dumetella carolinensis*	18	15	22	20
Starlings	European starling	*Sturnus vulgaris*	1	2	0	0
Waxwings	Cedar waxwing	*Bombycilla cedrorum*	8	15	2	0
Warblers	Golden-winged warbler*	*Vermivora chrysoptera*	5	2	9	0
	Nashville warbler	*Vermivora ruficapilla*	3	2	4	0
	Northern parula	*Parula americana*	1	2	0	0
	Yellow warbler	*Dendroica petechia*	37	27	43	60
	Chestnut-sided warbler	*Dendroica pensylvanica*	15	15	15	20
	Pine warbler	*Dendroica pinus*	4	2	7	0
	Black-and-white warbler	*Mniotilta varia*	25	17	28	60
	American redstart	*Setophaga ruticilla*	21	24	20	0
	Ovenbird*	*Seiurus aurocapilla*	38	22	48	80
	Northern waterthrush	*Seiurus noveboracensis*	3	7	0	0
	Common yellowthroat	*Geothlypis trichas*	36	32	41	20
Tanagers	Scarlet tanager	*Piranga olivacea*	3	5	2	0
Sparrows/allies	Chipping sparrow	*Spizella passerina*	21	17	26	0
	Song sparrow	*Melospiza melodia*	63	63	65	40
	Swamp sparrow*	*Melospiza georgiana*	24	12	28	80
	White-throated sparrow*	*Zonotrichia albicollis*	7	0	13	0
Cardinals/allies	Northern cardinal	*Cardinalis cardinalis*	1	2	0	0
	Rose-breasted grosbeak*	*Pheucticus ludovicianus*	10	7	11	20

Table 3, continued.

Description	Common Name	Scientific Name	Frequency of occurrence[a]			
			Total	L. Boy	Wab	Lou
Blackbirds	Red-winged blackbird	*Agelaius phoeniceus*	46	63	30	40
	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	1	0	2	0
	Common grackle	*Quiscalus quiscula*	18	20	20	0
	Brown-headed cowbird	*Molothrus ater*	8	10	7	0
	Baltimore oriole	*Icterus galbula*	24	24	26	0
Finches	American goldfinch	*Carduelis tristis*	24	17	33	0

[a]Frequency of occurrence – The percent of surveyed sample sites in which a bird species occurred.

Bird Species Richness

Objectives

1. Calculate and map bird richness around the shoreline of Little Boy, Wabedo, and Louise Lakes

Introduction

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

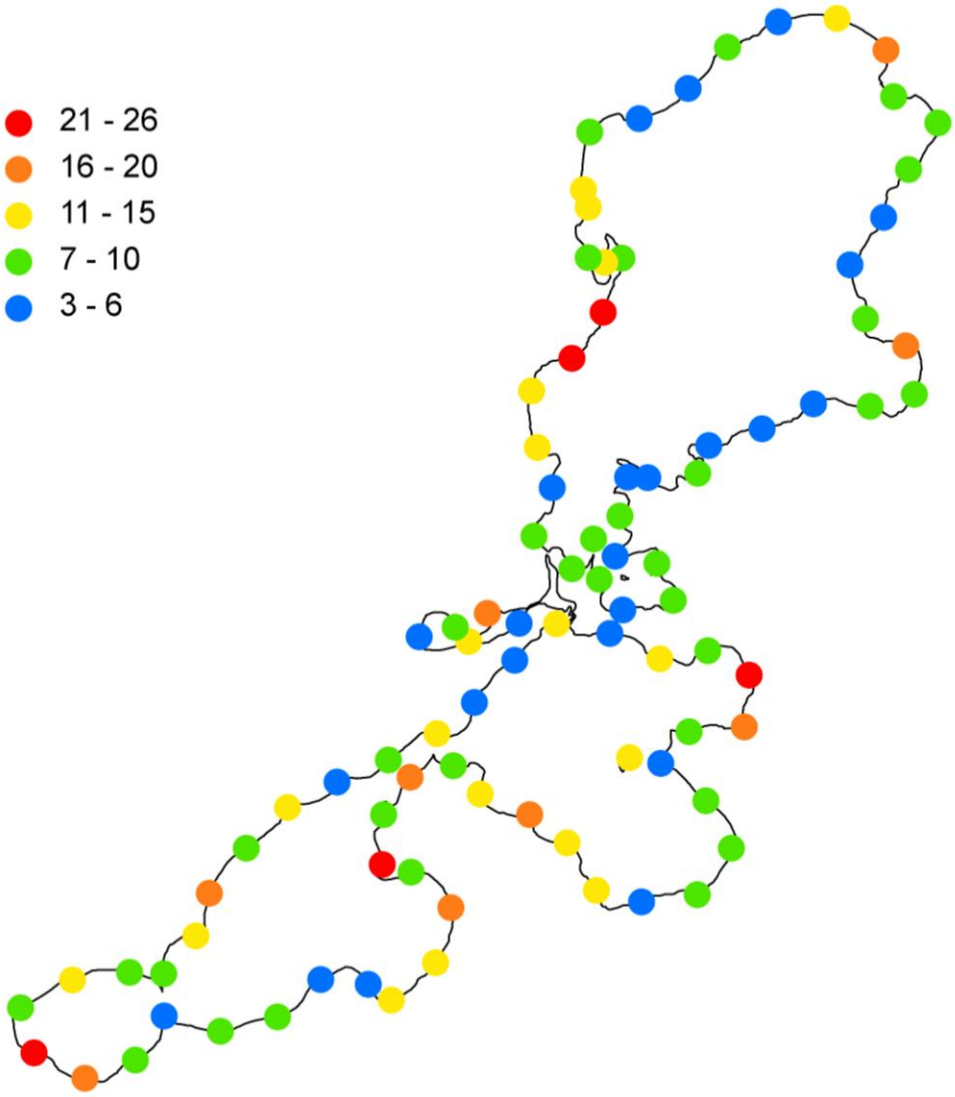
Methods

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

Results

Maximum bird species diversity was 26 species at a single sample location (Figure 46). Six additional sites contained 20 or more species, and 32 additional sites contained 10 or more species. The minimum number of bird species identified at a sample site was three. The two sites with the highest bird diversity were on Little Boy Lake, along the western shoreline. Five sites on Wabedo Lake that contained 20 or more species were scattered along the shoreline. The number of bird species of greatest conservation need at a single sample station ranged from zero to six. Two sample sites each on Little Boy Lake and Wabedo Lake had six bird species of greatest conservation need.

Figure 46. Bird species richness (number of species per sample site) at Little Boy, Wabedo, and Louise Lakes, 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

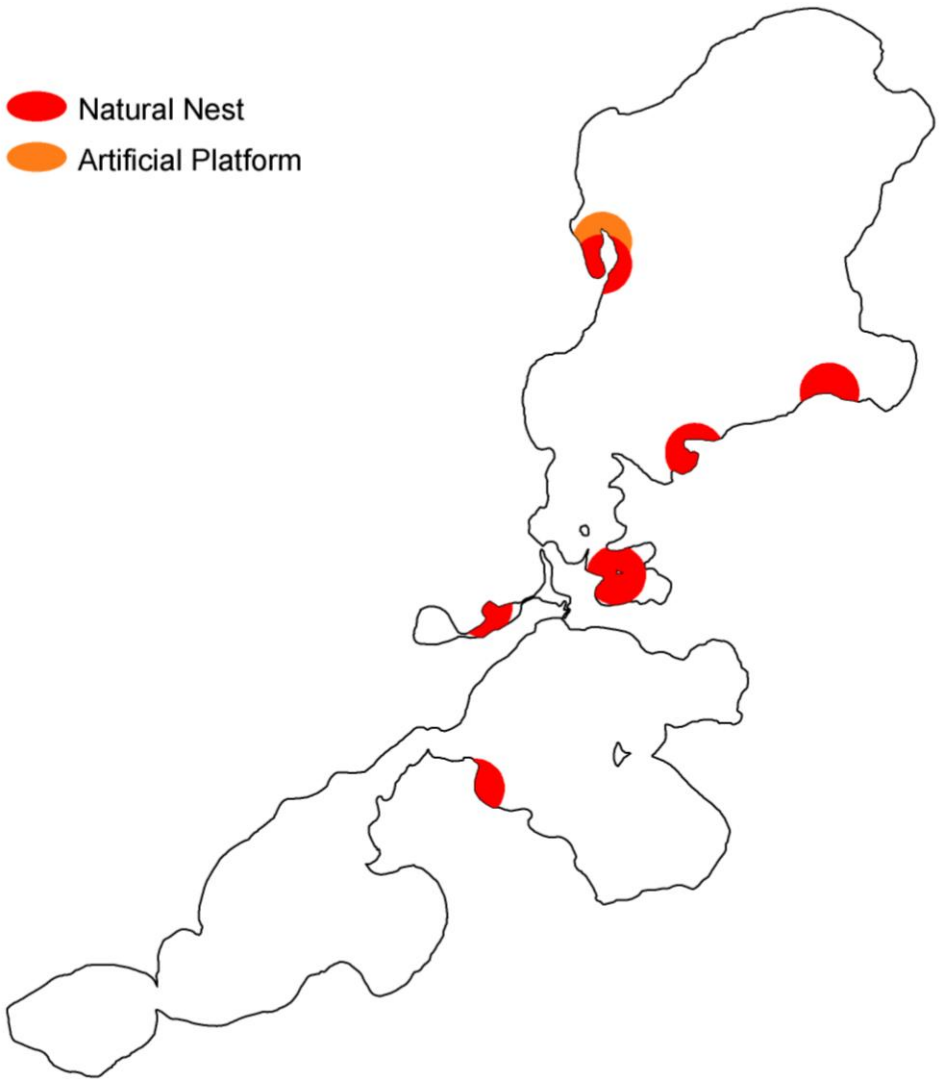
Using information from LoonWatcher reports and bird, fish, and vegetation survey crews, researchers mapped loon nesting locations in GIS. Mapped nests were buffered by 200 meters to account for locational uncertainty. Nests were identified as either natural or manmade (artificial platforms). All former 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 Little Boy Lake loons since 1981, and on Wabedo Lake loons since 1982.

Results

Between 1981 and 2008, seven probable loon nesting areas were identified on Little Boy, Wabedo, and Louise Lakes (Figure 47). One natural nest and one artificial nesting platform were located within the small bay on the western shoreline of Little Boy Lake, and two natural nests were located along the southeastern shoreline. A fourth nesting area was located at the southern tip of the lake. In Wabedo Lake, one natural nest was identified along the southern

shoreline of the northern basin. One natural nest was found in Louise Lake. In 2008, volunteers documented four active natural nests on Little Boy Lake, one active natural nest on Wabedo Lake, and one active natural nest on Louise Lake. In addition, loons nested on one artificial platform in Little Boy Lake. Three artificial platforms (two on Little Boy Lake, one on Wabedo Lake) were installed, but not utilized by loons.

Figure 47. Location of natural loon nests and manmade loon platforms recorded on Little Boy, Wabedo, and Louise Lakes between 1981 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 mink frog (*Rana septentrionalis*) and green frog (*Rana clamitans*). These frogs, which are strongly associated with larger lakes, are easily surveyed during their breeding season, which extends from May until August. During this time they establish and defend distinct territories, and inhabit vegetated areas along the lakeshore.

Figure 48. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

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

Figure 49. Green frog

Photo by: Jeff LeClere, www.herpnet.net

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

Methods

The aquatic frog survey methodology followed the Minnesota Frog and Toad Calling Survey (MFTCS) protocol (see Minnesota's Sensitive Lakeshore Identification Manual for additional information on how this protocol was adjusted for water routes). Frog survey points were located around the entire lake, spaced 400 meters apart. Surveys were conducted between sunset and 1:00 AM. At each station surveyors listened for up to five minutes for all frog and toad calls. An estimate of abundance and a calling index were recorded for both green and mink frogs. For other species, only calling index was recorded. If survey conditions such as rain or wind noticeably affected listening ability, the survey was terminated. Due to time constraints, frog surveys were not conducted on Louise Lake.

Results

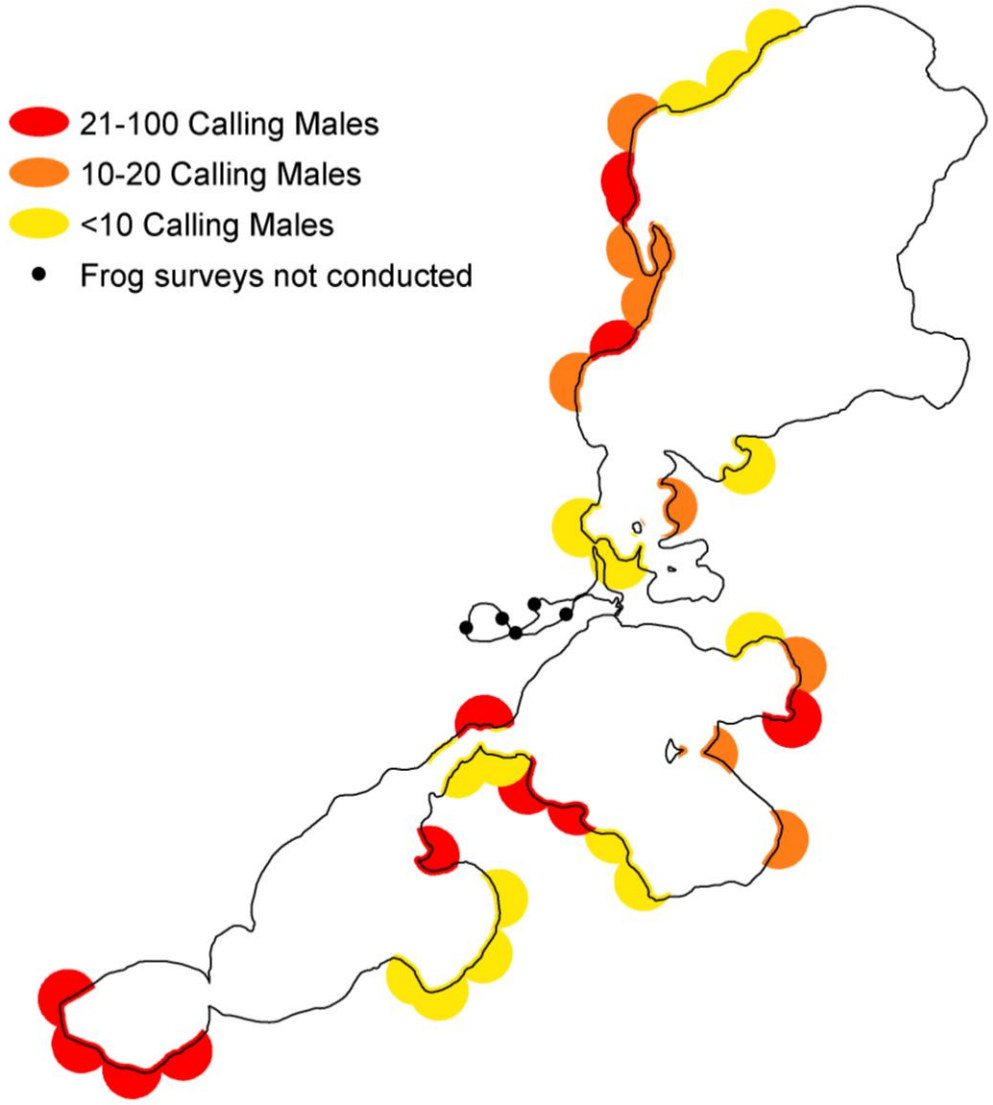
Target species

Green frogs were the only target species detected during the frog surveys. Green frogs were heard at 21 stations on Little Boy Lake and at 16 stations on Wabedo Lake (Figure 50). At Little Boy Lake sites with frogs, abundance estimates ranged from one frog (at two sites) to 21 – 100 individuals (at four sites). Index values ranged from one (individual frog calls were distinct) to three (full chorus; frog calls were continuous and overlapping). At Wabedo Lake stations with frogs, estimates of abundance ranged from one frog (at two sites) to 21 – 100 frogs (at 10 sites). Index values ranged from one to three. During the 2008 bird surveys, surveyors heard mink frogs at one station on each lake.

Other species

The only additional anuran species heard during the frog surveys was the gray treefrog (*Hyla versicolor*). This species was heard at six stations on Little Boy Lake and at seven stations on Wabedo Lake. In addition, survey crews conducting bird surveys in 2008 heard an American toad (*Bufo americanus*) on Wabedo Lake and a leopard frog (*Rana pipiens*) on Louise Lake. Other frog or toad species that may be found near these lakes, such as wood frog (*Rana sylvatica*), spring peeper (*Pseudacris crucifer*), and chorus frog (*Pseudacris triseriata*) tend to breed earlier in the year and are not strongly associated with larger lakes.

Figure 50. Abundance of green frogs heard during surveys on Little Boy and Wabedo Lakes, 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 51) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess a distinctively upturned mouth that gives them a "pugnose" appearance. They are secretive mnnows, and are often found in schools of 15 to 35 individuals. Pugnose shiners inhabit clear lakes and low-gradient streams and are intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 51. Pugnose shiner

Photo by: Konrad Schmidt

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

Figure 52. Least darter

Photo by: Konrad Schmidt

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

Figure 53. Longear sunfish

Photo by: Konrad Schmidt

Proxy species

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

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

Figure 54. Blackchin shiner

Photo by: Konrad Schmidt

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

Figure 55. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 56) are slender fish with slightly flattened heads. The mouth, which opens dorsally, is an adaptation for surface feeding. Dark vertical bars are present along

the sides. Size ranges from about 50 – 100 mm. Calm, clear, shallow water with abundant aquatic vegetation and a sandy or gravely substrate is preferred by the killifish.

Figure 56. Banded killifish

Photo by: Konrad Schmidt

Methods

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

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

Results

One near-shore fish species of greatest conservation need and all three proxy species were detected during the nongame fish surveys. The pugnose shiner was found at two sample sites on Little Boy Lake and at four sample sites on Wabedo Lake (Figure 58). Surveyors found only one or two individuals at each of the sites. The pugnose shiners tended to be located within bays. Least darters and longear sunfish were not documented during the surveys.

Banded killifish were the most commonly found proxy species. Surveyors found banded killifish at 23 stations (Figure 59). Seven stations on Little Boy Lake contained 47 individuals, and 16 stations on Wabedo Lake contained 27 individuals. Blackchin shiners and blacknose shiners were found at seven sampling stations each. Blackchin shiners were found in Little Boy (N=6 individuals) and Wabedo (N=2) Lakes, and blacknose shiners were found in Little Boy (N=8) and Louise (N=5) Lakes. All proxy species were found both within isolated bays and along sections of the main shoreline.

Aquatic plant biovolume was nearly twice as high at sites that contained pugnose shiners than sites that did not. Substrate type was generally soft and small in diameter, and included muck, silt, and sand. Proxy species were also found mainly on sand or silt substrates. Aquatic plant biovolume was virtually identical between sites that contained proxy species and sites that did not. Louise Lake sampling sites generally had the highest biovolume; values averaged nearly 70 percent. Little Boy Lake and Wabedo Lake sampling site biovolume values were similar, and averaged around 30 percent.

Thirty-five fish species were identified at the 92 sampling stations (Table 4). Yellow perch were found most frequently; surveyors found this fish at all of the sampling stations on Wabedo Lake and at 39 of 41 stations on Little Boy Lake. Bluegills were also widespread. This species was documented at all sampling stations on Wabedo Lake, and at nearly 90 percent of the stations on Little Boy Lake. Mimic shiners were found in the greatest numbers on Little Boy Lake, due to several large trap net hauls; one haul contained over 20,000 shiners. On Wabedo Lake and Louise Lake, bluegills were found in the greatest numbers. Bluntnose minnows were also common, numbering nearly 500 in Little Boy Lake and over 1000 in Wabedo Lake. Surveyors documented six fish species in Little Boy Lake that they did not find in Wabedo Lake. These species were blacknose shiner, brook stickleback, burbot, finescale dace, greater redhorse, and hornyhead chub. Wabedo Lake surveys included two species (muskellunge and brown bullhead) that were not identified in Little Boy Lake. The emerald shiner was the only species found in Louise Lake that was not documented in either Little Boy or Wabedo Lake.

Several fish species previously undocumented in the lakes were identified during the nongame fish surveys. Eleven new species were identified at Little Boy Lake, bringing the total historical observed fish community in this lake to 38 species. The newly documented species in Little Boy Lake included blackchin shiner, banded killfish, brook stickleback, central mudminnow, finescale dace, golden shiner, hornyhead chub, Iowa darter, mimic shiner, mottled sculpin, and pugnose shiner. Eight previously undocumented species were identified at Wabedo Lake, bringing the total historical observed fish community in that lake to 35 species. The newly documented species in Wabedo Lake were blackchin shiner, banded killifish, bluntnose minnow, central mudminnow, mimic shiner, mottled sculpin, pugnose shiner, and spottail shiner. The nongame fish surveys conducted as part of this study were the first fish surveys conducted on Louise Lake.

One additional fish species of greatest conservation need, the greater redhorse (*Moxostoma valenciennesi*; Figure 57) was documented during the nongame fish surveys. Two greater redhorse were found in Little Boy Lake, at two sampling stations. Although greater redhorse are not a near-shore species, they are sensitive to chemical pollutants and turbidity, and inhabit clear water rivers and lakes.

Figure 57. Greater redhorse

Figure 58. Distribution of near-shore fish species of greatest conservation need documented during Little Boy, Wabedo, and Louise Lake fish surveys, June – July 2007.

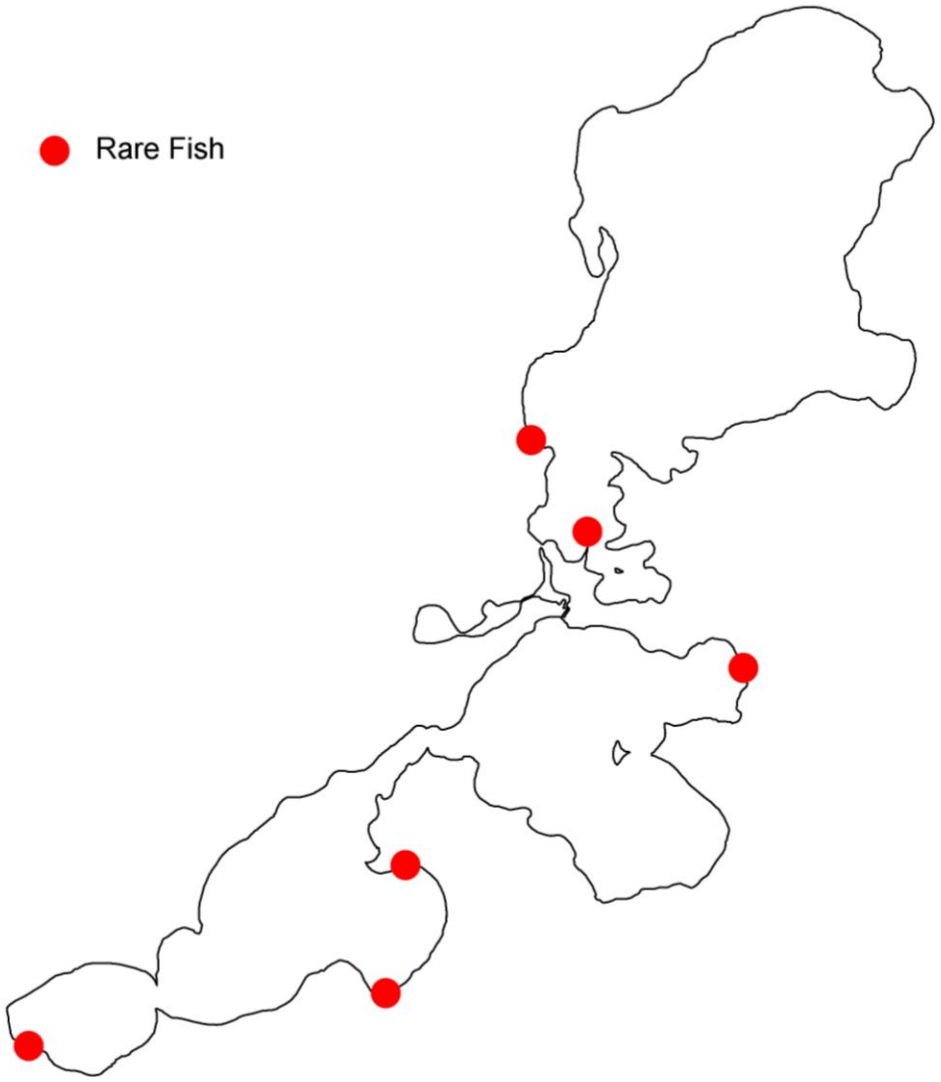


Figure 59. Distribution of fish proxy species documented during Little Boy, Wabedo, and Louise Lake fish surveys, June – July 2007.

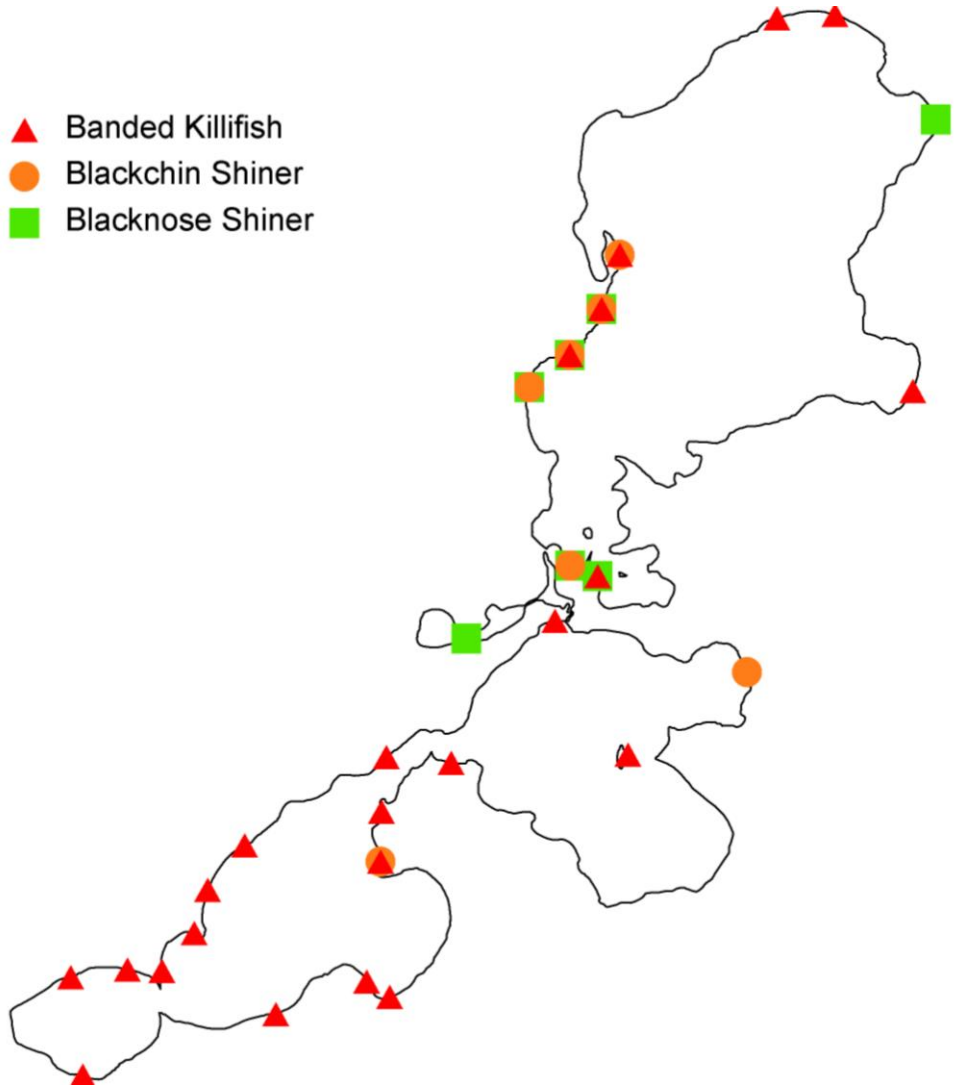


Table 4. Abundance and frequency of fish species identified during surveys, June – July 2007.
* denotes species of greatest conservation need

Common Name	Scientific Name	Little Boy		Wabedo		Louise	
		# [a]	% [b]	#	%	#	%
Bowfin	*Amia calva*	47	54	22	35	1	20
Common shiner	*Notropis cornutus*	27	5	4	9	–	–
Hornyhead chub	*Nocomis biguttatus*	1	2	–	–	–	–
Golden shiner	*Notemigonus crysoleucas*	3	2	7	9	1	20
Pugnose shiner*	*Notropis anogenus*	3	5	4	9	–	–
Emerald shiner	*Notropis atherinoides*	–	–	–	–	5	40
Blackchin shiner	*Notropis heterodon*	6	12	2	4	–	–
Blacknose shiner	*Notropis heterolepis*	8	15	–	–	5	20
Spottail shiner	*Notropis hudsonius*	2	2	1	2	–	–
Mimic shiner	*Notropis volucellus*	~37000	78	84	20	–	–
Finescale dace	*Phoxinus neogaeus*	2	2	–	–	–	–
Bluntnose minnow	*Pimephales notatus*	447	71	1000	63	–	–
White sucker	*Catostomus commersonii*	73	24	2	2	–	–
Greater redhorse*	*Moxostoma valenciennesi*	2	5	–	–	–	–
Black bullhead	*Ameiurus melas*	3	7	11	13	–	–
Yellow bullhead	*Ameiurus natalis*	35	34	66	65	2	40
Brown bullhead	*Ameiurus nebulosus*	–	–	2	4	–	–
Tadpole madtom	*Noturus gyrinus*	4	10	3	7	–	–
Northern pike	*Esox lucius*	4	10	7	13	–	–
Muskellunge	*Esox masquinongy*	–	–	1	2	–	–
Central mudminnow	*Umbra limi*	6	10	61	15	19	60
Burbot	*Lota lota*	1	2	–	–	–	–
Banded killifish	*Fundulus diaphanus*	47	17	27	35	–	–
Brook stickleback	*Culaea inconstans*	1	2	–	–	–	–
Mottled sculpin	*Cottus bairdii*	1	2	4	9	–	–
Rock bass	*Ambloplites rupestris*	138	78	201	87	–	–
Pumpkinseed	*Lepomis gibbosus*	113	59	174	72	35	40
Bluegill	*Lepomis macrochirus*	753	88	2100	100	80	40
Smallmouth bass	*Micropterus dolomieu*	144	37	53	43	–	–
Largemouth bass	*Micropterus salmoides*	320	80	614	85	2	20
Black crappie	*Pomoxis nigromaculatus*	19	27	103	65	1	20
Iowa darter	*Etheostoma exile*	4	7	26	22	–	–
Johnny darter	*Etheostoma nigrum*	43	12	73	33	–	–
Yellow perch	*Perca flavescens*	4300	95	1800	100	19	40
Walleye	*Sander vitreus*	3	7	11	15	–	–

[a] # – Total number of individuals found. Numbers above 1000 were rounded to the nearest hundred; numbers above 10000 were rounded to the nearest 1000.

[b] % – Percent of surveyed sample sites in which a species occurred (Little Boy N=41, Wabedo N=46, Louise N=5)

Aquatic Vertebrate Richness

Objectives

1. Calculate and map aquatic vertebrate richness around the shoreline of Little Boy, Wabedo, and Louise Lakes

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

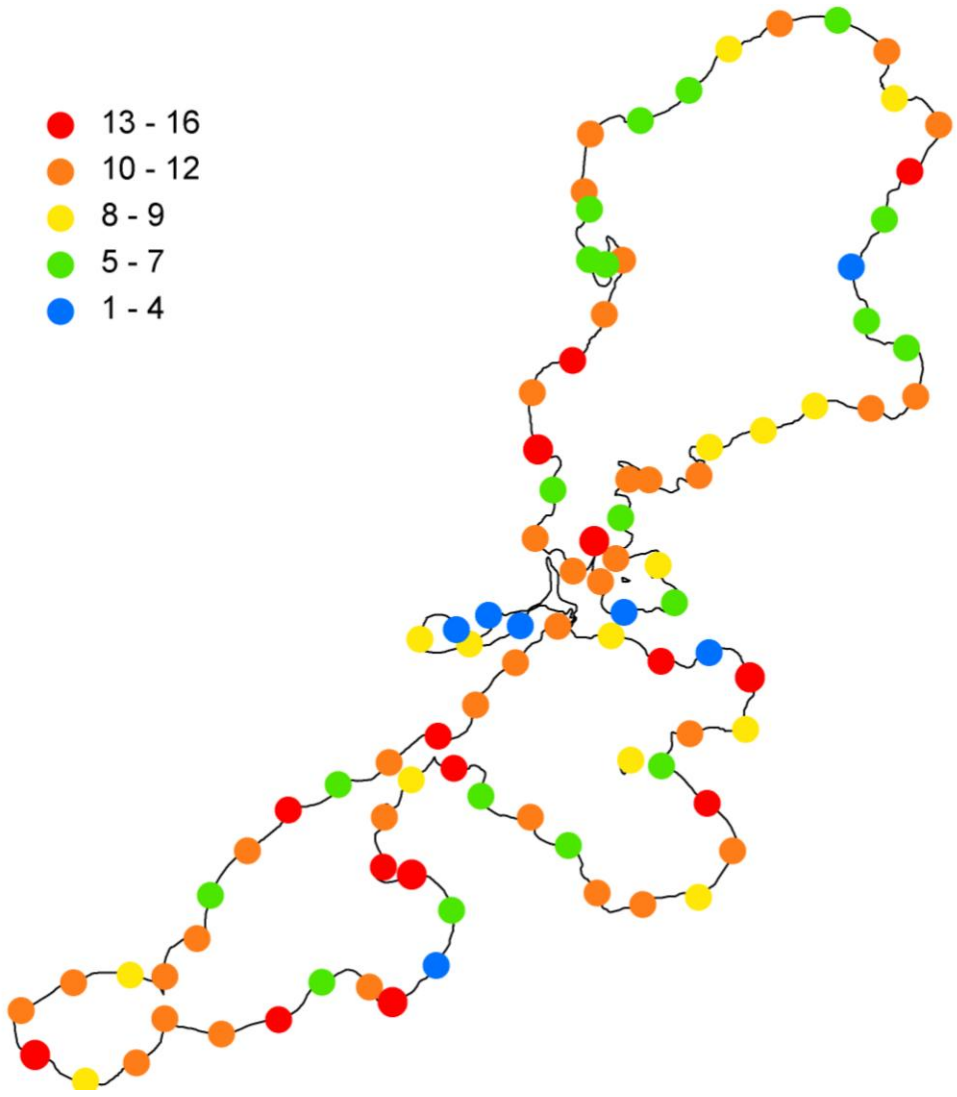
Overall, sample stations contained between one and 16 aquatic vertebrate species (Figure 60). Little Boy Lake had the maximum number of species at a single site (N=16). Twenty of 41 stations contained 10 or more species, and only two stations contained fewer than five aquatic vertebrate species. The minimum number of species found at a Little Boy Lake site was four. The majority of the documented species were fish, although mink frogs, green frogs, painted turtles (*Chrysemys picta)*, and snapping turtles (*Chelydra serpentina)* were also documented. Hybrid sunfish were observed during the surveys, but were not included in the analysis. All of the aquatic vertebrate species identified during the surveys were native. Several invertebrate species were also documented during the sampling, including rusty crayfish (*Orconectes rusticus*).

Maximum aquatic vertebrate species richness at Wabedo Lake was 15 species, and 29 of 46 stations had 10 or more species. Only two stations had fewer than five aquatic vertebrate species. Green frogs, painted turtles, and snapping turtles were documented during the fish surveys. Hybrid sunfish were observed during the surveys, as were the non-native invertebrate rusty crayfish.

Of the three lakes, Louise Lake had the lowest aquatic vertebrate species richness. While two of the sites contained eight species, the remaining three sample stations contained only one or two species. The painted turtle was the only non-fish species collected during the sampling at this lake. However, the low species richness numbers calculated for Louise Lake do not necessarily

reflect the conditions at this lake. The steep walls of the lake basin made fish sampling difficult. Surveyors were not able to conduct any seine hauls, and the electrofishing surveys, which were conducted from a boat, may not have been as effective as standard electrofishing surveys. Therefore, aquatic vertebrate species richness in Louise Lake may well be higher than the survey results indicate.

Figure 60. Aquatic vertebrate species richness (number of species per sample site) in Little Boy, Wabedo, and Louise Lakes, June – July 2007.



Other Rare Features

Objectives

1. Map rare features occurring within the extended state-defined shoreland area of Little Boy, Wabedo, and Louise Lakes

Introduction

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

Methods

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

Results

Three rare features have been documented within 1320 feet of the Little Boy Lake shoreline (Figure 61). These features include two locations of a bird species of Special Concern status and a vascular plant of Special Concern status. The publication of exact descriptive and locational information is prohibited in order to help protect these rare species. No rare features have been documented within 1320 feet of Wabedo Lake or Louise Lake.

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

Figure 61. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Little Boy, Wabedo, and Louise Lake shorelines.

Bay Delineation

Objectives

1. Determine whether areas of the lakes 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.

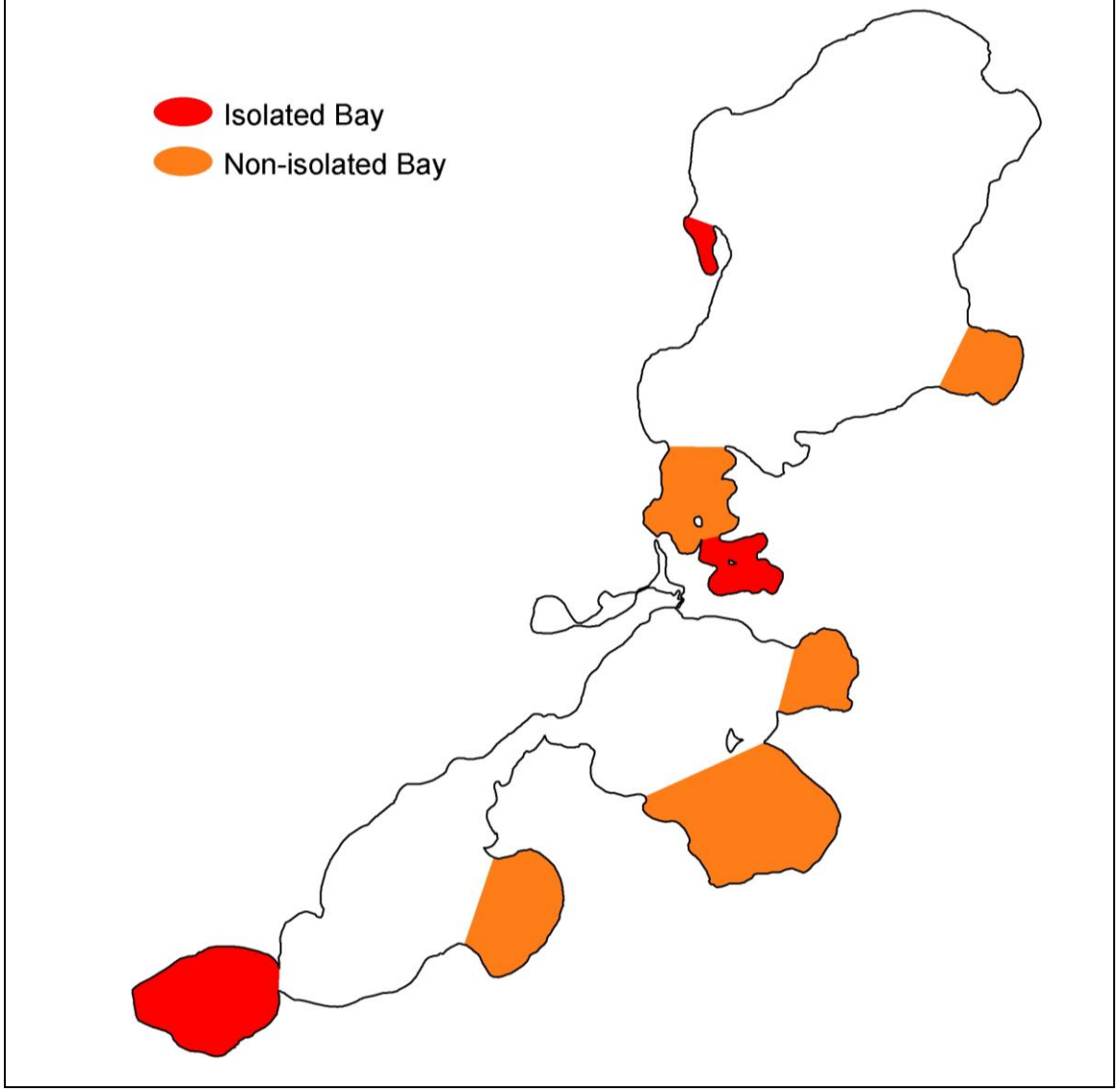
Methods

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

Overall, three isolated bays and five non-isolated bays were identified on Little Boy, Wabedo, and Louise Lakes (Figure 62). Two of the isolated bays were located on Little Boy Lake; one was along the western shoreline and another was at the southern tip of Little Boy Lake. The third isolated bay was at the southwestern tip of Wabedo Lake. Two of the non-isolated bays were within the southwest basin of Wabedo Lake and two were within the northeast basin. The final non-isolated bay was located along the eastern shoreline of Little Boy Lake. No bays were identified on Louise Lake.

Figure 62. Location of isolated and non-isolated bays on Little Boy, Wabedo, and Louise Lakes.



II. Ecological Model Development

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

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

Scores for each of the layers were summed (Figure 63). 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 64). 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 65).

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

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

Table 5, continued.

Variable	Score	Criteria
Aquatic Plant Richness	3	Total number of plant taxa per analysis window > 10
	2	Total number of plant taxa 5 – 10
	1	Total number of plant taxa 1 – 4
	0	No vegetation present
Presence of Emergent and Floating-leaf Plant Beds	3	Emergent and/or floating-leaf plant stands occupy > 25% of the aquatic portion of the analysis window
	2	Stands occupy 5 – 25%
	1	Stands present but occupy less than 5%
	0	No emergent or floating-leaf plant beds present
Unique 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 (> 50% of points within analysis window consist 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 species of greatest conservation need (SGCN) within analysis window
	2	Presence of 2 SGCN
	1	Presence of 1 SGCN
	0	No SGCN present
Bird Richness	3	Total number of bird species within analysis window > 25
	2	Total number of bird species 11 – 25
	1	Total number of bird species 1 – 10
	0	No bird species observed
Loon Nesting Areas	3	Presence of natural loon nest within analysis window
	2	Presence of artificial loon nest (nesting platform)
	0	No loon nesting observed
Frogs	3	Presence of both mink frogs and green frogs within analysis window
	2	Presence of mink frogs or green frogs
	0	Neither mink frogs 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 observed
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 one Natural Heritage feature
	0	No Natural Heritage feature present
Bays	3	Isolated bay within analysis window
	2	Non-isolated bay
	0	Not a distinctive bay

Figure 63. Total score layer created by summing scores of all 15 variables. Highest total scores represent most sensitive areas of shoreline.

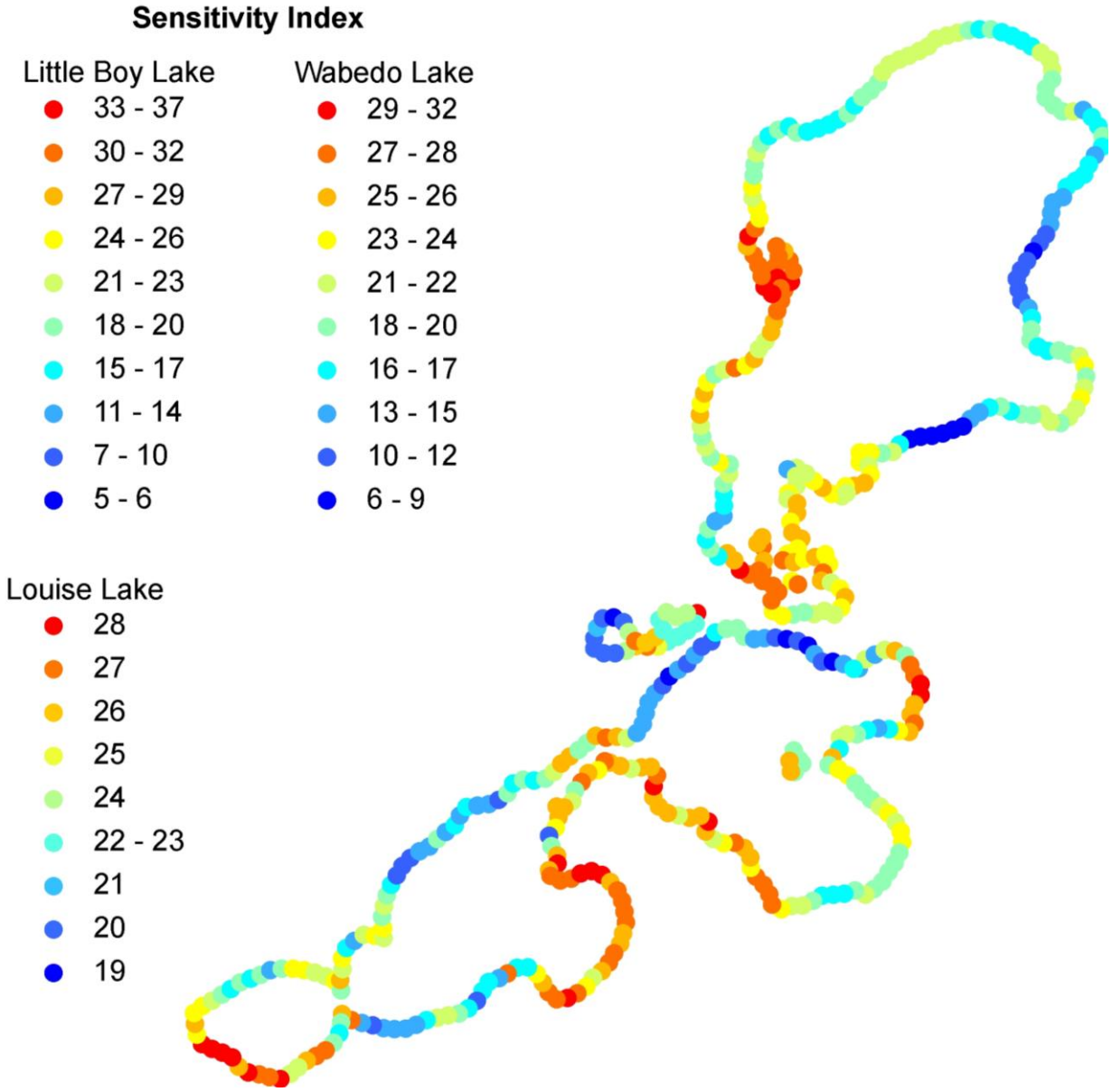


Figure 64. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland).

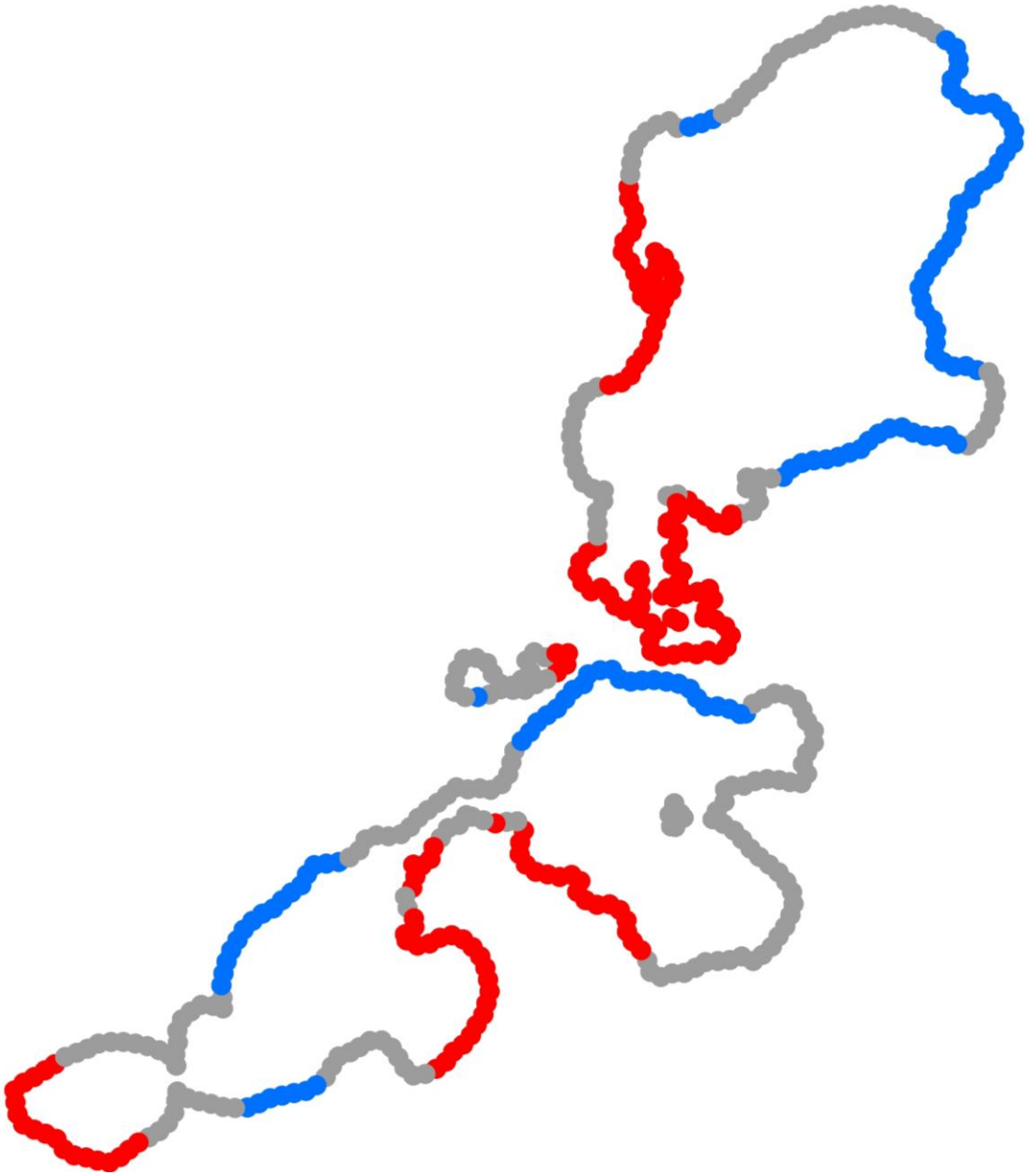
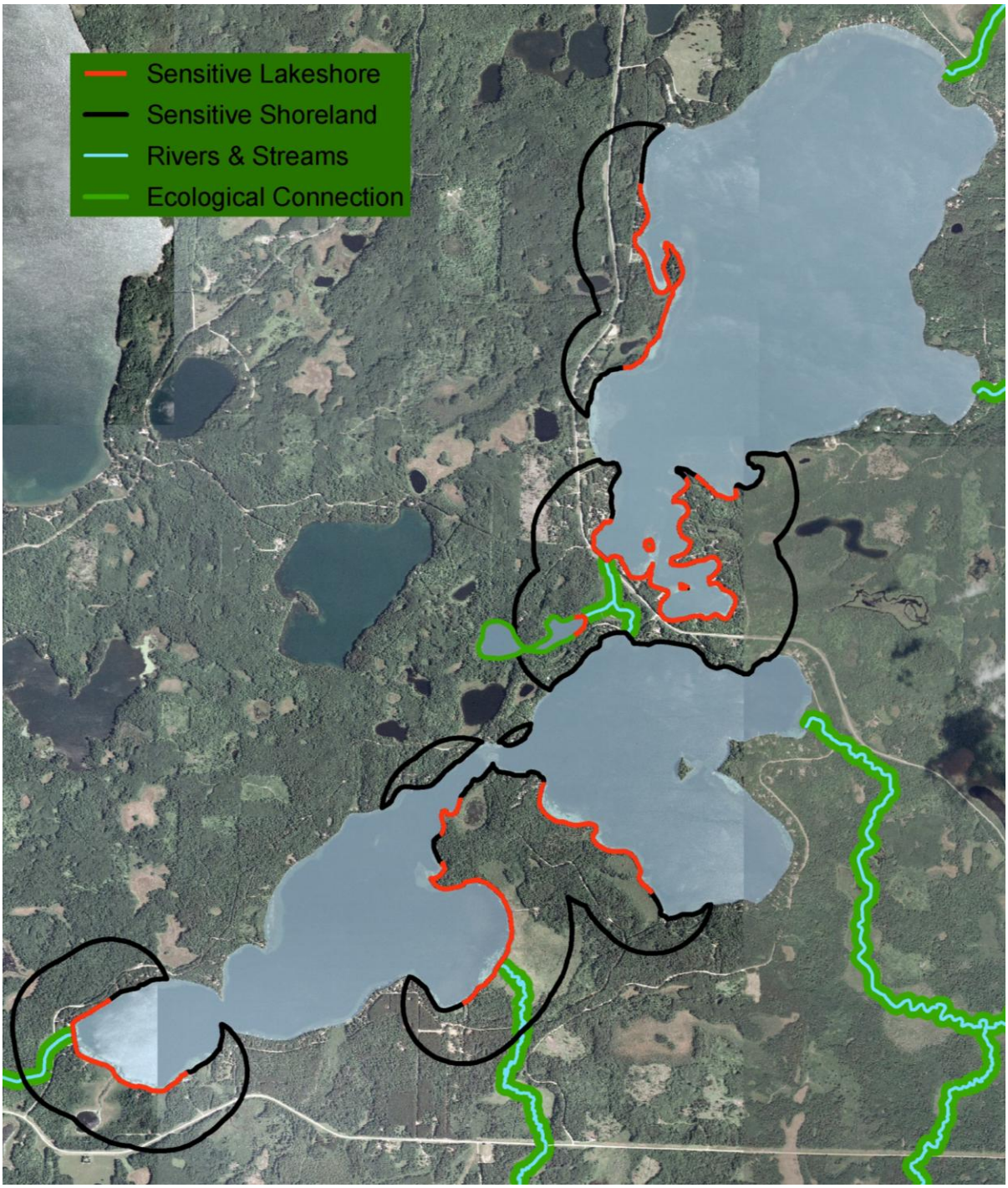


Figure 65. The Little Boy, Wabedo, and Louise Lake sensitive lakeshore areas identified by the ecological model, and ecological connections.



Habitat Connectivity

In addition to the sensitive shorelands identified through the GIS model, surveyors considered adjacent river shorelines that provide habitat connectivity to and from the lake shorelands. Aquatic habitat connectivity allows for the movement of aquatic organisms within a watershed,

and the benefits are numerous. Organisms can move between existing habitats, colonize new areas, or recolonize former habitat in the wake of local extinctions. Connectivity allows organisms to move between multiple waterbodies and access various food sources. It allows animals with different vegetation requirements during different life stages to access those habitats. It allows movement of animals from various populations, increasing diversity. Several rivers and streams, the channel between Little Boy, Wabedo, and Louise Lakes, and Louise Lake itself, were identified as important ecological connections. The outlet of Little Boy Lake connects with Rice and Inguadona Lakes and the Boy River. Although a dam is present, it is not always a barrier to movement. The eastern inlet of Little Boy Lake connects to McCarthey Lake nearby. Northern pike are known to move through this passage, and movement of other species is likely. Wabedo Lake inlets, including Stoney Creek and Spring Creek, see spring spawning movement of northern pike, walleye, and likely other species. The channel between Little Boy, Wabedo, and Louise Lakes provides valuable habitat connectivity between these waterbodies.

Depending on the existing shoreland classification of these rivers and streams, the County may use the ecological connection recommendation to consider reclassifying to a more protective river class.

Other Areas of Ecological Significance

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

Emergent and floating-leaf plant beds that occur outside of the sensitive shoreland districts are areas of ecological significance. Extensive stands of hard-stem bulrush occur in Little Boy Lake and isolated stands occur in Wabedo Lake. Many of these stands have already been fragmented by boat channels. Further destruction of bulrush plants would be particularly detrimental because attempts to restore these types of plants have had limited success.

Native submerged plant beds are also considered sites of ecological significance, regardless of whether or not they are associated with priority shorelines. Not only do these beds provide critical habitat for fish and wildlife, but they may also help mitigate the potentially harmful impacts if invasive plants occur in the lake.

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

Several stretches of shoreline along Little Boy, Wabedo, and Louise Lakes were identified as sensitive by the ecological model. These stretches supported the greatest diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such as wetland habitat, was also present in the highest quantities near these areas. The ecological model

displays these areas both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby has significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. The rivers and streams connected to Little Boy, Wabedo, and Louise Lakes are also an important part of the ecosystem. They provide valuable connectivity between the lakes and nearby habitat. Protection of these important corridors will help minimize fragmentation, and will help maintain the health of the lake 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 Little Boy, Wabedo, and Louise Lakes, and the value of the lakes themselves.

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Appendix 1. Shoreline emergent aquatic plants recorded in Little Boy and Wabedo Lakes, 2007.

Description	Common Name	Scientific Name	Survey Type[a]	
			Little Boy	Wabedo
SHORELINE EMERGENT	Willow herb	*Epilobium* sp.	2	---
	Jewelweed	*Impatiens* sp.	2	2
	Swamp milkweed	*Asclepias incarnata*	1	---
	Joe-pye weed	*Eupatorium maculatum*	2	2
	Common mint	*Mentha arvensis*	2	2
	Virginia creeper	*Parthenocissus* sp.	2	2
	Wild grapes	*Vitis* sp.	2	---
	Poison ivy	*Rhus toxicodendra*	---	2
	Wide-leaved sedge	*Carex* sp.	2	---
	Fine-leaved sedge	*Carex* sp.	---	2
	Wiregrass sedge	*Carex* sp.	---	2
	Bottle-brush sedge	*Carex* sp.	---	2
	Pennsylvania sedge	*Carex pennsylvanica*	---	2
	Reed canary grass	*Phalaris arundinaceae*	1, 2	2
	Bluegrass	*Poa* sp.	2	2
	Bulb-bearing hemlock	*Cicuta bulbifera*	2	2
	Sphagnum moss	*Sphagnum* sp.	2	---
	Pyrola	*Pyrola* sp.	2	---
	Wild geranium	*Geranium maculatum*	2	---
	Smartweed	*Polygonum* sp.	2	---
	Meadow sweet	*Spiraea* sp.	2	---
	Chickweed	*Stellaria calycantha*	2	---
	Wild rye	*Elymus* sp.	2	---
	Stinging nettle	*Utrica dioica*	2	2
	Marsh skullcap	*Scutellaria galericulata*	2	---
	Beggarticks	*Bidens* sp.	2	2
	Tufted loosestrife	*Lysimachia thyrsiflora*	---	2
	Loosestrife	*Lysimachia* sp.	---	2
	Aster	*Aster* sp.	---	2
	Waterdock	*Rumex* sp.	---	2
	Mad dog skullcap	*Scuttellaria lateriflora*	---	2
	Water horehound	*Lycopus uniflorus*	---	2
	Woundwort	*Stachys palustris*	---	2
	Marsh bellflower	*Campanula aparinoides*	---	2
	Bedstraw	*Galium* sp.	---	2
	Manna grass	*Glyceria canadensis*	2	---
	Marsh fern	*Thelypteris palustris*	---	2
	Bugleweed	*Lycopus* sp.	---	2
	Cut-leaved bugleweed	*Lycopus americanus*	1	---

Appendix 1, continued.

Description	Common Name	Scientific Name	Survey Type	
			Little Boy	Wabedo
SHORELINE SHRUBS and TREES	Basswood	*Tilia americana*	2	---
	Sugar maple	*Acer saccharum*	---	2
	Paper birch	*Betula papyrifera*	2	---
	Red maple	*Acer rubrum*	2	---
	Cedar	*Thuja* sp.	2	---
	Alder	*Alnus incana*	2	2
	Juneberry	*Amelanchier* sp.	2	2
	Red-osier dogwood	*Cornus stolonifera*	2	2
	Silky dogwood	*Cornus amomum*	---	2
	Bog birch	*Betula glandulifea*	---	2
	Bebb's willow	*Salix cf. bebbia*	2	2
	Sandbar willow	*Salix cf. gracillima*	---	2
	Balsam willow	*Salix pyrifolia*	---	2
	Wild strawberry	*Fragaria virginiana*	2	---
	Raspberry	*Rubus* sp.	2	---
	Wild rose	*Rosa* sp.	2	2
	Gooseberry	*Ribes* sp.	2	---
	Black cherry	*Prunus serotina*	---	2
	Staghorn sumac	*Rhus typhina*	---	2
	Alder-leaved buckthorn	*Rhamnus alnifolia*	---	2
UPLAND FORBS	Wild pea	*Lathyrus palustris*	2	2
	Solomon's seal	*Polygonatum* sp.	---	2
	Twisted stalk	*Streptopus* sp.	---	2
	Thistle	*Cirsium* sp.	2	2
	Dandelion	*Taraxacum officinale*	2	2
	Sweet clover	*Melilotus* sp.	---	2
	Purple flowered orchid	*Platanthera pyscoides*	---	2
	Hog peanut	*Amhicarpa bracteata*	---	2
	Sensitive fern	*Onaclea sensibilis*	---	2

[a]Survey type: 1 = Located only during Minnesota County Biological Survey, 29 August 2008 (K. Myhre)
2 = Located during nearshore vegetation plots, 31 July 2007 (D. Perleberg and S. Loso)
--- = Plant not found during surveys.

Nomenclature follows MNTaxa 2009.

Appendix 2. Bird species list for Little Boy Lake. Includes all species within Little Boy Lake and shoreland recorded during surveys and casual observation, June 2008.

Common Name	**Scientific Name**
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Ring-billed Gull	*Larus delawarensis*
Black Tern	*Chlidonias niger*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Winter Wren	*Troglodytes troglodytes*
Veery	*Catharus fuscescens*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*

Appendix 2, continued.

Common Name	Scientific Name
European Starling	*Sturnus vulgaris*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Nashville Warbler	*Vermivora ruficapilla*
Northern Parula	*Parula americana*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Pine Warbler	*Dendroica pinus*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Northern Waterthrush	*Seiurus noveboracensis*
Common Yellowthroat	*Geothlypis trichas*
Scarlet Tanager	*Piranga olivacea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
American Goldfinch	*Carduelis tristis*

Appendix 3. Bird species list for Wabedo Lake. Includes all species within Wabedo Lake and shoreland recorded during surveys and casual observation, May – June 2008.

Common Name	Scientific Name
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Ring-necked Duck	*Aythya collaris*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Ruffed Grouse	*Bonasa umbellus*
Common Loon	*Gavia immer*
Eared Grebe	*Podiceps nigricollis*
American White Pelican	*Pelecanus erythrorhynchos*
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Broad-winged Hawk	*Buteo platypterus*
Merlin	*Falco columbarius*
Wilson's Snipe	*Gallinago delicata*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Sterna caspia*
Mourning Dove	*Zenaida macroura*
Great Horned Owl	*Bubo virginianus*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*

Appendix 3, continued.

Common Name	Scientific Name
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Golden-crowned Kinglet	*Regulus satrapa*
Veery	*Catharus fuscescens*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Pine Warbler	*Dendroica pinus*
Palm Warbler	*Dendroica palmarum*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Scarlet Tanager	*Piranga olivacea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*

Appendix 4. Bird species list for Louise Lake. Includes all species within Louise Lake and shoreland recorded during surveys and casual observation, May – June 2008.

Common Name	**Scientific Name**
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Osprey	*Pandion haliaetus*
Broad-winged Hawk	*Buteo platypterus*
Common Nighthawk	*Chordeiles minor*
Belted Kingfisher	*Megaceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Pileated Woodpecker	*Dryocopus pileatus*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
Veery	*Catharus fuscescens*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-and-white warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Baltimore Oriole	*Icterus galbula*