Final Report
Sensitive Lakeshore Survey
Roosevelt Lake (11-0043-00)
Lawrence Lake (11-0053-00)
Cass County, Minnesota

June 2010

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES

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

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

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Executive Summary

Aquatic vegetation surveys of Roosevelt Lake and Lawrence Lake documented a total of 40 native aquatic plant taxa. These taxa included 26 submerged and free-floating, six floating-leaf and eight emergent species. Non-native aquatic plant species were not found. Submerged plants occurred to a depth of 25 feet in Roosevelt Lake and 20 feet in Lawrence Lake. In Roosevelt Lake, vegetation was most common in the shore to 20 feet depth zone, where 80% of the sites were vegetated. In Lawrence Lake, vegetation was common from shore to 15 feet in depth, where 72% of the sites contained plants. Common submerged plants included muskgrass and narrow-leaf and broad-leaf pondweeds. Approximately 68 acres of emergent vegetation and 26 acres of floating-leaf plant beds were mapped in these lakes. Two unique submerged aquatic plant species were also documented during the surveys.

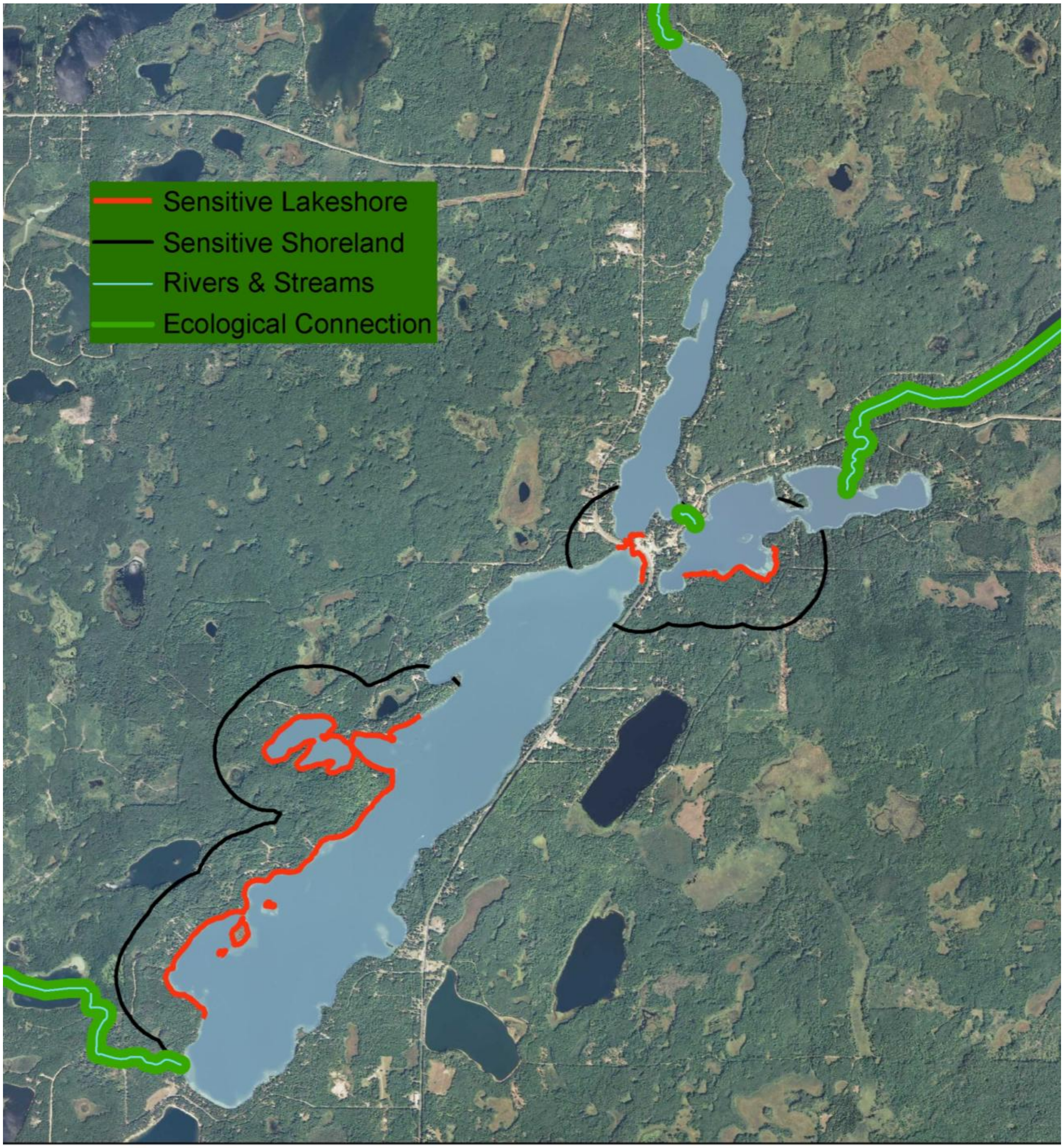
Surveyors documented 69 bird species on the two lakes, including 66 species on Roosevelt Lake and 49 species on Lawrence Lake. Thirteen of the species were identifed as species of greatest conservation need. Ovenbirds were the most commonly recorded species of greatest conservation need, whereas song sparrows were most abundant overall.

Two fish species of greatest conservation need (least darter and longear sunfish) and three proxy species (blackchin shiner, blacknose shiner, and banded killifish) were identified in Roosevelt and Lawrence Lakes. In total, 35 fish species were recorded during the nongame fish surveys. Surveyors recorded eight fish species previously undocumented in Roosevelt Lake and six previously undocumented species in Lawrence Lake. Green frogs were documented at numerous locations on both lakes, and mink frogs were also recorded.

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

The ecological model identified three primary sensitive lakeshore areas to be considered for potential resource protection districts by Cass County. The inlet and outlet of Roosevelt Lake, the inlet of Lawrence Lake, and the channel connecting the two lakes were identified as ecological connections. The County may use this objective, science-based information in

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



Introduction

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

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

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

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

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

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

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

Lake Descriptions

Roosevelt and Lawrence Lakes are located in north-central Minnesota on the border of Cass and Crow Wing counties (Figure 1). These connected water bodies lie in the northeast corner of the Pine River Watershed.

Roosevelt Lake is an elongated lake with distinct north and south basins that are connected by a narrow channel. There are also several smaller bays that branch from the southern basin. The northern two-thirds of the lake are within Cass County and the south end is in Crow Wing County (Figure 2). Lawrence Lake is located on the east side of Roosevelt Lake and a navigable channel joins the two lakes. Lawrence Lake lies entirely within Cass County.

Both Roosevelt Lake and Lawrence Lake receive flow from inlets on their northern ends. An outlet on the south end of Roosevelt Lake flows through a series of lakes to the Pine River and eventually to the Mississippi River.

Figure 1. Location of Roosevelt and Lawrence Lakes in Cass and Crow Wing Counties, Minnesota.

Land use in the Pine River Watershed is predominantly forests and wetlands with numerous lakes. The shorelines of Roosevelt and Lawrence Lakes are under private ownership except for about a half mile of public land on the southwest shore of Roosevelt Lake. The shorelines are developed with residential homes and resorts. Public accesses are located on the east side of Roosevelt Lake and on the southwest side of Lawrence Lake (Figure 2).

Roosevelt Lake has a surface area of 1510 acres and nine miles of shoreline. It has a maximum depth of 129 feet and only 26% of the lake basin is less than 15 feet in depth (Figure 3). Lawrence Lake has a surface area of 225 acres and five miles of shoreline. It has a maximum depth of 71 feet and 39% of the lake basin is less than 15 feet in depth.

Both Roosevelt and Lawrence Lakes are described as mesotrophic, with moderate levels of nutrient enrichment. Between 1994 and 2008, the average Secchi depth (which measures water transparency) for Roosevelt Lake was 11 feet (MPCA 2009). During the same time period, the average Secchi depth for Lawrence Lake was 10 feet. Based on these measurements, both lakes have moderate summer water clarity.

Figure 2. Features of Roosevelt and Lawrence Lakes.

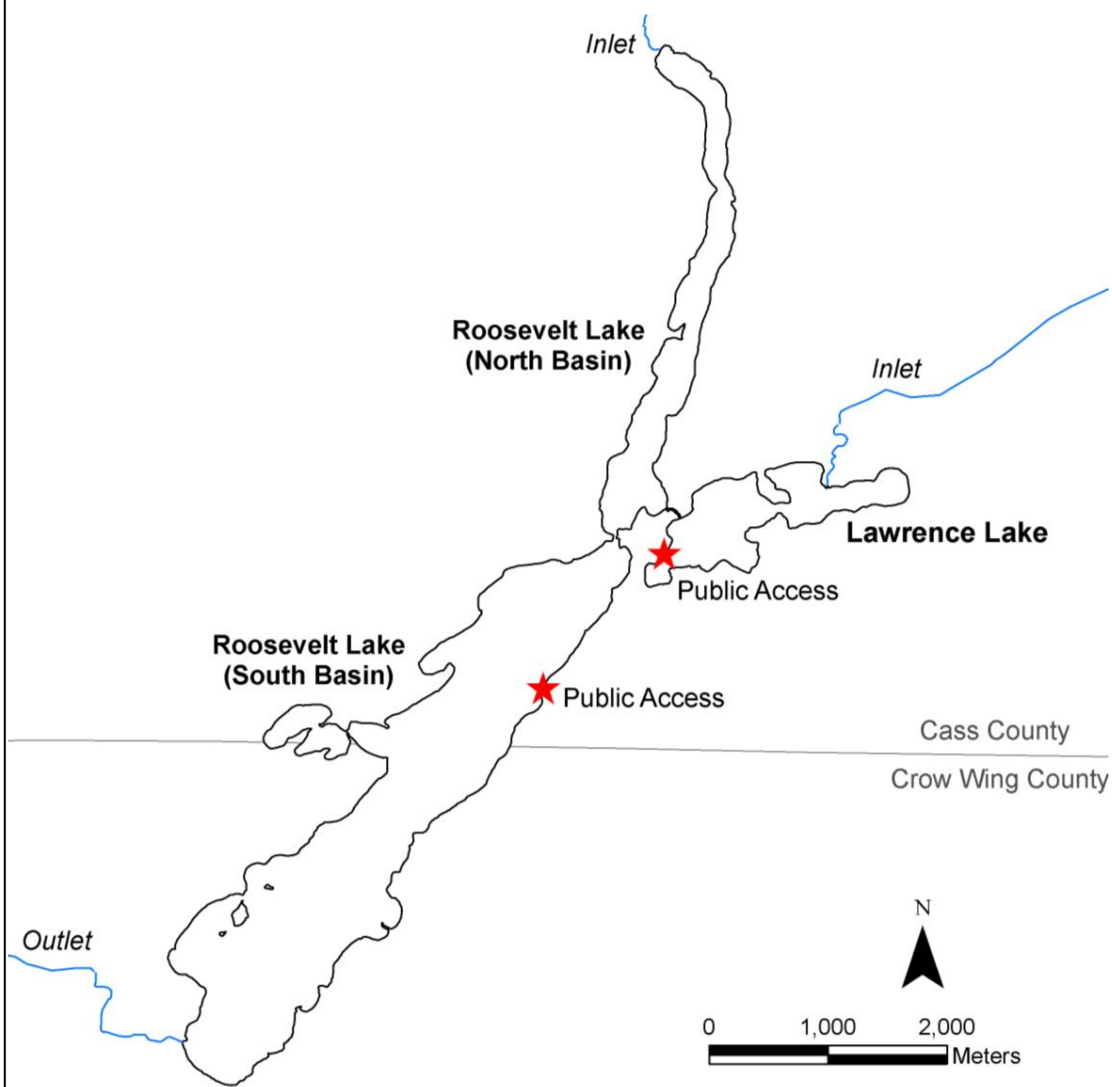
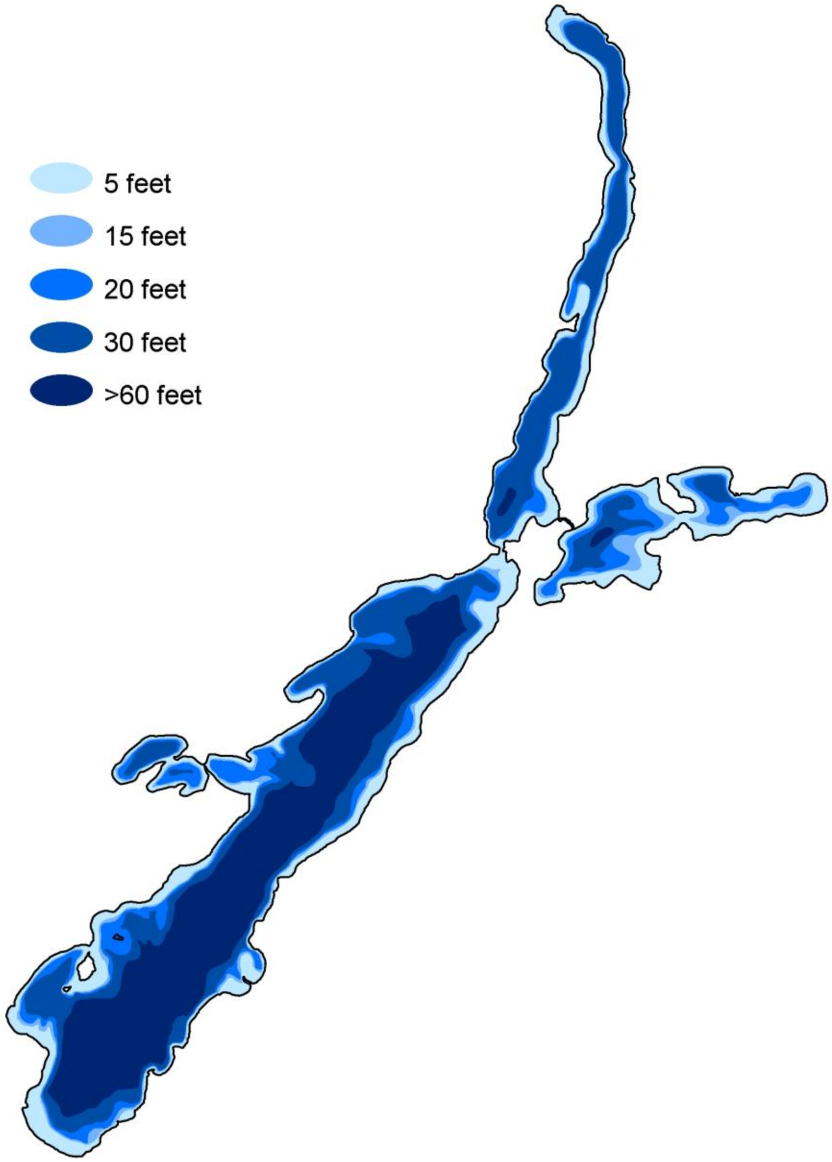


Figure 3. Depth contours of Roosevelt and Lawrence Lakes.



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

Objective

1. Map wetlands within the extended state-defined shoreland area (within 1320 feet of shoreline) of Roosevelt and Lawrence Lakes

Introduction

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

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

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

Methods

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

Results

Approximately 202 acres, or about 6.5% of the Roosevelt and Lawrence shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI (Figure 4). Wetlands were present along the entire lakeshore of these lakes, but were not common.

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

Figure 4. Wetlands within 1320 feet of Roosevelt and Lawrence Lake shorelines.

Hydric Soils

Objective

1. Map hydric soils within the extended state-defined shoreland area (within 1320 feet of shoreline) of Roosevelt and Lawrence 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.

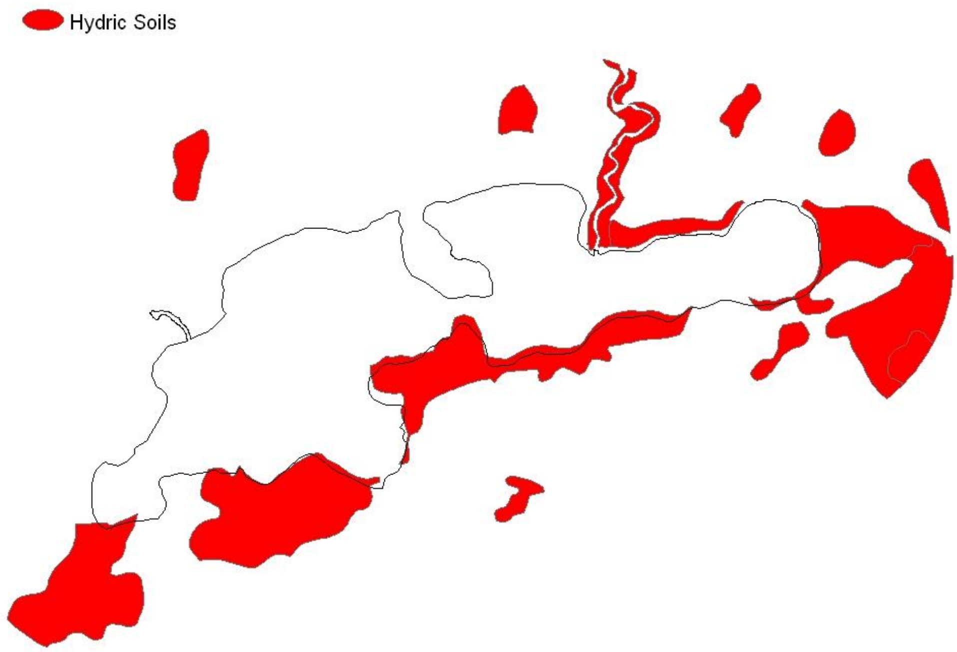
Methods

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. Digitized soil survey data are not available for Crow Wing County (e.g., southern half of Roosevelt Lake), so only Lawrence Lake shoreland soils were analyzed.

Results

Hydric soils were widespread along the shoreline of Lawrence Lake (Figure 5), and encompassed approximately 151 acres within the shoreline district. Large areas of hydric soils were more common on the southern and western shorelands of Lawrence Lake. The organic matter content of the majority of these soils was very high, and most were very poorly drained.

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



Plant Surveys

Objectives

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

Summary

Aquatic vegetation surveys of Roosevelt Lake and Lawrence Lake were conducted in July and September 2008. Surveys included a lakewide assessment of vegetation at over 1300 sample stations, characterization of shoal substrate types, and mapping of emergent and floating-leaf plant beds.

The aquatic plant communities of Roosevelt and Lawrence lakes are similar to those found in other hard water Cass County lakes. A total of 40 native aquatic plant taxa were recorded and included 26 submerged and free-floating, six floating-leaf and eight emergent species. Non-native aquatic plant species were not found. More than 30 additional shoreline emergent taxa were also recorded.

Aquatic plants occurred around the entire perimeter of Roosevelt and Lawrence Lakes. Within the shore to five feet depth zone, ten percent of the sample sites in Roosevelt Lake and 19% of the sample sites in Lawrence Lake contained at least one emergent or floating-leaf plant. Approximately 68 acres of bulrush (*Schoenoplectus* sp.) and 26 acres of waterlily beds (*Nymphaea odorata* and *Nuphar variegata*) were mapped in these lakes.

Submerged plants occurred to a depth of 25 feet in Roosevelt Lake and 20 feet in Lawrence Lake. In Roosevelt Lake, vegetation was most common in the shore to 20 feet depth zone, where 80% of the sites were vegetated. In Lawrence Lake, vegetation was common from shore to 15 feet in depth, where 72% of the sites contained plants. Common submerged plants included muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), and narrow-leaf and broad-leaf pondweeds (*Potamogeton* spp.).

Unique submerged aquatic plants documented during the surveys included lesser bladderwort (*Utricularia minor*) and flat-leaved bladderwort (*Utricularia intermedia*).

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 Roosevelt and Lawrence Lakes. However, if they invade the lakes, they may directly or indirectly impact the native plant communities. 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 hard water Minnesota lakes. This plant resembles higher plants but does not form flowers or true leaves, stems and roots. Muskgrass grows entirely submerged, is often found at the deep edge of the plant zone (Arber 1920), and may form thick "carpets" on the lake bottom. These beds provide important habitat for fish spawning and nesting. Muskgrass has a brittle texture and a characteristic "musky" odor. It is adapted to a variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer.

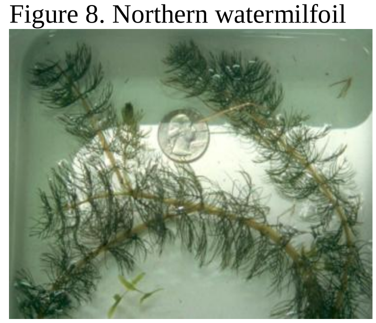
Figure 6. Bed of muskgrass

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

Figure 7. Coontail

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 8) is a rooted, perennial submerged plant with finely dissected leaves. It may reach the water surface, particularly in depths less than ten feet and its flower stalk extends above the water surface. It spreads primarily by stem fragments and overwinters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. This native plant provides fish shelter and insect habitat and the extensive root systems help stabilize near-shore substrates.

Figure 8. Northern watermilfoil



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

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 9) 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 overwinter by winter buds.

Figure 9. Flat-stem pondweed

Fries' pondweed (*Potamogeton friesii*; Figure 10) is a rooted, perennial submerged plant and has small, thin leaves that grow entirely below the water surface but flowers that extend above the water. This plant overwinters as rhizomes and winter buds. There are several species of narrow-leaf pondweeds and they can be difficult to identify if not found in flower or fruit. Fries' pondweed (*Potamogeton friesii*) was positively identified in both lakes, but additional narrow-leaf species may have also been present. For analysis, all narrow-leaf pondweeds were grouped together.

Figure 10. Fries' pondweed

Broad-leaf pondweeds include white-stem pondweed (*Potamogeton praelongus*), large-leaf pondweed (*P. amplifolius*), Illinois pondweed (*P. illinoensis*; Figure 11), and variable pondweed (*P. gramineus*). These plants are often called "cabbage" plants by anglers. Some broad-leaf pondweeds may form floating leaves in sheltered sites while other species have only submerged leaves. Species like white-stem and large-leaf pondweed are common in many clear water Minnesota lakes but are often among the first species to decline in degraded water. White-stem pondweed is not tolerant of turbidity (Nichols 1999b) and may be negatively impacted by increased lake development.

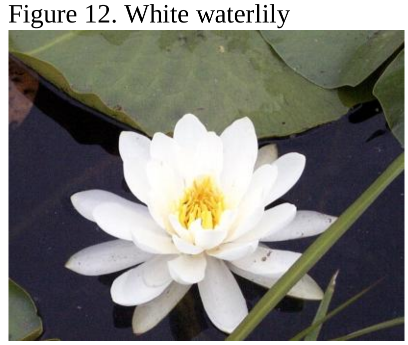
Figure 11. Illinois pondweed

Photo by: Allison Fox, U. of Florida. © 1996

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 12. White waterlily



White and yellow waterlilies can be found in lakes in both northern and southern Minnesota. White waterlily (*Nymphaea odorata*; Figure 12) has showy white flowers and round leaves with radiating veins. Yellow waterlily (*Nuphar variegata*; Figure 13) 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 while white waterlily may occur to depths of ten feet (Nichols 1999b).

Figure 13. Yellow waterlily

Floating-leaf pondweed (*Potamogeton natans*; Figure 14) also occurs in lakes throughout the state. It may co-occur with other vegetation or may be found on the deep end of bulrush beds. This plant forms very narrow submerged leaves and oval-shaped floating-leaves. The fruits of floating-leaf pondweed are eaten by geese and ducks, including scaup and blue-winged teal (Borman et al. 2001).

Figure 14. Floating-leaf pondweed

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

Figure 15. Bulrush bed in Roosevelt Lake, 2008

Hard-stem bulrush (*Schoenoplectus acutus*) is an emergent, perennial plant that occurs in lakes and wetlands throughout Minnesota (Ownbey and Morley 1991). Bulrush stems are round in cross section and lack showy leaves (Figure 15). Clusters of small flowers form near the tips of long, narrow stalks. This emergent 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.

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

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

Bladderworts (*Utricularia* spp.) are a group of submerged plants that produce roots but do not firmly anchor to the lake bottom. Greater bladderwort (*U. vulgaris)* is found in lakes and ponds throughout Minnesota but several other species are much less common. Unique bladderwort species include lesser bladderwort (*Utricularia minor;* Figure 16) and flat-leaved bladderwort (*U. intermedia*). These small, submerged plants are often confused with algae because of their fine stems and leaves. Bladderworts have specialized air bladders that regulate their position in the

Figure 16. Lesser bladderwort

Photo by: Paul Skawinski, UW-Stevens Point Herbarium. © 2009 water column. They act as "underwater Venus fly-traps" by catching and digesting small insects in the bladders. Bladderworts produce small but showy flowers that emerge above the water surface. They prefer soft substrates (Nichols 1999b) but also float freely in the water column and may be found in protected areas such as waterlily beds. They are found in protected, shallow lake areas and have been documented at scattered locations throughout northern Minnesota (Ownbey and Morley 1991).

Species richness

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

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

Methods

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

Grid point-intercept survey

A grid point-intercept survey was conducted in Roosevelt and Lawrence Lakes on July 1, 2, 8, 9, 14, 21, and 22, 2008 (Perleberg and Loso 2008). A GIS computer program was used to establish aquatic plant survey points throughout the littoral (i.e., vegetated) zone of the lake to a depth of 25 feet. Points were spaced 40 meters apart in both Roosevelt and Lawrence Lakes, and a total of 1343 sites were sampled. Surveyors did not survey several shallow sites in Lawrence Lake or around the southern islands in Roosevelt Lake because they either occurred in dense beds of emergent or floating-leaf vegetation or in shallow rocky areas. Surveyors navigated to each site using a handheld Global Positioning (GPS) unit. At each sample site, water depth and all vegetation within a one-meter squared sample area was sampled using a double-headed garden rake. All aquatic plant species present within the sample plot were recorded and frequency of occurrence was calculated for each species. Any additional species found outside the sample plots were recorded as present in the lake. Voucher specimens were collected for most species and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Emergent and floating-leaf bed delineation

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

Near-shore vegetation survey

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

Searches for unique and rare species

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

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

A targeted search for rare aquatic vascular plants was conducted by the Minnesota County Biological Survey Program in Lawrence Lake on July 21, 2008 and in Roosevelt Lake on July 22, 2008 (Myhre 2008). This search focused on sites that were most likely to contain rare plant species. Botanists used professional experience to select rare species search sites and included factors such as shoreline development, substrate type, water depth, and native plant community type in their site selection. To gain access to shallow vegetated areas, searches were conducted by slowly kayaking, canoeing and/or wading through the site.

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

Results

Distribution of plants by water depth

Aquatic plants occurred around the entire perimeter of each lake. Roosevelt Lake had a narrow vegetated zone that, in many areas, extended lakeward only 35 meters (Figure 17). Lawrence Lake had a broader vegetated zone that, in some areas, extended 200 meters into the lake. Within the sampled area (shore to 25 feet depth zone), vegetation occurred in 61% of the Roosevelt Lake sites and in 46% of the Lawrence Lake sites.

Plants were found to a water depth of 25 feet in Roosevelt Lake and to a depth of 20 feet in Lawrence Lake. In Roosevelt Lake, vegetation was most common in the shore to 20 feet depth zone, in which 80% of the sites were vegetated. In depths greater than 20 feet, only seven percent of the Roosevelt Lake sites contained plants. In Lawrence Lake, vegetation was common from shore to 15 feet in depth; 72% of the sites within this zone contained plants. In depths greater than 15 feet, only one percent of the Lawrence Lake sites were vegetated.

Aquatic plant species observed

A total of 40 aquatic plant taxa were recorded in Roosevelt and Lawrence Lakes in 2008. These included 26 submerged taxa (Table 1), six floating-leaf and eight emergent taxa (Table 2). Submerged plants included plants that were strongly anchored to the lake bottom as well as plants that floated freely with the water currents. More than 30 shoreline plants were also recorded (Appendix 1).

Figure 17. Aquatic plant distribution in Roosevelt and Lawrence Lakes, 2008.

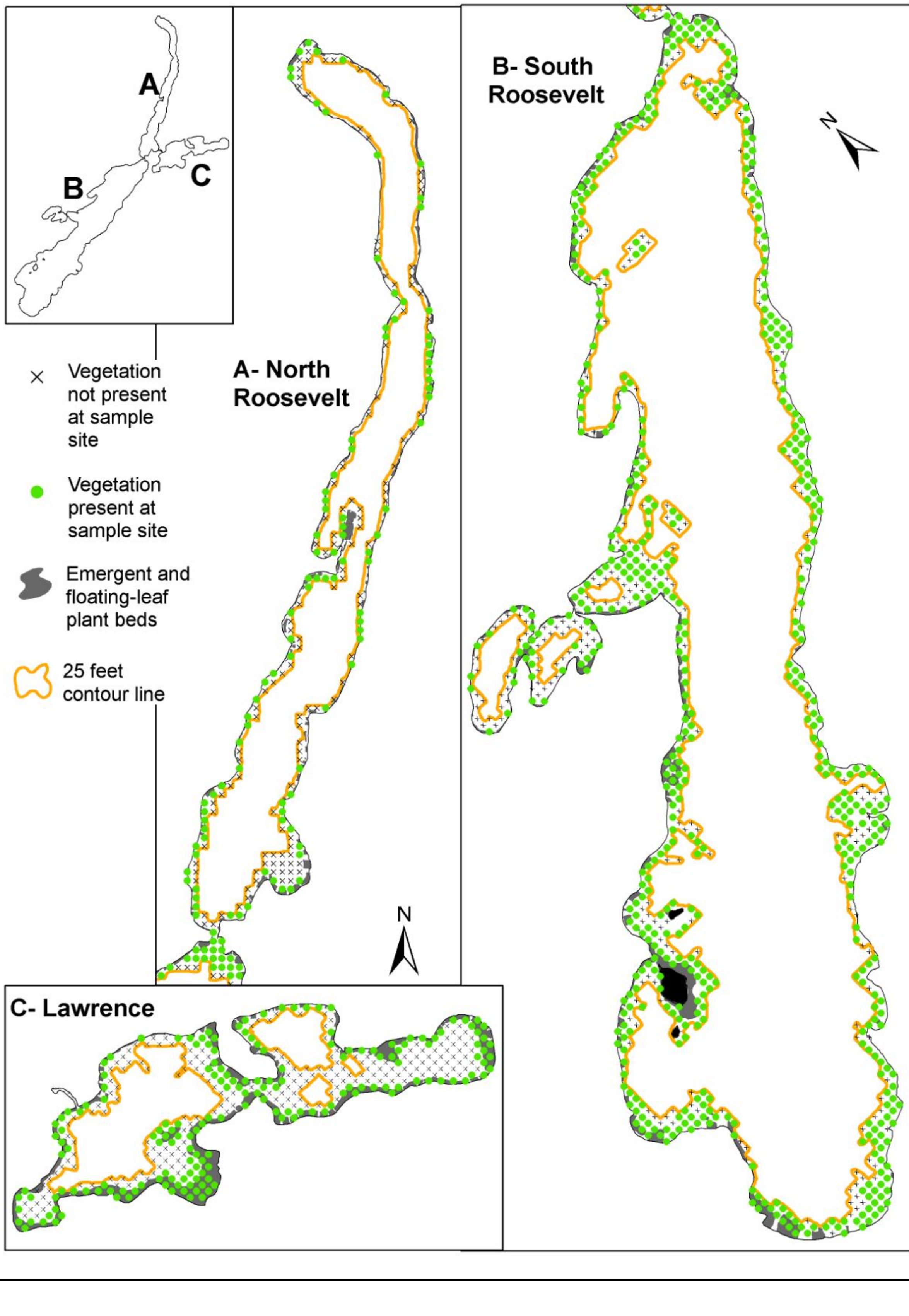


Table 1. Submerged and free-floating aquatic plants of Roosevelt and Lawrence Lakes, 2008.

Description		Common Name	Scientific Name	Frequency of Occurrence[a] Roosevelt	Frequency of Occurrence[a] Lawrence
Algae and Mosses		Muskgrass	*Chara* sp.	38	15
Algae and Mosses		Stonewort	*Nitella* sp.	2	–
Algae and Mosses		Watermoss	Not identified to species	<1	3
Rooted plants	Grass-leaf plants	Flat-stem pondweed	*Potamogeton zosteriformis*	17	24
Rooted plants	Grass-leaf plants	Water stargrass	*Zosterella dubia*	4	6
Rooted plants	Grass-leaf plants	Wild celery	*Vallisneria americana*	2	12
Rooted plants	Dissected-leaf plants	Coontail	*Ceratophyllum demersum*	17	15
Rooted plants	Dissected-leaf plants	Northern watermilfoil	*Myriophyllum sibiricum*	15	19
Rooted plants	Dissected-leaf plants	Water marigold	*Megalodonta beckii*	1	7
Rooted plants	Dissected-leaf plants	White water buttercup	*Ranunculus aquatilis*	1	2
Rooted plants	Dissected-leaf plants	Whorled watermilfoil	*Myriophyllum verticillatum*	–	MCBS[c]
Rooted plants	Narrow-leaf pondweeds[b]	Fries' pondweed	*Potamogeton friesii*	19	15
Rooted plants	Narrow-leaf pondweeds[b]	Very small pondweed	*Potamogeton pusillus*		
Rooted plants	Narrow-leaf pondweeds[b]	Straight-leaved pondweed	*Potamogeton strictifolius*		
Rooted plants	Narrow-leaf pondweeds[b]	Sago pondweed	*Stuckenia pectinata*	4	9
Rooted plants	Narrow-leaf pondweeds[b]	Blunt-tipped sago	*Stuckenia filiformis*	–	MCBS
Rooted plants	Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	10	4
Rooted plants	Broad-leaf pondweeds	Illinois pondweed	*Potamogeton illinoensis*	8	5
Rooted plants	Broad-leaf pondweeds	Variable pondweed	*Potamogeton gramineus*	3	1
Rooted plants	Broad-leaf pondweeds	Clasping-leaf pondweed	*Potamogeton richardsonii*	2	4
Rooted plants	Broad-leaf pondweeds	Large-leaf pondweed	*Potamogeton amplifolius*	1	8
Rooted plants	Small-leaf plants	Canada waterweed	*Elodea canadensis*	3	8
Rooted plants	Small-leaf plants	Bushy pondweed	*Najas flexilis*	1	5
Free-drifting		Greater bladderwort	*Utricularia vulgaris*	<1	–
Free-drifting		Lesser bladderwort	*Utricularia minor*	–	<1
Free-drifting		Flat-leaved bladderwort	*Utricularia intermedia*	–	Present[d]
Free-drifting		Star duckweed	*Lemna trisulca*	<1	6
Free-drifting		Greater duckweed	*Spirodela polyrhiza*	<1	MCBS

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations at Roosevelt Lake (N = 992) and Lawrence Lake (N = 351). They represent the percent of the sample stations that contained a plant taxon.

[b]Three species of "narrow-leaf pondweeds" were identified in these lakes and include *Potamogeton friesii, P. pusillus*, and *P. strictifolius*. Some specimens were identifiable only to the genus level and therefore all narrow-leaf pondweeds were grouped together for analyses.

[c]MCBS = located only during Minnesota County Biological Survey, 21 July 2008 (Lawrence Lake) and 22 July 2008 (Roosevelt Lake).

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

"– " indicates plant taxa was not found in lake.

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaf and emergent aquatic plants of Roosevelt and Lawrence Lakes, 2008.

Description	Common Name	Scientific Name	Frequency of Occurrence[a]	
			Roosevelt	Lawrence
FLOATING-LEAF	Yellow waterlily	*Nuphar variegata*	3	11
	White waterlily	*Nymphaea odorata*	2	8
	Floating-leaf pondweed	*Potamogeton natans*	1	3
	Watershield	*Brasenia schreberi*	<1	–
	Floating-leaf burreed	*Sparganium* sp.	<1	–
	Floating-leaf smartweed	*Persicaria amphibia*	Present[b]	–
EMERGENT	Hard-stem bulrush	*Schoenoplectus acutus*	5	3
	Spikerush	*Eleocharis erythropoda*	<1	1
	Smalls spikerush	*Eleocharis acicularis*	<1	MCBS[c]
	Water horsetail	*Equisetum fluviatile*	<1	<1
	Giant burreed	*Sparganium eurycarpum*	<1	1
	Broad-leaved arrowhead	*Sagittaria latifolia*	<1	<1
	Narrow-leaf sedge	*Carex* sp.	<1	<1
	Broad-leaf cattail	*Typha latifolia*	–	<1

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations at Roosevelt Lake (N = 992) and Lawrence Lake (N = 351). They represent the percent of the sample stations that contained a plant taxon.

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

[c]MCBS = located only during Minnesota County Biological Survey, 21 July 2008 (Lawrence Lake) and 22 July 2008 (Roosevelt Lake).

"–" indicates plant taxa was not found in lake.

Nomenclature follows MNTaxa 2009.

Submerged plants

Within the shore to 25 feet depth zone, submerged plants occurred in 66% of the Roosevelt Lake sites and in 46% of the Lawrence Lake sites. A mixture of submerged plant types were found and the most commonly occurring taxa were muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), and narrow-leaf and broad-leaf pondweeds (*Potamogeton* spp.).

Muskgrass was found in approximately 38% of the sites in Roosevelt Lake and 15% of the sites in Lawrence Lake (Table 1). It was widespread around the vegetated zones of each lake (Figure 18A) and could be found growing in thick beds with no other vegetation or within mixed beds of pondweeds and other submerged plants. Muskgrass was most often found in depths less than ten feet in both Roosevelt Lake and Lawrence Lake.

Coontail was found in 17% of Roosevelt Lake sample sites and 26% of Lawrence Lake sample sites. It occurred throughout the vegetated zone, and was frequently found in the shallow bays of southern Roosevelt Lake and throughout Lawrence Lake (Figure 18B). Coontail was most common within the 11 to 25 feet depth zone in Roosevelt Lake, but in Lawrence Lake it was common between six and 15 feet in depth.

Eleven different pondweed species (*Potamogeton* spp. and *Stuckenia* spp.) were found in Roosevelt and Lawrence Lakes and were most common in depths of ten feet and less. The most common species was flat-stem pondweed, which occurred with a frequency of 17% in Roosevelt Lake and 24% in Lawrence Lake (Table 1). Flat-stem pondweed had a widespread distribution (Figure 18C) and often co-occurred with muskgrass and coontail. Fries' pondweed was the second most common pondweed. This species occurred in six percent of the Roosevelt Lake survey sites and 13% of the Lawrence Lake survey sites, and was scattered around the shoreline in both lakes (Figure 18B). Broad-leaf pondweeds were scattered around both lakes (Figure 19A) and included white-stem, Illinois, variable, clasping-leaf, and large-leaf pondweeds.

Northern watermilfoil was found in 15% of the Roosevelt Lake sample sites and 19% of Lawrence Lake sample sites. Northern watermilfoil was abundant in six to ten feet of water and occurred throughout Roosevelt and Lawrence Lakes (Figure 18D).

Figure 18. Distribution of common aquatic plants in Roosevelt and Lawrence Lakes, 2008.

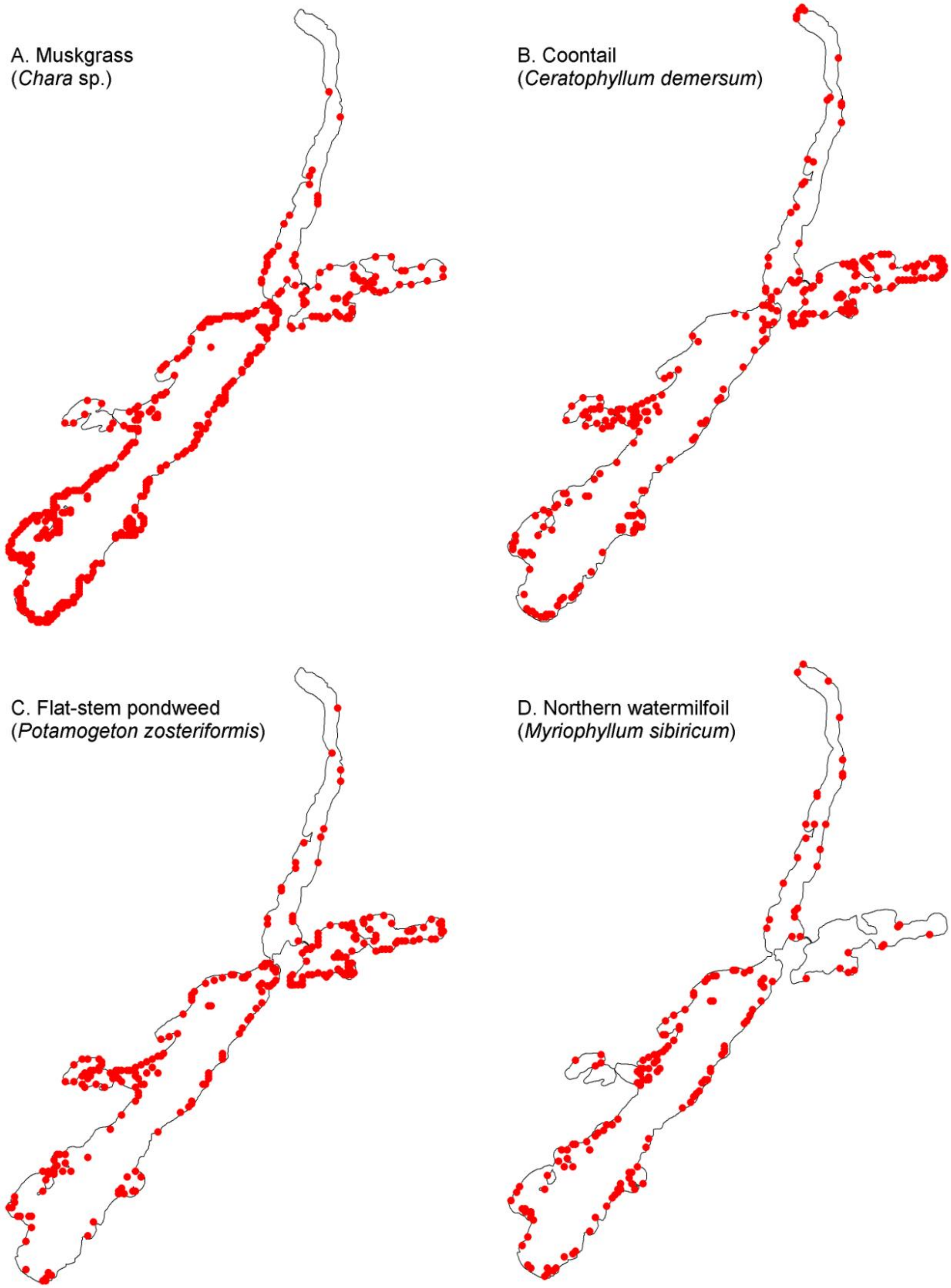
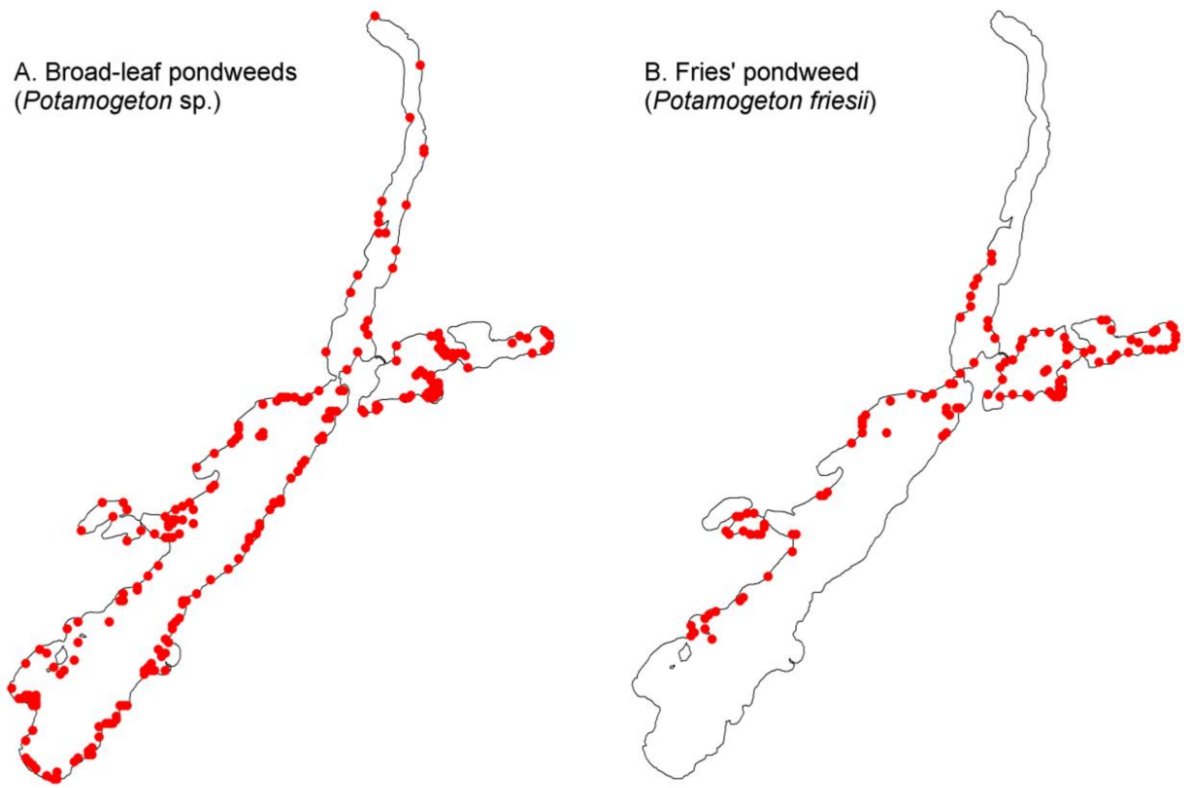


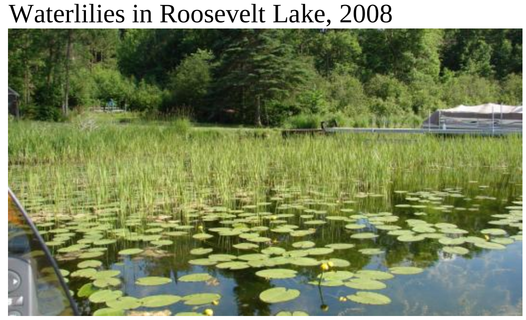
Figure 19. Distribution of common aquatic plants in Roosevelt and Lawrence Lakes, 2008.



Floating-leaf and emergent plants

Emergent and floating-leaf plants were most often found in water depths of five feet and less. Within this depth zone, 27% of the Roosevelt Lake sites and 64% of the Lawrence Lake sites contained at least one emergent or floating-leaf plant. Surveyors mapped approximately 18 acres of floating-leaf plant beds in Roosevelt Lake and eight acres in Lawrence Lake; these beds were found scattered around the shorelines of both lakes (Figure 20). The most common floating-leaf species were white waterlily, yellow waterlily, floating-leaf pondweed, and watershield. Because surveyors avoided motoring into floating-leaf plant beds, the frequency values obtained for these taxa (Table 2) are lower than the actual lakewide occurrence. Frequency values for floating-leaf taxa represent the occurrence of these taxa only within the sites that were surveyed. Waterlily beds often contained scattered bulrush plants as well as submerged plants and were usually associated with muck sediments.

Waterlilies in Roosevelt Lake, 2008

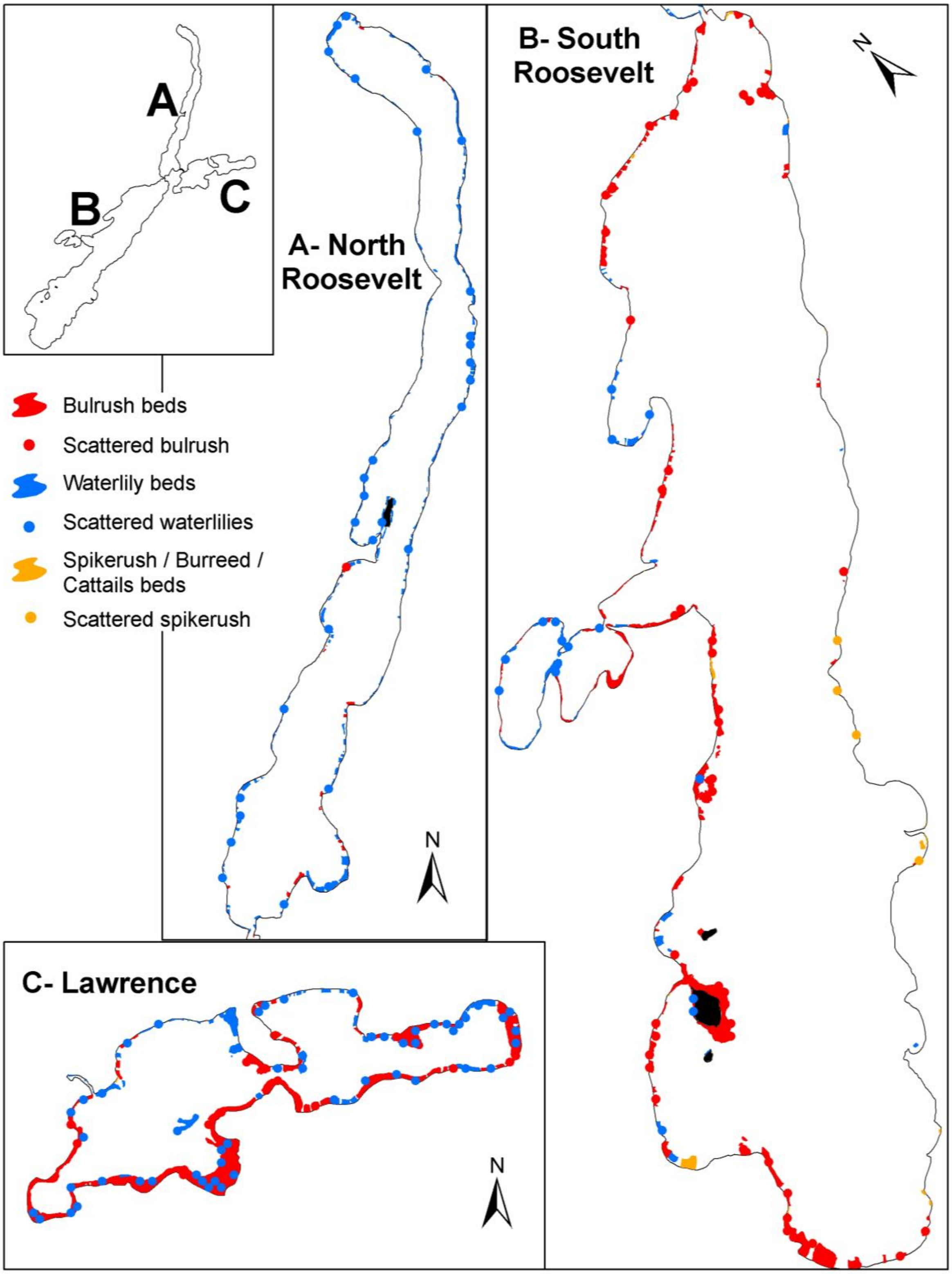


Surveyors also delineated approximately 68 acres of emergent plants. Thirty-two acres of bulrush beds or bulrush beds mixed with waterlilies were delineated in Roosevelt Lake. Thirtysix acres of emergent plants were delineated in Lawrence Lake; the most common taxa was hard-stem bulrush. Bulrush was found throughout Lawrence Lake and along the sandy shorelines of the southern half of Roosevelt Lake (Figure 20).

Bulrush in Roosevelt Lake, 2008

Other emergent plants occurred at scattered locations around the lakes and included spikerush (*Eleocharis erythropoda*), arrowhead (*Sagittaria latifolia*) and burreed (*Sparganium eurycarpum*). 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.

Figure 20. Distribution of emergent and floating-leaf plant beds in Roosevelt and Lawrence Lakes, 2008.



Unique plants

In addition to the commonly occurring plants in Roosevelt and Lawrence Lakes, two unique plant species, lesser bladderwort and flat-leaved bladderwort, were documented. Both bladderworts were found within bulrush beds, along the sandy shores in the south bay of Lawrence Lake (Figure 21). These species are not widespread in Minnesota but their presence is indicative of relatively undisturbed native plant beds in this area of Lawrence Lake.

Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to 12 (Figure 22). Sites with the highest number of species occurred primarily in Lawrence Lake, but also occurred at scattered locations in Roosevelt Lake. Sites with high plant richness were often found near shore, within mixed beds of emergent, floating-leaf and submerged plants. In water depths greater than 15 feet, most sites contained fewer than two species.

Figure 21. Unique aquatic plants in Roosevelt and Lawrence Lakes, 2008.

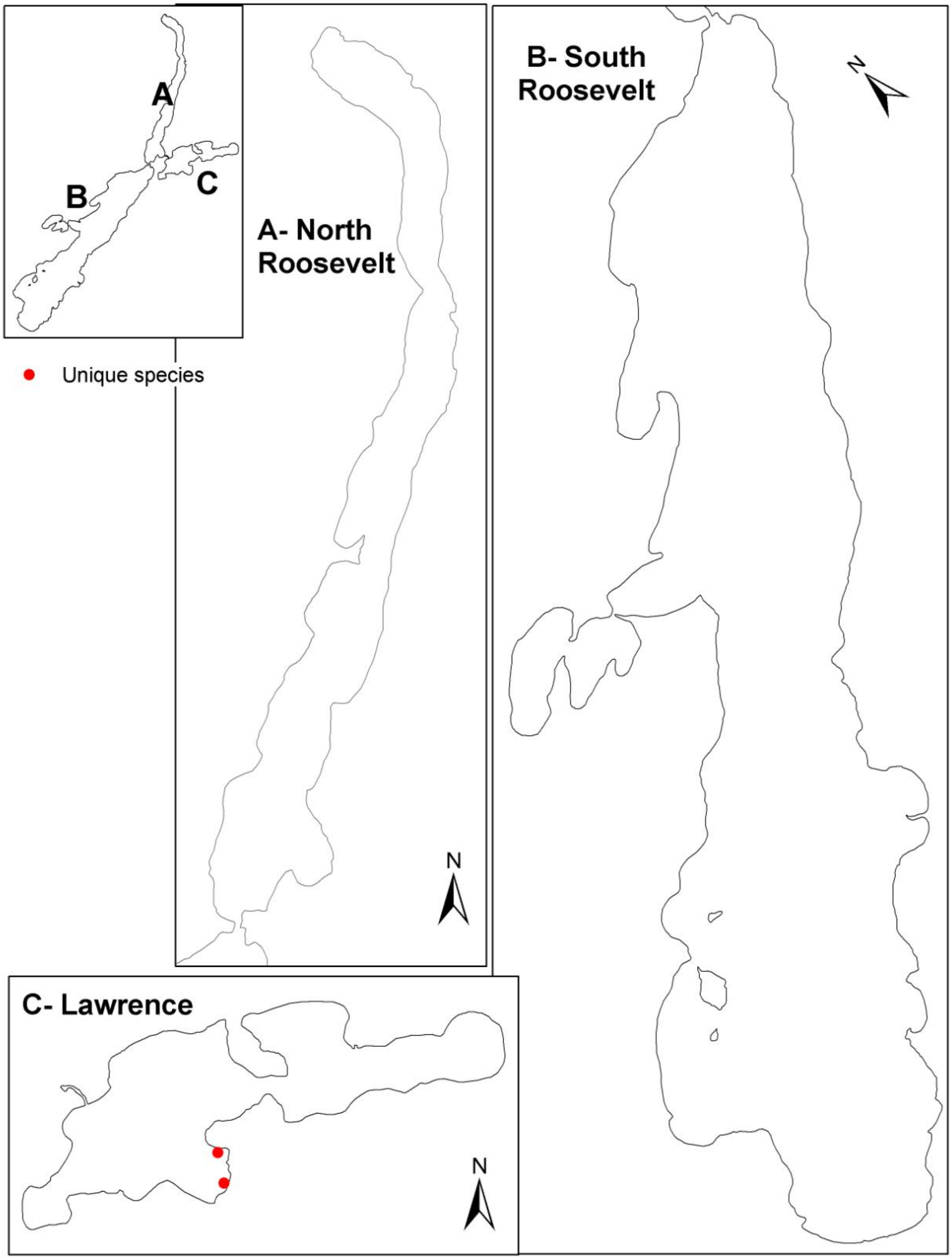
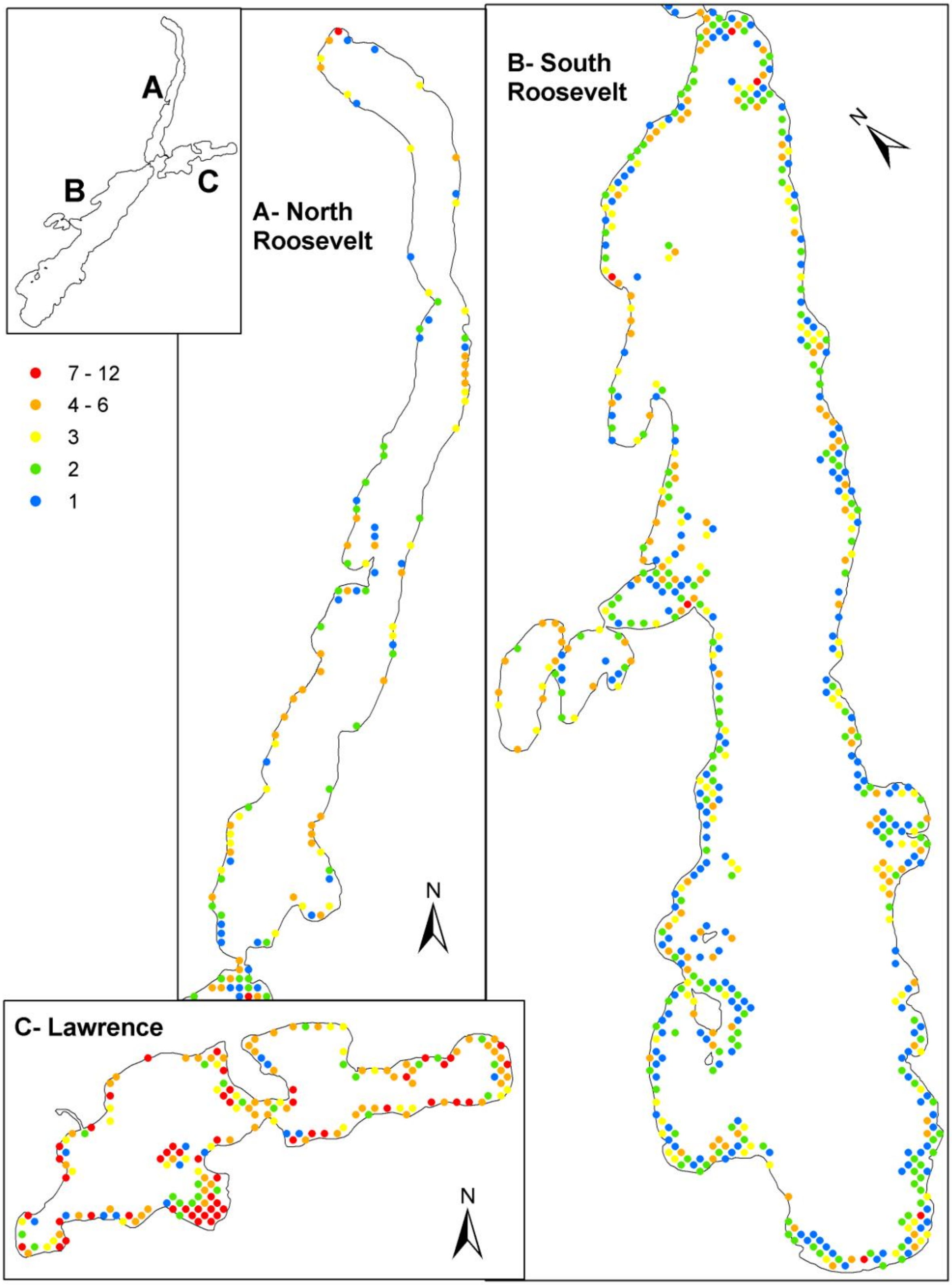


Figure 22. Aquatic plant richness (number of taxa per sampling station) in Roosevelt and Lawrence Lakes, 2008.



Near-shore Substrates

Objective

1. Describe and map the near-shore substrates of Roosevelt and Lawrence 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 such as silt, muck, and sand. Other species, such as walleye, prefer hard bottom substrates with a large diameter, such as gravel and rubble. A diverse substrate will also allow plants with different habitat requirements to exist within a system. For example, bulrush may occur on sand or gravel whereas yellow waterlily prefers soft substrates (Nichols 1999b).

Rubble shoreline on Roosevelt Lake

Methods

Near-shore substrate in Roosevelt and Lawrence Lakes was evaluated at a total of 924 sampling stations set up in the point-intercept aquatic plant surveys and near-shore fish surveys. Plant sample stations were 40 meters apart and occurred in a grid from shore to a depth of 25 feet; substrate was evaluated at sample stations where water depth was seven feet or less. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore vegetation sample stations and near-shore fish sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 75 of these stations on Roosevelt Lake and 20 stations on Lawrence Lake.

Standard lake substrate classes were based on the DNR Fisheries Survey Manual (MN DNR 1993):

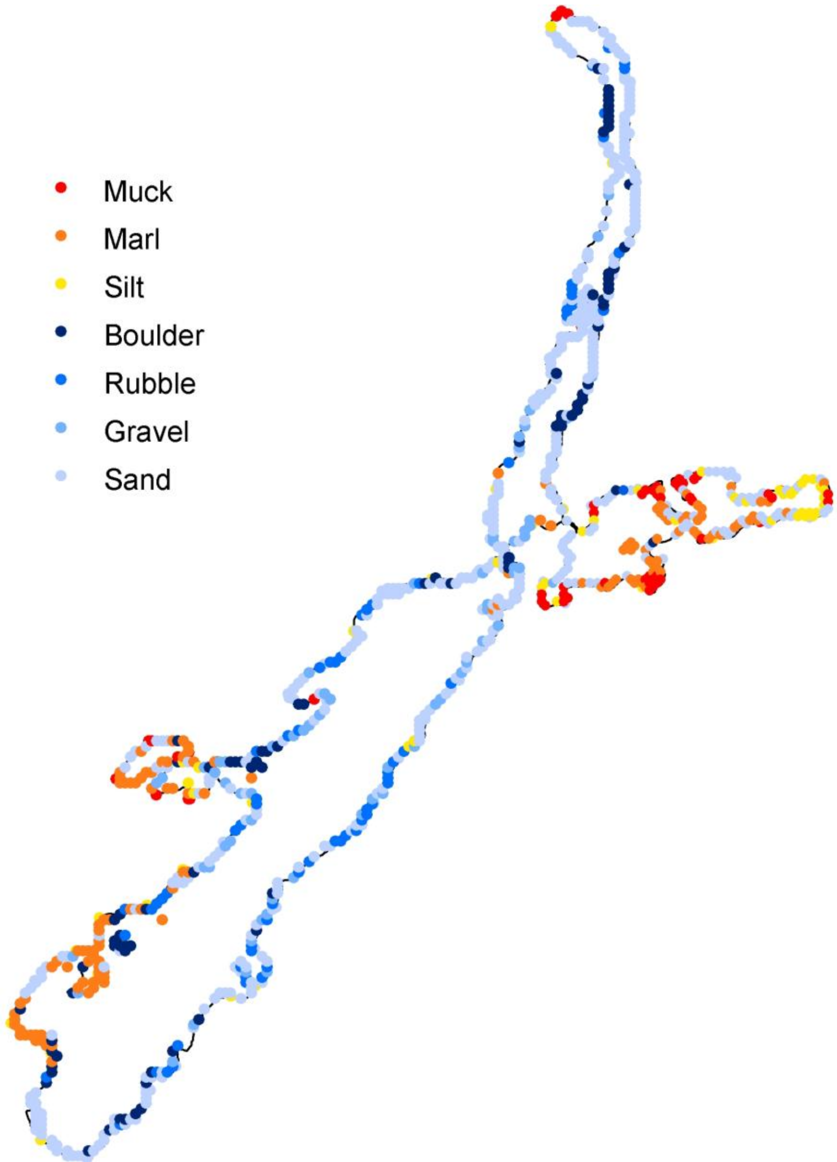
Substrate Group	Type	Description
Hard Bottom	Boulder	Diameter over 10 inches
	Rubble	Diameter 3 to 10 inches
	Gravel	Diameter 1/8 to 3 inches
	Sand	Diameter less than 1/8 inch
Soft Bottom	Silt	Fine material with little grittiness
	Marl	Calcareous material
	Muck	Decomposed organic material

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.

Results

The main shoreline of Roosevelt Lake was dominated by hard substrates, such as boulders, rubble, gravel, and sand (Figure 23). The substrate composition differed within the bays, where soft substrates like marl and silt were more common. These soft substrates were also frequently found within the bays of Lawrence Lake. The main shoreline in Lawrence Lake was comprised of a mix of hard and soft substrates.

Figure 23. Distribution of near-shore substrates in Roosevelt and Lawrence Lakes, 2008.



Bird Surveys

Objectives

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

Introduction

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

Figure 24. Bald eagle

Photo by: Carrol Henderson

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

Figure 25. Common loon

Photo by: Carrol Henderson

Common loons (*Gavia immer*; Figure 25) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. These large diving birds possess red eyes and a large, dark pointed bill that is well-adapted for catching fish. 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.

Common nighthawks (*Chordeiles minor*; Figure 26) are most often seen in the air, exhibiting an erratic flight pattern as they forage for insects. They are cryptically colored with brown, gray, and white mottling. A white bar is visible across the wing when the bird is in flight. The breeding ritual includes a dramatic display during which the male dives straight toward the ground before quickly turning upward; air rushing through the wings makes a deep booming sound. Originally found in open, rural areas, the nighthawk has adapted to urban settings and will even nest on gravel rooftops. Despite their adaptability, nighthawks have declined in some areas. Predation and a decreased insect food base due to the use of pesticides may be factors in this decline.

Figure 26. Common nighthawk

Photo by: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 27) are medium-sized, nondescript birds common in Eastern forests. They utilize multiple habitat types, including deciduous forests, mixed woods, and suburban areas. This bird gets its name from its call, a slurred "pee-ah-wee." Eastern wood-pewees are grayish-olive above, with a paler throat and belly and whitish wingbars. They forage throughout the canopy, often flying out from their perch to catch insects before returning to the same perch. Populations of eastern wood-pewees are declining throughout much of their range. One possible cause of the decline is the increase in white-tailed deer. Deer browse the canopy and decrease the foraging area available to the pewee.

Figure 27. Eastern wood-pewee

Photo by: J.A. Spendelow

Golden-winged warblers (*Vermivora chrysoptera*; Figure 28) are small, active, insectivorous warblers. They possess a distinctive yellow crown and yellow patch on the wings. A black mask and throat contrast with the gray and white plumage on the back and breast. They often inhabit forest edges, such as those along marshes, bogs, and fields, and are also common in alder shrub swamps. Regional declines of the golden-winged warbler are considerable. Human-caused disturbance and hybridization with increasing numbers of blue-winged warblers are correlated with the declines.

Figure 28. Golden-winged warbler

Photo by: Carrol Henderson

Least flycatchers (*Empidonax minimus*; Figure 29) are the smallest flycatchers found in Minnesota. Like many other flycatchers, they are olive to gray in color with two white wingbars and whitish underparts. They have a small bill and a prominent white eye ring. The best way to distinguish least flycatchers from other flycatchers is the call, a harsh "che-bek." These birds are often found along water edges in mature, open woods. Least flycatchers are common throughout most of their range where habitat is suitable. However, they are sensitive to human disturbance and require large areas of forest to survive.

Figure 29. Least flycatcher

Photo by: J.A. Spendelow

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

Figure 30. Ovenbird

Photo source: U.S. Fish and Wildlife Service

Rose-breasted grosbeaks (*Pheucticus ludovicianus*; Figure 31) are summer visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes and meadows and woodlands, and suburban parks and gardens. The winter range spans from southern Mexico to South America and the Caribbean. Significant regional declines in rose-breasted grosbeak populations have been noted.

Figure 31. Rose-breasted grosbeak

Photo by: J.A. Spendelow

The <u>swamp sparrow's</u> (*Melospiza georgiana*; Figure 32) 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 32. Swamp sparrow

Photo by: Jim Stasz

The <u>veery</u> (*Catharus fuscescens*; Figure 33) is one of the most easily identifiable thrushes. It has faint dark spots on a buffy breast and a reddish brown back and head. The legs are pink and the eyes are dark with an indistinct light eye ring. The veery was named after its most common call, a "vee-er" sound. Riparian areas with dense vegetation and wetlands within large forests are good places to find the veery. The veery is suffering declines throughout many parts of its range. Destruction of winter habitat and parasitism by brown-headed cowbirds are major reasons cited for the decline.

Figure 33. Veery

Photo by: Deanna Dawson

The <u>whip-poor-will</u> (*Caprimulgus vociferus*; Figure 34) is a medium-sized member of the nightjar family (the common nighthawk is also part of this group). Whip-poor-wills are active at night, when they come out to forage for insects. They spend their days sleeping on the forest floor, where their cryptic coloring helps them remain hidden. The feathers are mottled black, brown, and gray, and the outer tail feathers are tipped with white or tan. The throat is black with a light-colored band. Whip-poor-wills breed in mixed or deciduous forests with little or no understory, often adjacent to grassy fields or other openings. Long-term population declines have been documented through much of the whip-poor-will's range, though the reasons are not well understood. Threats include habitat loss and fragmentation, predation, and a declining prey base (due to pesticide use).

Figure 34. Whip-poor-will

Photo by: John Cassady, www.audubon.org (Common Birds in Decline)

White-throated sparrows (*Zonotrichia albicollis*; Figure 35) are common in Minnesota during their spring and fall migrations. They are recognizable by the white patch on the throat and their characteristic "Old Sam Peabody Peabody Peabody" song. The head is striped with black and tan or white, and has a yellow spot above the eye. The chest is gray and the back is streaked with brown and black. They inhabit coniferous or mixed forests, and prefer areas with multiple openings and abundant low-growing vegetation. Although white-throated sparrows are widespread, they are declining over portions of their breeding range.

Figure 35. White-throated sparrow

Photo by: Dave Herr

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 36) 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 36. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Bird surveys were conducted during May and June 2009. Surveyors used several techniques to collect information on bird species. Point counts were conducted at 95 stations (75 stations on Roosevelt Lake, 20 stations on Lawrence 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 species were most likely to be singing. Call-playback surveys were conducted at survey stations that had appropriate habitat. At each station, surveyors played a tape that included the calls of six marsh birds (least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), American bittern (*Botaurus lentiginosus*), and pied-billed grebe (*Podilymbus podiceps*) and listened for a response. Call-playback surveys took place in the evening. Both survey techniques were dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or on the lakeshore were also recorded.

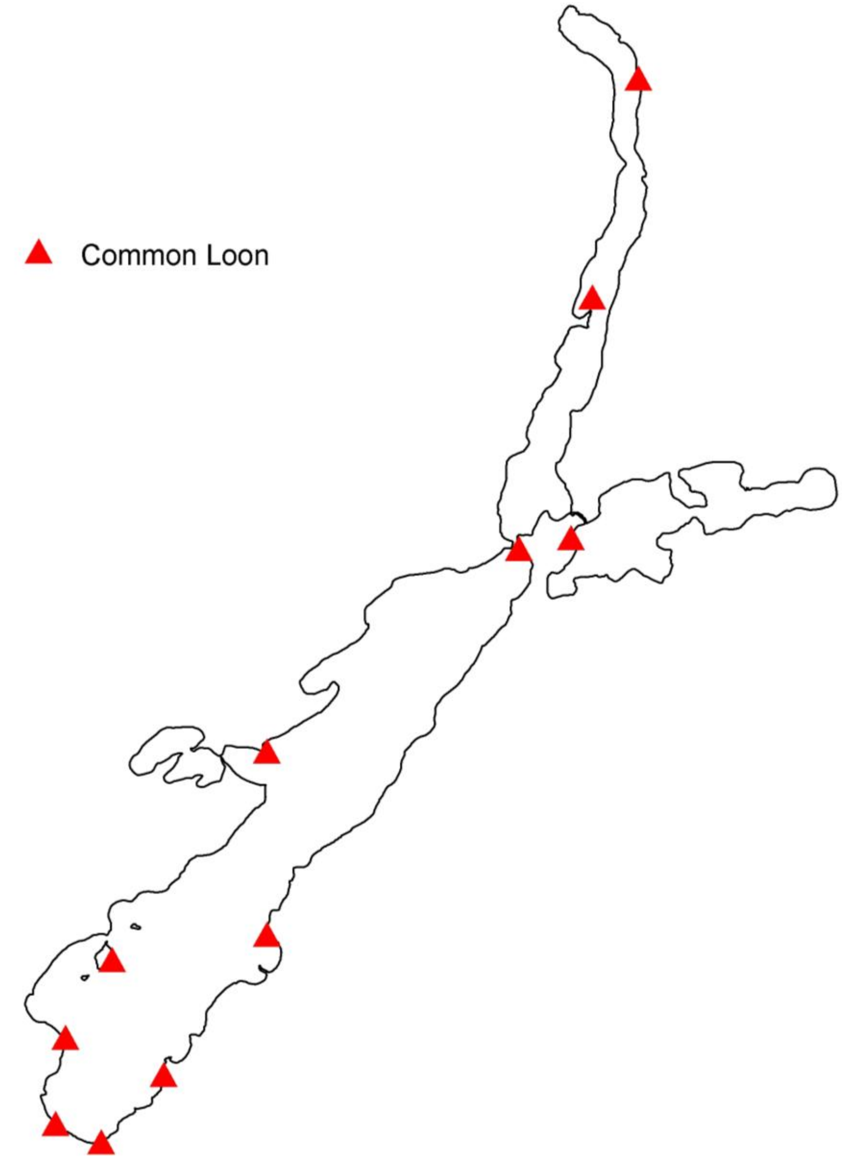
Results

Thirteen bird species of greatest conservation need were identified on Roosevelt and Lawrence Lakes. The ovenbird was the most commonly documented, and occurred at approximately 40% of the survey stations on both Roosevelt and Lawrence Lakes. The common loon and yellow-bellied sapsucker were also detected regularly on Roosevelt Lake; these species were each found at 10 (of 75) survey stations. These two species were detected less frequently on Lawrence Lake; the common loon was detected at one survey station, and no yellow-bellied sapsuckers were identified. Several additional species of greatest conservation need (bald eagle, common nighthawk, and eastern wood-pewee) were recorded only on Roosevelt Lake. The bald eagle was detected at two survey stations, and the common nighthawk and eastern wood-pewee were documented at one station each. The white-throated sparrow and whip-poor-will were identified only on Lawrence Lake. Overall, surveyors documented 11 species of greatest conservation need on Roosevelt Lake; these species were bald eagle, common loon, common nighthawk, eastern wood-pewee, golden-winged warbler, least flycatcher, ovenbird, rose-breasted grosbeak, swamp sparrow, veery, and yellow-bellied sapsucker. Nine bird species of greatest conservation need (common loon, golden-winged warbler, least flycatcher, ovenbird, rose-breasted grosbeak, swamp sparrow, veery, white-throated sparrow, and whip-poor-will) were documented on Lawrence Lake. While the vast majority of the bird species of greatest conservation need were documented during the bird point count and call-playback surveys, the whip-poor-will was heard during an evening frog survey, and is not associated with a specific survey station.

Sixty-seven species were recorded during the Roosevelt and Lawrence Lakes point count and call-playback bird surveys (Table 3). An additional two species were recorded during other observation of the lakes, for a total of 69 species (Appendices 2 – 3). The song sparrow was the most commonly heard species at each of the lakes; surveyors recorded this bird at 80% of the survey stations on Roosevelt Lake and 90% of the stations on Lawrence Lake. The red-eyed vireo was also heard regularly on Roosevelt Lake, and was recorded at over 70% of the survey stations there. The next three most commonly detected species on Roosevelt Lake (chipping sparrow, eastern phoebe, and ovenbird) were each heard at fewer than 50% of the stations. The species make-up differed somewhat on Lawrence Lake, where the red-winged blackbird (found at 85% of the survey stations) was second in abundance, followed by the American robin (found at 65% of the survey stations). Common yellowthroats and red-eyed vireos were also each detected at over 60% of the survey stations on Lawrence Lake. Surveyors recorded a total of 66 species at Roosevelt Lake and 49 species at Lawrence Lake.

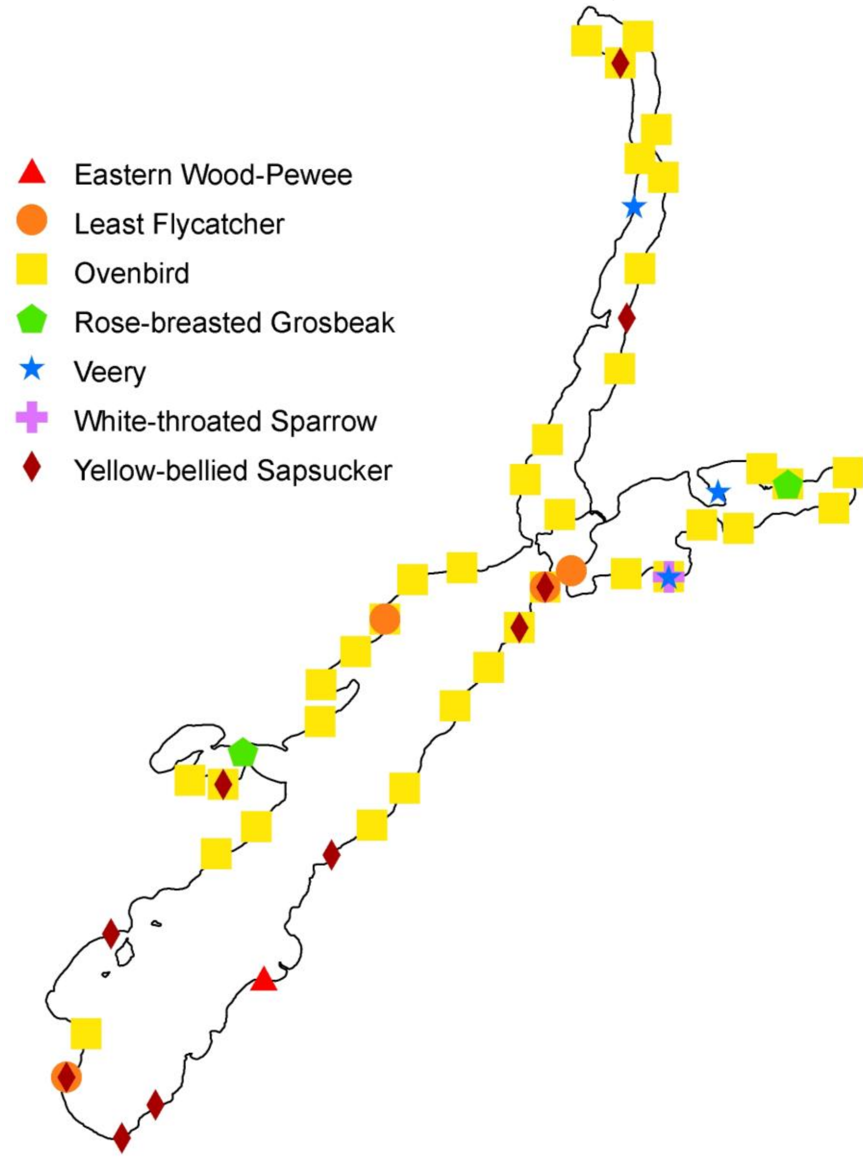
The common loon, an aquatic habitat-dwelling species of greatest conservation need, was documented on both Roosevelt and Lawrence Lakes (Figure 37). Surveyors recorded it at ten survey stations on Roosevelt Lake, in both the north and south basins. One common loon was recorded in Lawrence Lake, near the channel connecting it to Roosevelt Lake.

Figure 37. Distribution of aquatic habitat-dependent bird species of greatest conservation need in Roosevelt and Lawrence Lakes, May – June 2009.



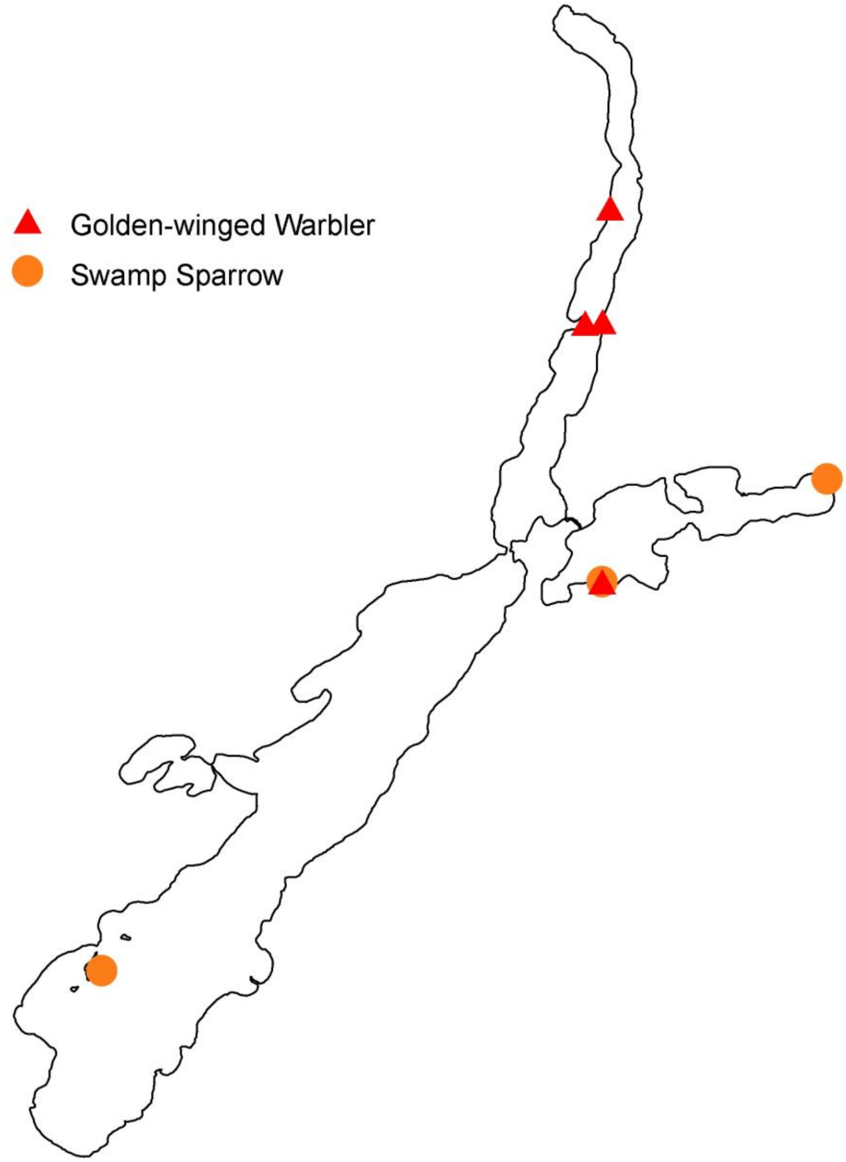
The most commonly documented species of greatest conservation need, the ovenbird, is a forest-dwelling species. It was found at 28 survey stations on Roosevelt Lake and eight stations on Lawrence Lake, and was distributed widely along the shorelines (Figure 38). The one eastern wood-pewee record came from the southeast edge of Roosevelt Lake, while the one white-throated sparrow was detected in a small bay along the southern edge of Lawrence Lake. The other forest-dependent species of greatest conservation need were scattered along the lake shorelines.

Figure 38. Distribution of forest habitat-dependent bird species of greatest conservation need in Roosevelt and Lawrence Lakes, May – June 2009.



The two wetland habitat-dependent species of greatest conservation need documented during the bird surveys were the golden-winged warbler and the swamp sparrow. The golden-winged warbler was detected at three stations in the north basin of Roosevelt Lake and at one station along the southern shoreline of Lawrence Lake (Figure 39). One swamp sparrow was heard on an island in the south basin of Roosevelt Lake, while the other was recorded on the far eastern edge of Lawrence Lake.

Figure 39. Distribution of wetland habitat-dependent bird species of greatest conservation need in Roosevelt and Lawrence Lakes, May – June 2009.



Bald eagles and common nighthawks both utilize a variety of habitat types. Bald eagles were documented at two survey stations on the western shoreline of Roosevelt Lake, while a common nighthawk was detected in the southeastern corner of the lake (Figure 40).

Figure 40. Distribution of bird species of greatest conservation need that occupy other habitats in Roosevelt and Lawrence Lakes, May – June 2009.

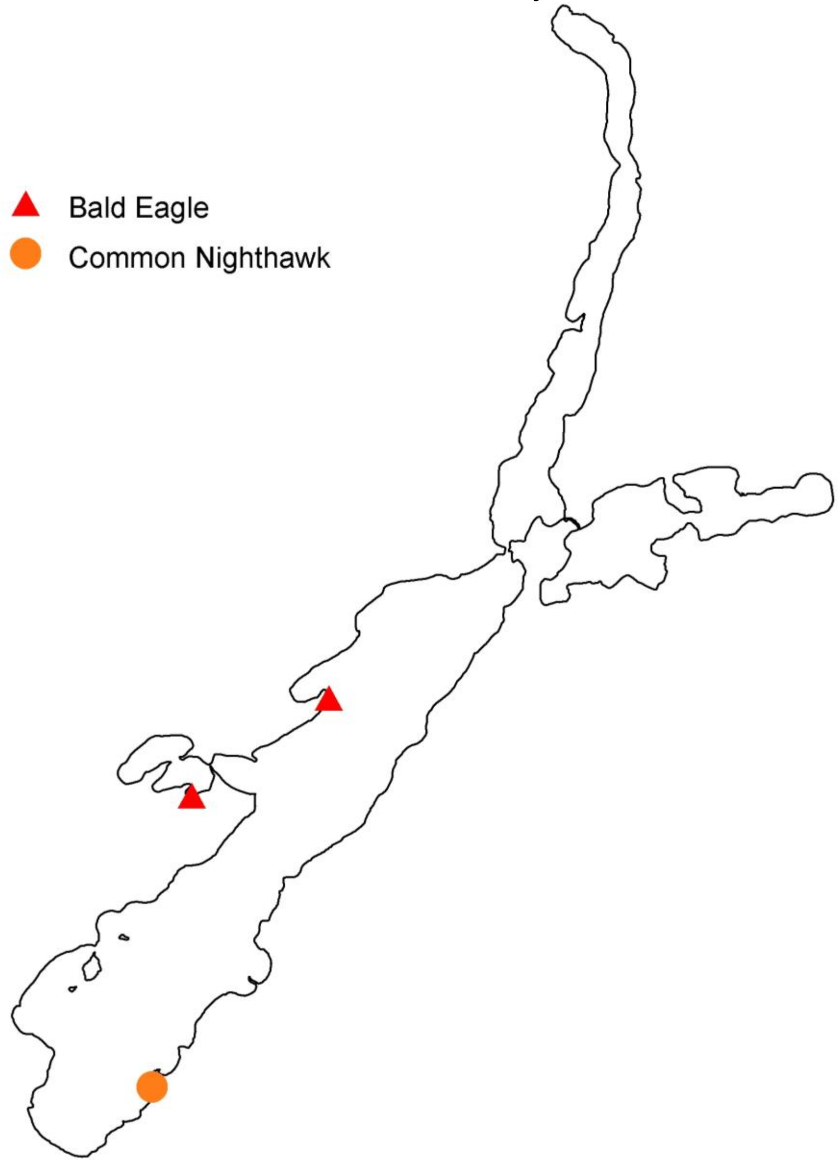


Table 3. Species list and frequency of occurrence of bird species identified during Roosevelt and Lawrence Lakes bird surveys, May – June 2009.

Description	Common Name	Scientific Name	Frequency of Occurrence[a]	
			Roosevelt	Lawrence
Waterfowl	Canada Goose	*Branta canadensis*	4	5
	Mallard	*Anas platyrhynchos*	5	–
	Common Goldeneye	*Bucephala clangula*	4	–
	Common Merganser	*Mergus merganser*	4	–
Loons	Common Loon*	*Gavia immer*	13	5
Herons/bitterns	Great Blue Heron	*Ardea herodias*	13	–
	Green Heron	*Butorides virescens*	11	5
Hawks/eagles	Osprey	*Pandion haliaetus*	3	10
	Bald Eagle*	*Haliaeetus leucocephalus*	3	–
	Sharp-shinned Hawk	*Accipiter striatus*	1	–
Sandpipers	Spotted Sandpiper	*Actitis macularius*	1	–
Gulls/terns	Ring-billed Gull	*Larus delawarensis*	4	5
	Caspian Tern	*Hydroprogne caspia*	1	–
Pigeons/doves	Mourning Dove	*Zenaida macroura*	–	10
Nightjars	Common Nighthawk*	*Chordeiles minor*	1	–
Hummingbirds	Ruby-throated Hummingbird	*Archilochus colubris*	5	5
Kingfishers	Belted Kingfisher	*Megaceryle alcyon*	13	30
Woodpeckers	Red-bellied Woodpecker	*Melanerpes carolinus*	5	10
	Yellow-bellied Sapsucker*	*Sphyrapicus varius*	13	–
	Downy Woodpecker	*Picoides pubescens*	3	–
	Hairy Woodpecker	*Picoides villosus*	7	5
	Northern Flicker	*Colaptes auratus*	5	5
	Pileated Woodpecker	*Dryocopus pileatus*	3	5
Flycatchers	Eastern Wood-Pewee*	*Contopus virens*	1	–
	Alder Flycatcher	*Empidonax alnorum*	7	5
	Least Flycatcher*	*Empidonax minimus*	4	5
	Eastern Phoebe	*Sayornis phoebe*	37	45
	Great Crested Flycatcher	*Myiarchus crinitus*	9	–
	Eastern Kingbird	*Tyrannus tyrannus*	9	20
Vireos	Warbling Vireo	*Vireo gilvus*	1	15
	Red-eyed Vireo	*Vireo olivaceus*	72	60
Jays/crows	Blue Jay	*Cyanocitta cristata*	32	35
	American Crow	*Corvus brachyrhynchos*	16	35
Swallows	Tree Swallow	*Tachycineta bicolor*	15	20
	Cliff Swallow	*Petrochelidon pyrrhonota*	1	–
	Barn Swallow	*Hirundo rustica*	9	15

Table 3, continued.

Description	Common Name	Scientific Name	Frequency of Occurrence	
			Roosevelt	Lawrence
Chickadees	Black-capped Chickadee	*Poecile atricapilla*	33	45
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	11	15
	White-breasted Nuthatch	*Sitta carolinensis*	11	5
Wrens	House Wren	*Troglodytes aedon*	5	–
Thrushes	Eastern Bluebird	*Sialia sialis*	1	–
	Veery*	*Catharus fuscescens*	1	10
	Hermit Thrush	*Catharus guttatus*	5	–
	American Robin	*Turdus migratorius*	36	65
Mockingbirds	Gray Catbird	*Dumetella carolinensis*	13	20
Waxwings	Cedar Waxwing	*Bombycilla cedrorum*	15	5
Warblers	Golden-winged Warbler*	*Vermivora chrysoptera*	4	5
	Nashville Warbler	*Vermivora ruficapilla*	–	5
	Yellow Warbler	*Dendroica petechia*	17	40
	Chestnut-sided Warbler	*Dendroica pensylvanica*	9	–
	Blackpoll Warbler	*Dendroica striata*	1	–
	Black-and-white Warbler	*Mniotilta varia*	33	15
	American Redstart	*Setophaga ruticilla*	12	–
	Ovenbird*	*Seiurus aurocapillus*	37	40
	Common Yellowthroat	*Geothlypis trichas*	36	60
Sparrows/allies	Chipping Sparrow	*Spizella passerina*	40	40
	Song Sparrow	*Melospiza melodia*	80	90
	Swamp Sparrow*	*Melospiza georgiana*	1	10
	White-throated Sparrow*	*Zonotrichia albicollis*	–	5
Cardinals/allies	Northern Cardinal	*Cardinalis cardinalis*	1	5
	Rose-breasted Grosbeak*	*Pheucticus ludovicianus*	1	5
Blackbirds	Red-winged Blackbird	*Agelaius phoeniceus*	23	85
	Common Grackle	*Quiscalus quiscula*	12	45
	Brown-headed Cowbird	*Molothrus ater*	1	5
	Baltimore Oriole	*Icterus galbula*	7	20
Finches	Pine Siskin	*Spinus pinus*	1	–
	American Goldfinch	*Spinus tristis*	35	50

[a]% – Percent of surveyed sample sites in which a bird species occurred in Roosevelt Lake (N = 75) and Lawrence Lake (N = 20).

* indicates a species of greatest conservation need.

Bird Species Richness

Objective

1. Calculate and map bird richness around the shorelines of Roosevelt and Lawrence 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 bird species diversity.

Methods

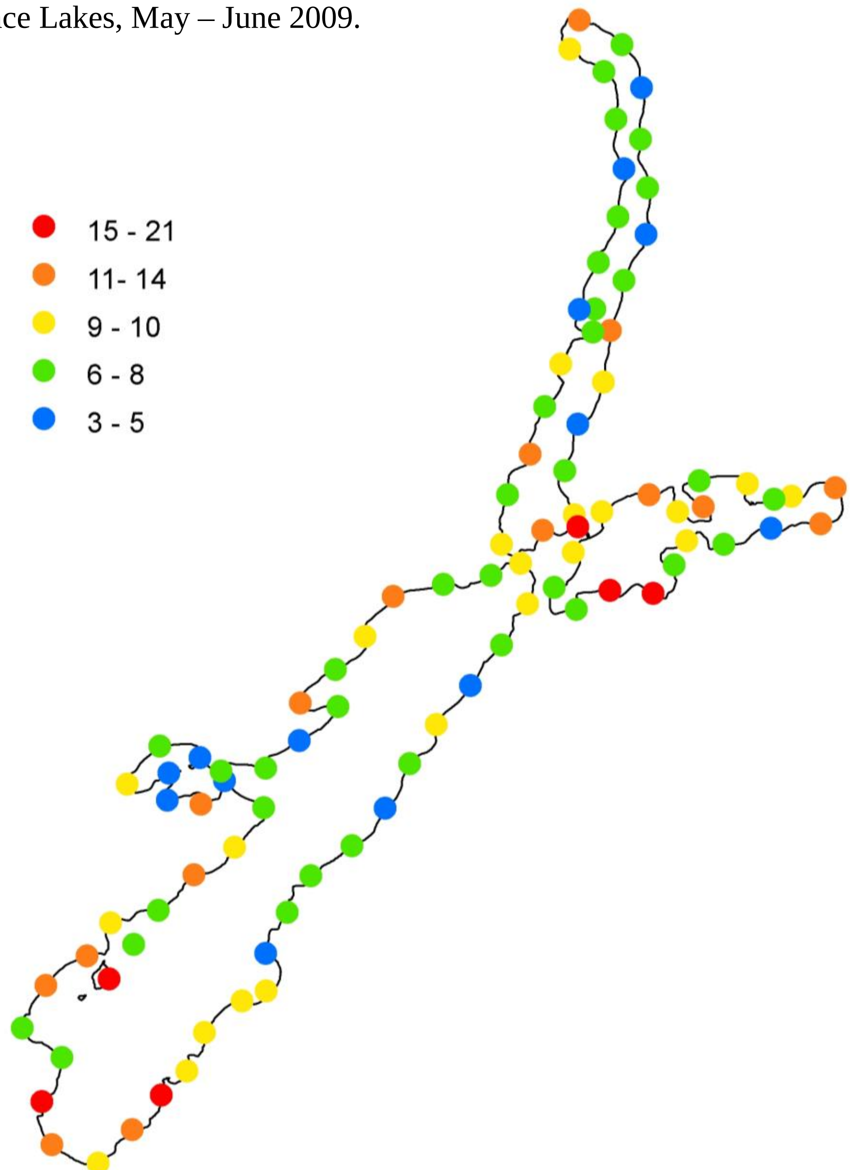
Bird species were documented during the point count and call-playback sampling surveys. At each sample station, surveyors identified and recorded the number of species found.

Results

Bird species diversity at Roosevelt and Lawrence Lakes ranged from three to 21 species at a single survey station (Figure 41). The survey station containing 21 species was located on Lawrence Lake; the maximum number of bird species at a single station on Roosevelt Lake was 18. An additional two survey sites on Lawrence Lake contained more than 15 species, and five sites had between 10 and 14 bird species recorded. Surveyors documented 10 or more bird species at nearly one-third (N = 23) of the Roosevelt Lake survey stations.

The maximum number of species of greatest conservation need documented at a single survey station was three. Two stations on each lake contained three SGCN, while between 35 – 45% of the sites did not have any species of greatest conservation need recorded.

Figure 41. Bird species richness (number of species per sample site) in Roosevelt and Lawrence Lakes, May – June 2009.



Loon Nesting Areas

Objectives

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

Introduction

Loon with two chicks on Roosevelt Lake, 2009.

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

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

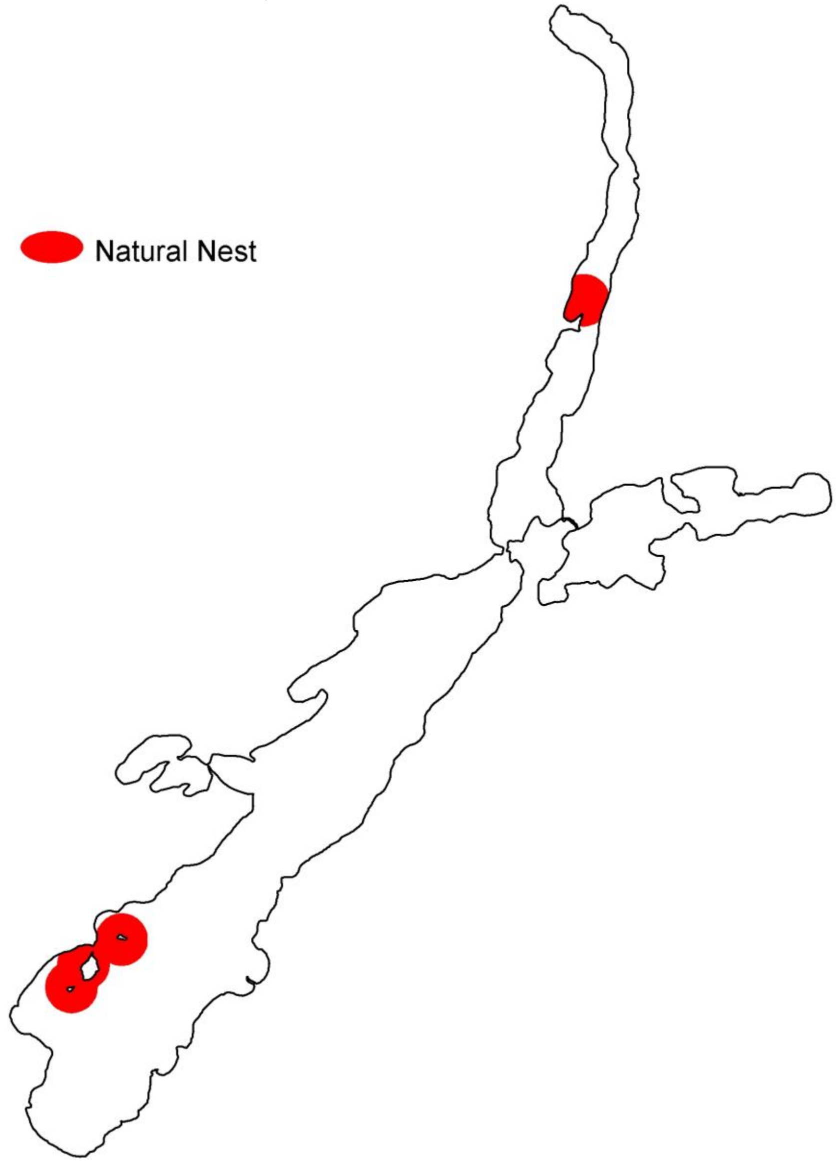
Methods

Using information from LoonWatcher reports and bird, fish, and vegetation survey crews, researchers mapped loon nesting locations in GIS. Mapped nests were buffered by 200 meters to account for locational uncertainty. Nests were identified as either natural or manmade (artificial platforms). All former and current natural nesting locations and artificial platforms used by loons were included in the maps and analysis; artificial platforms not utilized by loons were not included. Volunteers began reporting on Roosevelt Lake loons in 1983. There are no records of loon nesting areas on Lawrence Lake.

Results

Since 1983, four probable loon nesting areas have been identified on Roosevelt Lake (Figure 42). Three of the nesting areas are located on islands in the south basin, while the fourth was located on an island in the north lake basin. All three nesting areas in the south basin were occupied by loons in 2009. Active loon nesting areas have not been reported on Lawrence Lake.

Figure 42. Location of natural loon nests recorded on Roosevelt and Lawrence Lakes between 1983 and 2009.



Aquatic Frog Surveys

Objectives

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

Introduction

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

Target species for the frog surveys were the green frog (*Rana clamitans*) and the mink frog (*Rana septentrionalis*). 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.

Green frogs (Figure 43) are medium-sized, greenish or brownish frogs with small dark spots. The belly is often brighter in color than the back. A large tympanum (eardrum) helps identify the green frog. They can be found in a variety of habitats surrounding lakes, streams, marshes, and swamps, but are strongly associated with the shallow water of lakeshores. Although green frog populations are generally stable, regional declines and local extinctions have been noted.

Figure 43. Green frog

Photo by: Jeff LeClere, www.herpnet.net

Mink frogs (Figure 44) 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 44. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

Methods

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

Results

Target species
Frog surveys were conducted on Roosevelt and Lawrence Lakes during July 2009. Frogs were detected at 15 survey stations on Roosevelt Lake and 11 survey stations on Lawrence Lake (Figure 45). The vast majority of the frogs recorded during the surveys were green frogs; mink frogs were identified at only one survey station on Roosevelt Lake. Frogs were recorded along much of the shoreline of Lawrence Lake, but frog distribution in Roosevelt Lake was generally limited to the south basin.

At Roosevelt Lake survey stations where green frogs were present, estimates of abundance ranged from one to 20 individuals (Figure 46). Green frog abundance estimates on Lawrence Lake were all less than ten. Mink frogs were not recorded on Lawrence Lake (Figure 47). Fewer than 10 mink frog individuals were heard at one survey station on Roosevelt Lake.

Other species
One additional anuran species, the gray treefrog (*Hyla versicolor*), was documented during the frog surveys. Gray treefrogs were heard at 15 survey stations in Roosevelt Lake and three stations in Lawrence Lake. Index values for treefrogs ranged from 1 (individual frog calls were distinct, with no overlap) to 2 (individual frog calls distinct, but calls overlapped). Other frog or toad species that may be found near Roosevelt and Lawrence Lakes, such as wood frog (*Rana sylvatica*), spring peeper (*Pseudacris crucifer*), chorus frog (*Pseudacris triseriata*), leopard frog (*Rana pipiens*), and American toad (*Bufo americanus*), breed earlier in the year and are not strongly associated with larger lakes.

Figure 45. Distribution of mink and green frogs heard during Roosevelt and Lawrence Lakes frog surveys, July 2009.

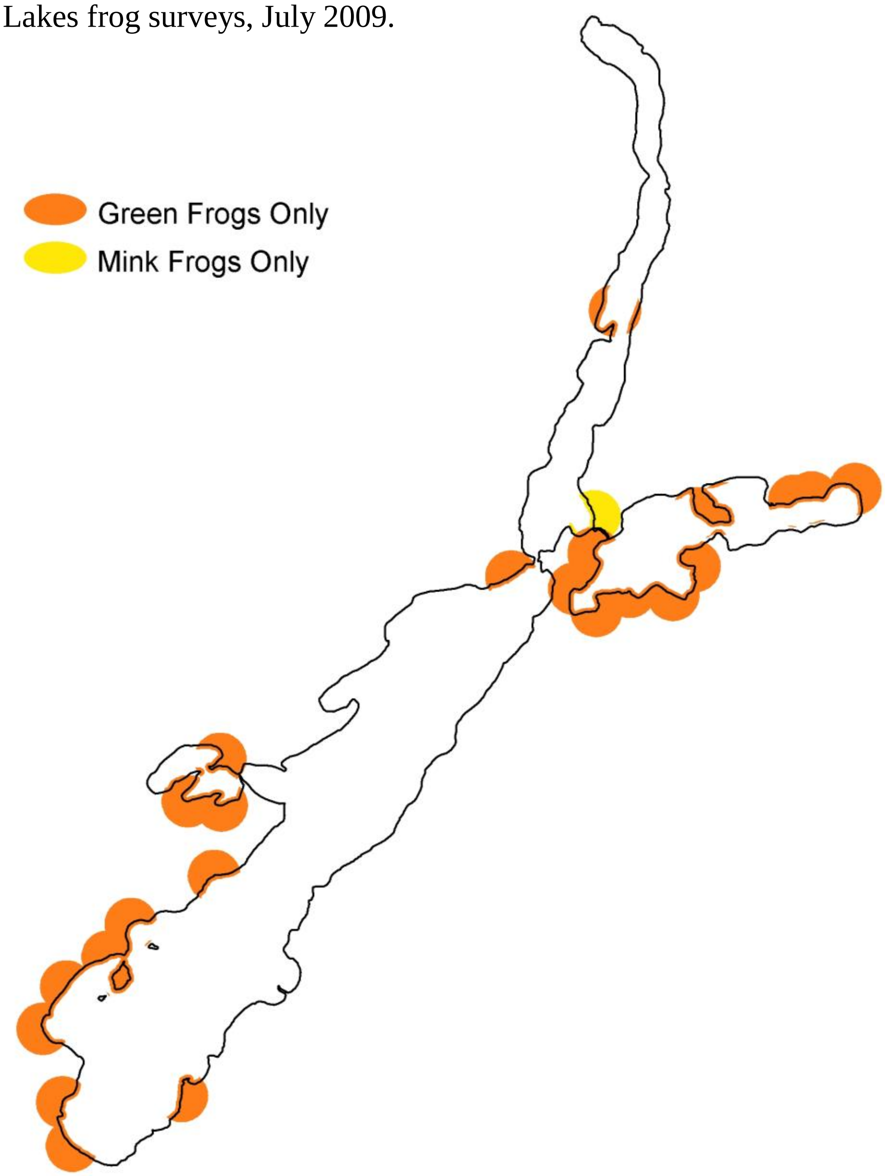


Figure 46. Abundance of green frogs heard during Roosevelt and Lawrence Lakes frog surveys, July 2009.

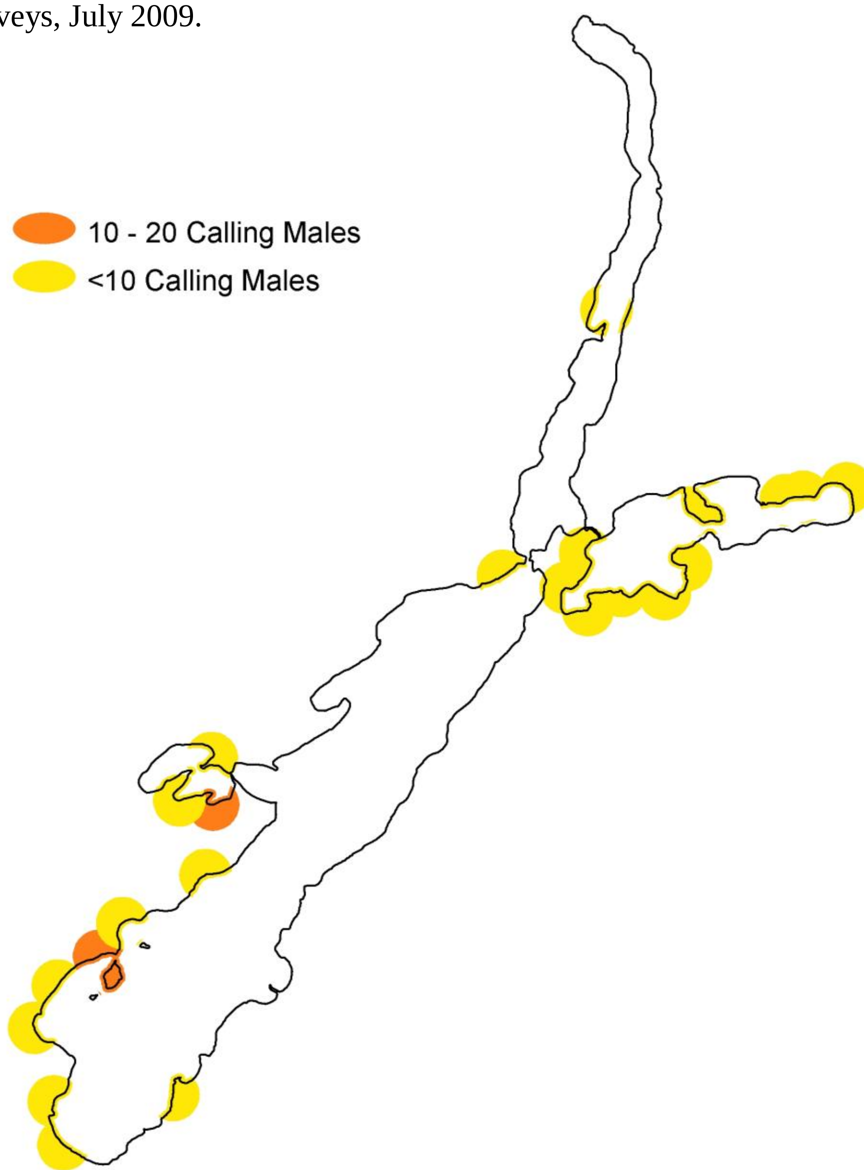
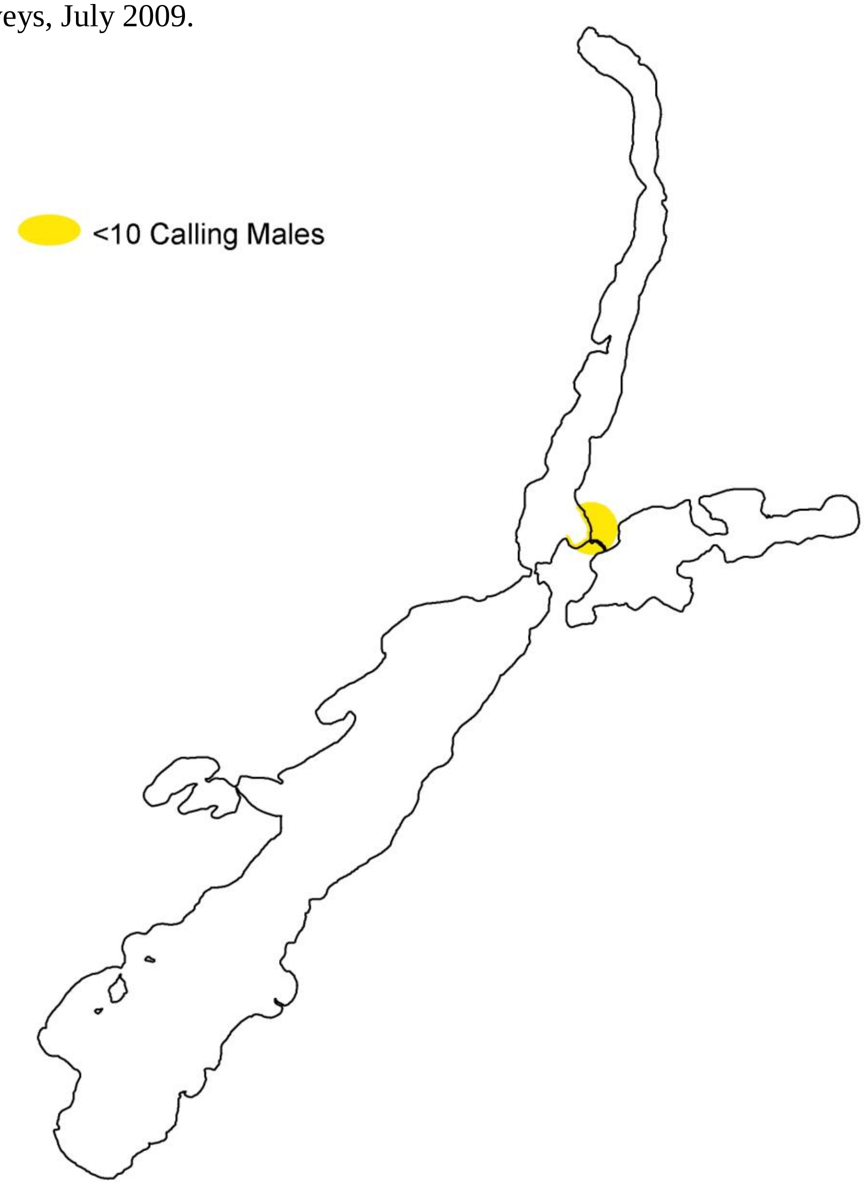


Figure 47. Abundance of mink frogs heard during Roosevelt and Lawrence Lakes frog surveys, July 2009.



Nongame Fish Surveys

Objectives

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

Introduction

Fish Species of Greatest Conservation Need

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

Pugnose shiners (*Notropis anogenus*; Figure 48) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess large eyes and a distinctively upturned mouth that gives them a “pugnose” appearance. They are secretive minnows, and are found often in schools of 15 to 35 individuals. Pugnose shiners inhabit clear lakes and low-gradient streams and are extremely intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 48. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (*Etheostoma microperca*; Figure 49) are Minnesota’s smallest fish, averaging only 25 – 38 mm in length. They are olive-brown in color with scattered dark brown spots and markings and four dark bars radiating from the eye. Males possess an extremely long pectoral fin. Least darters are found in clear, shallow areas of low-gradient streams or lakes. Extensive beds of muskgrass (*Chara* spp.) are a preferred habitat feature. Removal of vegetation, riparian area modification, and poor water quality all pose threats to the least darter.

Figure 49. Least darter

Photo by: Konrad Schmidt

Longear sunfish (*Lepomis megalotis*; Figure 50) 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 50. Longear sunfish

Photo by: Konrad Schmidt

Proxy species

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

Blackchin shiners (*Notropis heterodon*; Figure 51) 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 51. Blackchin shiner

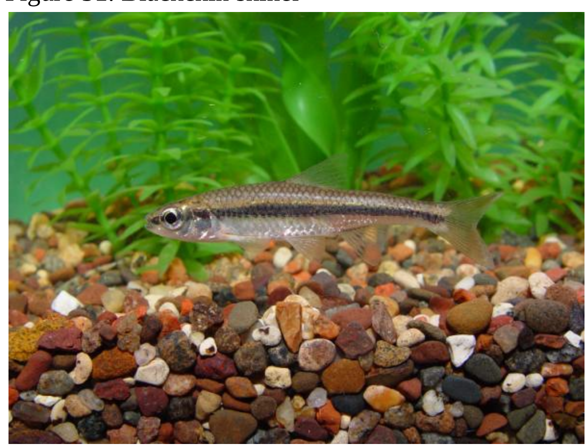


Photo by: Konrad Schmidt

Blacknose shiners (*Notropis heterolepis*; Figure 52) 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 52. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 53) 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 53. Banded killifish

Photo by: Konrad Schmidt

Methods

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

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

Results

Two near-shore fish species of greatest conservation need and three proxy species were identified during the Roosevelt and Lawrence Lakes nongame fish surveys. Least darters were documented at nine survey stations on Roosevelt Lake and at one survey station in Lawrence Lake (Figure 55). Between the two lakes, surveyors recorded nearly 20 individuals. One longear sunfish was detected at a survey station in the northeast corner of Lawrence Lake.

The banded killifish was the only proxy species that was documented in both Roosevelt and Lawrence Lakes (Figure 56). Surveyors counted over 200 individuals at 39 survey stations in Roosevelt Lake and approximately 20 individuals at nine stations in Lawrence Lake. Blackchin shiners were found at two survey stations, one within Lawrence Lake and one within the channel connecting the two lakes. One blacknose shiner was recorded at a survey station along the western edge of Roosevelt Lake.

One additional fish species of greatest conservation need, the greater redhorse (*Moxostoma valenciennesi*; Figure 54) was documented during the nongame fish surveys. Two greater redhorse were recorded at two survey stations in Roosevelt Lake. Although greater redhorse are not a near-shore species, they are sensitive to chemical pollutants and turbidity, and inhabit clear water rivers and streams.

Figure 54. Greater redhorse

The presence of fish species of greatest conservation need and proxy species may indicate minimal disturbance along some sections of shoreline. However, because populations of these species are at risk throughout their ranges, continued monitoring and maintenance are necessary to ensure continued existence of these populations. Limiting macrophyte removal, pesticide and herbicide use, and modification of the riparian zone will help maintain good water quality and a healthy aquatic plant community.

Aquatic plant biovolume at survey stations was approximately twice as high in Lawrence Lake as in Roosevelt Lake. In Lawrence Lake, biovolume was generally higher at sites where fish species of greatest conservation need were present than at sites where they were not. This difference was not noticeable in Roosevelt Lake. Substrate type at stations where species of greatest conservation need were present was primarily sand, but included silt and muck.

Thirty-five fish species were recorded at 95 survey stations in Roosevelt and Lawrence Lakes (Table 4). In both Roosevelt and Lawrence Lakes, bluegills were the most abundant and the most frequently documented species. Bluegills were identified at 100% of the survey stations in each of the lakes, and numbered over 5000 in total. Large numbers of mimic shiners and bluntnose minnows (over 1000 individuals) were also recorded in Roosevelt Lake. Other commonly found species included yellow perch, found at 90% of the survey stations in Roosevelt Lake, and largemouth bass, recorded at approximately 90% of the survey stations in Lawrence Lake. Eleven fish species that were recorded in Roosevelt Lake were not documented in Lawrence Lake. These species were emerald shiner, blacknose shiner, spottail shiner, mimic shiner, fathead minnow, creek chub, greater redhorse, tadpole madtom, tulibee, brook stickleback, and mottled sculpin. Blackchin shiners, black bullheads, and longear sunfish were found in Lawrence Lake but not in Roosevelt Lake.

During the nongame fish surveys, surveyors recorded several fish species previously undocumented in the lakes. Eight new species were identified in Roosevelt Lake, bringing the total historical observed fish community in the lake to 39 species. The newly recorded species were brook stickleback, central mudminnow, creek chub, emerald shiner, fathead minnow, least darter, mimic shiner, and mottled sculpin. Six new species were recorded in Lawrence Lake, including blackchin shiner, central mudminnow, common shiner, golden shiner, least darter, and longear sunfish. The historical observed fish community in this lake totals 29 species.

Figure 55. Distribution of rare near-shore fish species documented during Roosevelt and Lawrence Lakes fish surveys, July – August 2008.

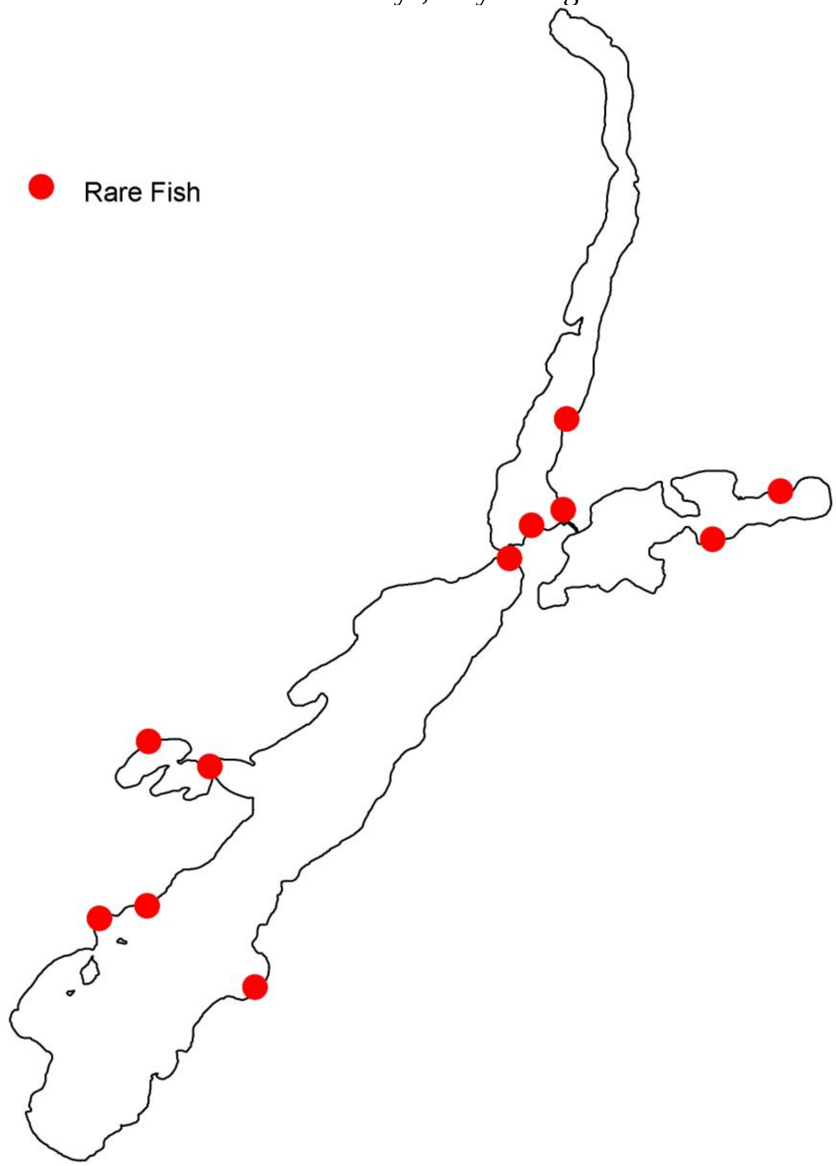


Figure 56. Distribution of fish proxy species documented during Roosevelt and Lawrence Lakes fish surveys, July – August 2008.

Table 4. Abundance and frequency of fish species identified during Roosevelt and Lawrence Lakes fish surveys, July – August 2008.

Description	Common Name	Scientific Name	Roosevelt		Lawrence	
			# [a]	% [b]	#	%
Bowfins	Bowfin	*Amia calva*	14	11	8	40
Minnows	Common shiner	*Luxilus cornutus*	15	15	1	5
	Golden shiner	*Notemigonus crysoleucas*	3	3	1	5
	Emerald shiner	*Notropis atherinoides*	1	1	–	–
	Blackchin shiner	*Notropis heterodon*	–	–	30	10
	Blacknose shiner	*Notropis heterolepis*	1	1	–	–
	Spottail shiner	*Notropis hudsonius*	32	15	–	–
	Mimic shiner	*Notropis volucellus*	~1100	35	–	–
	Bluntnose minnow	*Pimephales notatus*	~1100	67	106	45
	Fathead minnow	*Pimephales promelas*	28	13	–	–
	Creek chub	*Semotilus atromaculatus*	1	1	–	–
Suckers	White sucker	*Catostomus commersoni*	5	3	1	5
	Greater redhorse*	*Moxostoma valenciennesi*	2	3	–	–
Catfishes	Black bullhead	*Ameiurus melas*	–	–	1	5
	Yellow bullhead	*Ameiurus natalis*	17	15	26	65
	Tadpole madtom	*Noturus gyrinus*	57	33	–	–
Pikes	Northern pike	*Esox lucius*	3	4	2	10
Mudminnows	Central mudminnow	*Umbra limi*	7	3	3	10
Salmon	Tulibee (cisco)	*Coregonus artedi*	1	1	–	–
Killifishes	Banded killifish	*Fundulus diaphanus*	220	52	22	45
Sticklebacks	Brook stickleback	*Culaea inconstans*	1	1	–	–
Sculpins	Mottled sculpin	*Cottus bairdi*	62	19	–	–
Sunfishes	Rock bass	*Ambloplites rupestris*	238	84	23	65
	Green sunfish	*Lepomis cyanellus*	347	84	23	40
	Pumpkinseed	*Lepomis gibbosus*	113	52	22	50
	Bluegill	*Lepomis macrochirus*	~4300	100	808	100
	Longear sunfish*	*Lepomis megalotis*	–	–	1	5
	Smallmouth bass	*Micropterus dolomieu*	247	47	–	–
	Largemouth bass	*Micropterus salmoides*	294	81	110	90
	Black crappie	*Pomoxis nigromaculatus*	239	72	13	40
Perches	Iowa darter	*Etheostoma exile*	189	45	1	5
	Least darter*	*Etheostoma microperca*	18	12	1	5
	Johnny darter	*Etheostoma nigrum*	164	64	32	50
	Yellow perch	*Perca flavescens*	599	89	70	50
	Walleye	*Sander vitreus*	7	9	2	5

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

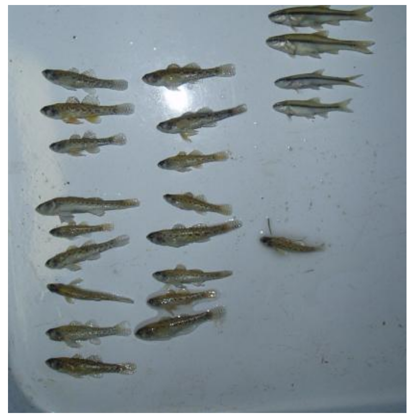
[b] % – Percent of surveyed sample sites in which a species occurred in Roosevelt (N=75) and Lawrence (N=20) Lakes.

Aquatic Vertebrate Richness

Objective

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

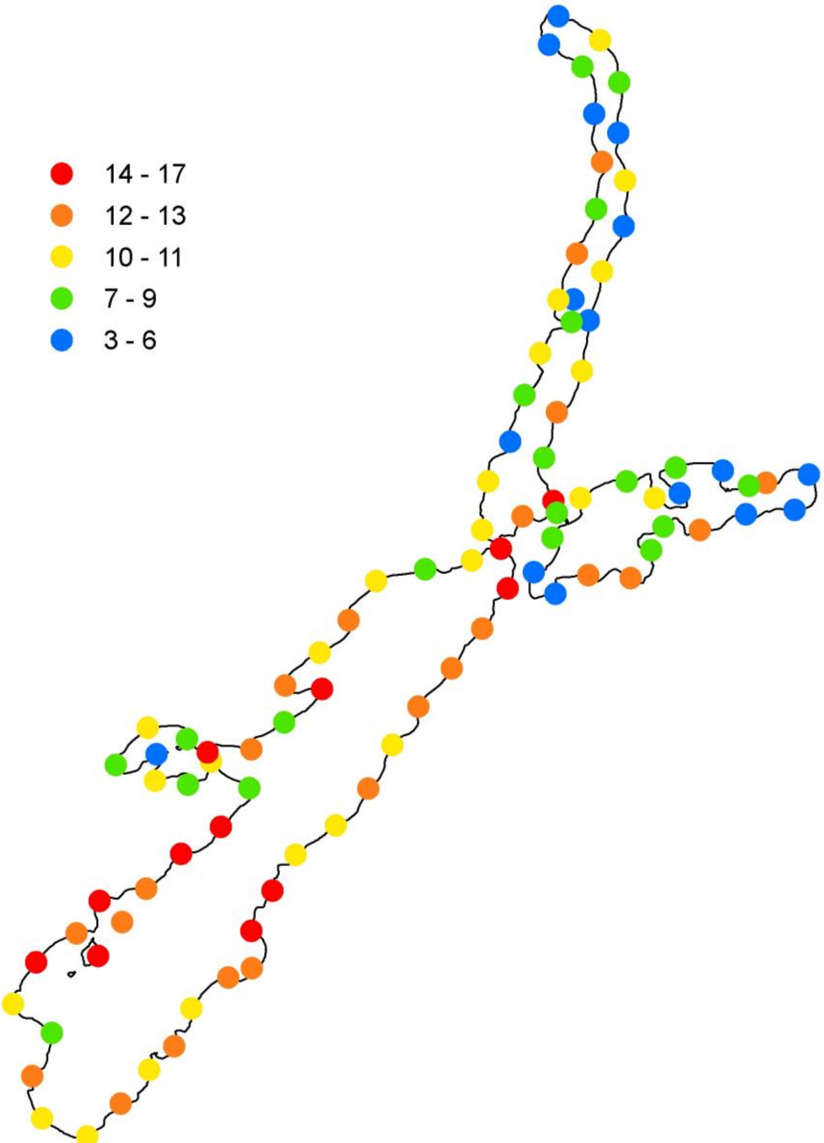
Aquatic vertebrate species were documented during the nongame fish sampling surveys. All aquatic vertebrates, including fish, frogs, and turtles, captured during trapnetting, seining, and electrofishing surveys were identified to the species level. Young-of-year animals that could not be identified to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

Results

Aquatic vertebrate richness in Roosevelt and Lawrence Lakes ranged between three and 17 species (Figure 57). One survey station (along the western shoreline of Roosevelt Lake's south basin) contained 17 aquatic vertebrate species, while an additional six stations in this lake contained between 15 and 16 species. Ten or more aquatic vertebrate species were found at over 70% of the Roosevelt Lake survey stations. Maximum aquatic vertebrate richness in Lawrence Lake was 12 species. Surveyors recorded 12 species at four different survey stations in Lawrence Lake.

The majority of the aquatic vertebrates documented during the surveys were fish, although green frogs, painted turtles, and snapping turtles were also recorded. Hybrid sunfish were detected in both Roosevelt and Lawrence Lakes, but were not included in the analysis.

Figure 57. Aquatic vertebrate species richness (number of species per survey station) in Roosevelt and Lawrence Lakes, July – August 2008.



Other Rare Features

Objective

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

Results

Twelve rare features were identified at Roosevelt and Lawrence Lakes (Figure 58). These features represent seven locations of fish species of Special Concern, three locations of a bird species of Special Concern, and two locations of a plant species of Special Concern. The publication of exact descriptive and locational information is prohibited in order to help protect this rare species.

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

Figure 58. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Roosevelt and Lawrence Lakes shorelines.

Bay Delineation

Objective

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

Introduction

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

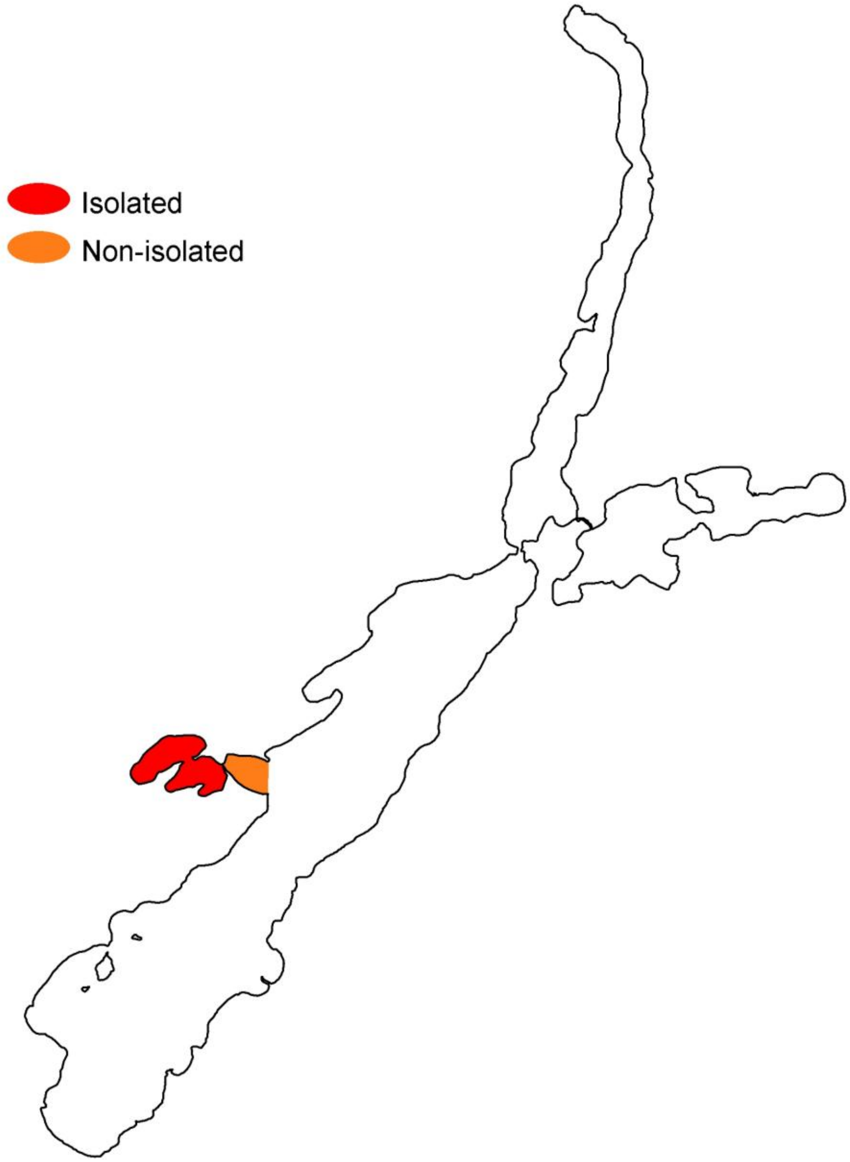
Methods

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

Results

One isolated bay and one non-isolated bay were identified in Roosevelt Lake (Figure 59). Both bays are located along the western edge of the south basin. No bays were identified in Lawrence Lake.

Figure 59. Location of isolated and non-isolated bays in Roosevelt and Lawrence Lakes.



II. Ecological Model Development

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

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

Scores for each of the layers were summed (Figure 60). This map represents an index of sensitivity; those points with higher total scores are highly sensitive, whereas points with lower total scores have lower sensitivity.

Once the total score index was developed for the shoreline, clusters of points along the shoreline with similar values were identified using GIS (Figure 61). The clusters with high values (i.e., areas of highly sensitive shoreline) were buffered by ¼ mile. These buffered areas were defined as most likely highly sensitive lakeshore areas. These areas will be forwarded to the local government for potential designation as resource protection areas (Figure 62).

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

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

Table 5, continued.

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

Table 5, continued.

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

Figure 60. Total score layer created by summing scores of all 14 - 15 variables. Highest total scores represent the most sensitive areas of shoreline.

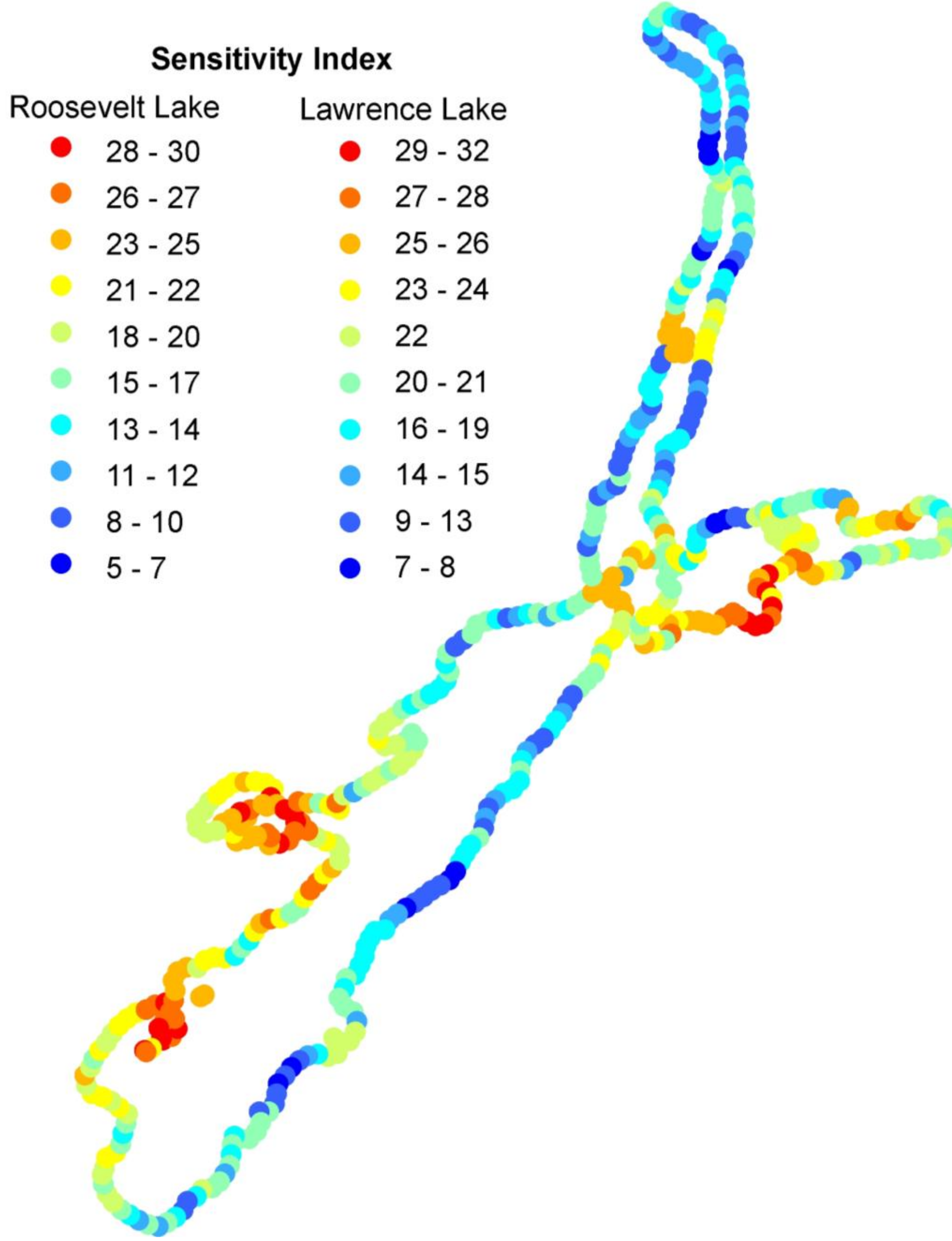


Figure 61. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland).

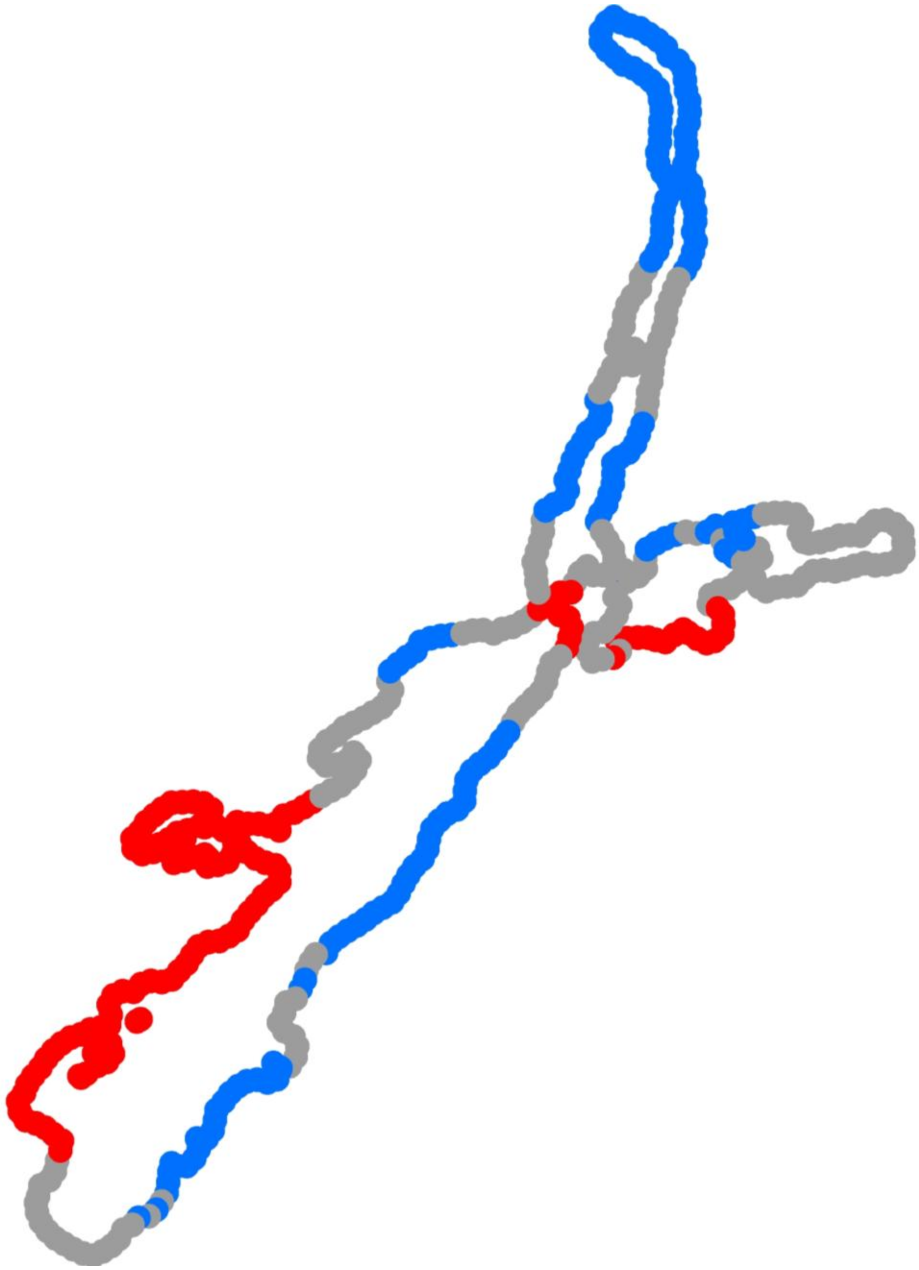
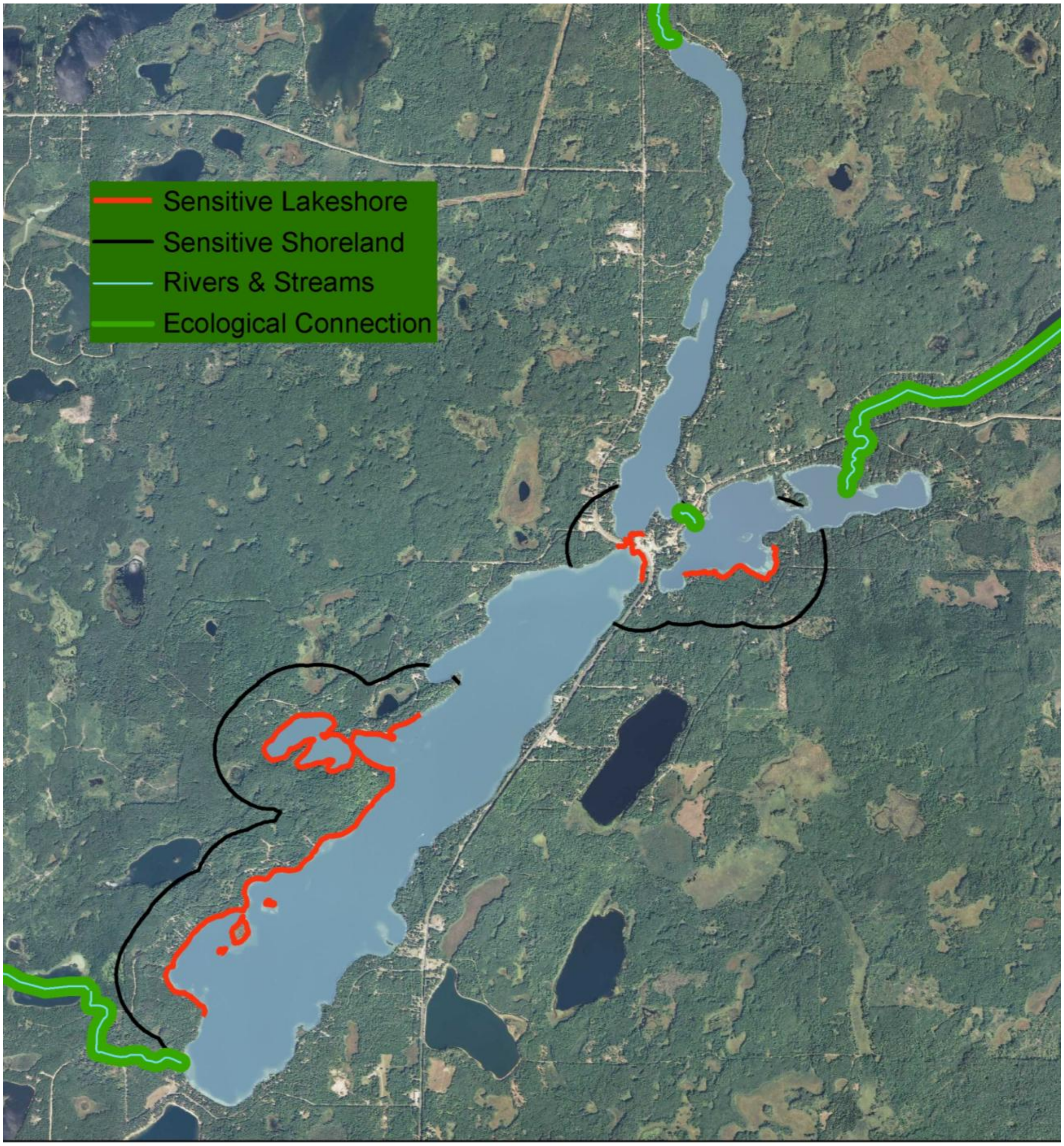


Figure 62. The Roosevelt Lake and Lawrence Lake sensitive lakeshore areas identified by the ecological model and ecological connections.



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 organisms within a watershed. Organisms can move between existing habitats, colonize new areas, or recolonize former habitat in the wake of local extinctions. The inlet and outlet of Roosevelt Lake, the inlet of Lawrence Lake, and the channel connecting the two lakes were all identified as ecological connections. Spring Brook is the inlet of Roosevelt Lake, while Lawrence Lake receives flow from Leavitt Lake. The outlet of Roosevelt Lake flows first into Pug Hole Lake before entering a number of other lakes and eventually reaching the Mississippi River. Depending on the existing shoreland classification of these rivers, the County may use the ecological connection recommendation to consider reclassifying to a more protective river class. The channel connecting Roosevelt and Lawrence Lakes also allows for the movement of fish and other species between the two lakes.

Other Areas of Ecological Significance

There are additional aquatic areas of ecological significance in Roosevelt and Lawrence Lakes that contain important aquatic plant communities but these sites are not necessarily associated with priority shoreland features. These are also sites that may not typically be associated with abundant aquatic plants or certain rare fish because they occur along less protected / higher energy shorelines (not bays) and are dominated by hard substrates. Often, these sites are too small to warrant inclusion as part of a shoreline protection district, but their small size is a defining feature that adds to their importance within the lake. Identifying these sites is important, although exact delineation of their boundaries can be difficult because they occur in the water and may be patchy in distribution.

Sensitive Lakeshore

Several areas on Roosevelt and Lawrence Lakes supported a high diversity of plant and wildlife species, including species of greatest conservation need. These areas also contained critical habitat, such as emergent and floating-leaf vegetation. The southwestern shoreline of Roosevelt Lake, where the two basins of Roosevelt Lake meet, and the southern shoreline of Lawrence Lake were identified by the ecological model as both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby may have significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. The ecological connections are also important components of the lake ecosystems. They provide habitat connectivity between Roosevelt Lake and Lawrence Lake, as well as between the two lakes and nearby habitat. They allow movement of animals from various populations, increasing diversity. Habitat connectivity also allows animals with different vegetation requirements during different life stages to access those habitats. Protection of both the shoreline itself and the habitat surrounding the shoreline will be the most effective way to preserve the plant and animal communities in and around Roosevelt and Lawrence Lakes, and the value of the lakes themselves.

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Appendix 1. Shoreline emergent aquatic plants of Roosevelt and Lawrence Lakes, 2008.

Description	Common Name	Scientific Name	Survey Type	
			Roosevelt	Lawrence
SHORELINE EMERGENT	Swamp milkweed	*Asclepias incarnata*	1, 2	1
	White-flowered aster	*Aster cf. borealis*	2	–
	Beggar ticks	*Bidens* sp.	2	–
	Brome grass	*Bromus* sp.	2	–
	Marsh bellflower	*Campanula aparinoides*	2	–
	Bottle brush sedge	*Carex comosa*	1	–
	Bottlebrush sedge	*Carex hystricina*	2	–
	Lake sedge	*Carex lacustris*	2	1
	Beaked sedge	*Carex utriculata*	–	1
	Bulb-bearing water hemlock	*Cicuta bulbifera*	1, 2	–
	Canada rush	*Juncus canadensis*	1	–
	Species of rush	*Juncus filiformis*	1	–
	Common boneset	*Eupatorium perfoliatum*	1	–
	Spotted joe-pye weed	*Eutrochium maculatum*	1, 2	1
	Jewelweed	*Impatiens capensis*	1, 2	–
	Cut-leaved bugleweed	*Lycopus americanus*	–	1
	Water horehound	*Lycopus uniflorus*	2	–
	Swamp candles	*Lysimachia terrestris*	–	1
	Wild mint	*Mentha arvensis*	2	–
	Small forget-me-not	*Myosotis laxa*	1	1
	True forget-me-not	*Myosotis scorpoides*	2	1
	Smartweed	*Persicaria amphibia*	2	–
	Reed canary grass	*Phalaris arundinacea*	1, 2	1
	Turf grass	*Poa* sp.	2	–
	Water dock	*Rumex* sp.	2	–
	Dark green bulrush	*Scirpus atrovirens*	1	1
	Woolgrass	*Scirpus cyperinus*	2	–
	Red-tinged bulrush	*Scirpus microcarpus*	–	1
	Marsh skullcap	*Scutellaria galericulata*	2	–
SHORELINE SHRUBS and TREES	Alder	*Alnus incana*	2	–
	Red-osier dogwood	*Cornus sericea*	2	–
	Ash	*Fraxinus* sp.	2	–
	Tamarack	*Larix laricina*	2	–
	Black spruce	*Picea mariana*	2	–
	Willow	*Salix* sp.	1, 2	1
	White cedar	*Thuja occidentalis*	2	–
UPLAND FORBS	Thistle	*Cirsium* sp.	2	–
	Dandelion	*Taraxacum* sp.	2	–

1. Myhre, K. July 21 and 22, 2008 (Minnesota County Biological Survey)
2. Perleberg, D. August 20, 2008 (nearshore vegetation plots)

Nomenclature follows MNTaxa 2009.

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

Common Name	Scientific Name
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Sharp-shinned Hawk	*Accipiter striatus*
Spotted Sandpiper	*Actitis macularia*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Hydroprogne caspia*
Mourning Dove	*Zenaida macroura*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Tree Swallow	*Tachycineta bicolor*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*

Appendix 2, continued.

Common Name	**Scientific Name**
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Golden-winged Warbler	*Vermivora chrysoptera*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Blackpoll Warbler	*Dendroica striata*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Pine Siskin	*Spinus pinus*
American Goldfinch	*Spinus tristis*
House Sparrow	*Passer domesticus*

Appendix 3. Bird species list. Includes all species within Lawrence Lake and shoreland recorded during bird surveys and casual observation, May – June 2009.

Common Name	**Scientific Name**
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Osprey	*Pandion haliaetus*
Ring-billed Gull	*Larus delawarensis*
Mourning Dove	*Zenaida macroura*
Whip-poor-will	*Caprimulgus vociferus*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Eastern Kingbird	*Tyrannus tyrannus*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Tree Swallow	*Tachycineta bicolor*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Veery	*Catharus fuscescens*
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*
Black-and-white Warbler	*Mniotilta varia*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*

Appendix 3, continued.

Common Name	**Scientific Name**
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	*Spinus tristis*