Final Report
Sensitive Lakeshore Survey
Big Portage Lake (11-0308-00)
Deep Portage Lake (11-0237-00)
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

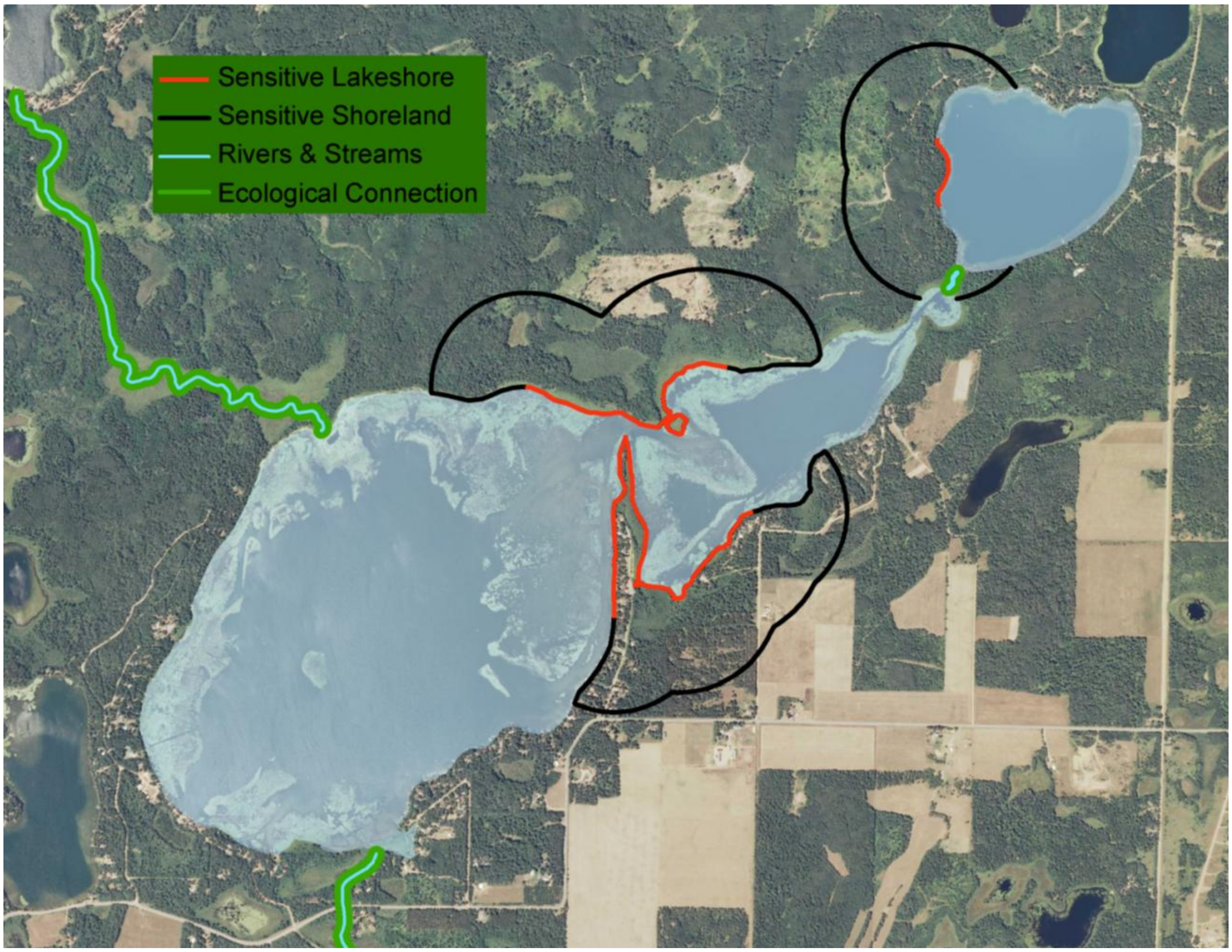
Thirty-three native aquatic plant taxa were found in Big Portage and Deep Portage Lakes, including five emergent, five floating-leaf, and 23 submerged or free-floating taxa. More than 30 shoreline emergent plant taxa were also recorded. Over 390 acres of Big Portage Lake was covered by emergent and floating-leaf plant beds, and fifteen acres of emergent and floating-leaf beds were mapped in Deep Portage Lake. Submerged plants were found to a depth of 16 feet in Big Portage Lake and to a depth of 20 feet in Deep Portage Lake. In both lakes, plants were most common from shore to ten feet in depth; approximately 95% of the sample sites within this zone contained vegetation. Muskgrass was the most frequently found submerged plant, though bladderwort, coontail, and several pondweed species were also common. Five unique aquatic plant species were documented during the surveys.

Two fish species of greatest conservation need were documented during the 2008 nongame fish surveys. Longear sunfish were found in Deep Portage Lake, while pugnose shiners were identified in Big Portage Lake. In total, 28 fish species were documented during the 2008 surveys. Bluegills and largemouth bass were found most frequently; they were recorded at 100% of the survey stations in Deep Portage Lake and at nearly 90% of the stations in Big Portage Lake. Surveyors also recorded five fish species not previously documented in Big Portage Lake and eleven species previously undocumented in Deep Portage Lake. Both green frogs and mink frogs were identified during Big Portage Lake frog surveys, and green frogs were recorded at nearly all Deep Portage Lake survey stations.

During the 2009 field season, surveyors documented 76 bird species on Big Portage and Deep Portage Lakes, including 18 species of greatest conservation need. The highest species counts and greatest diversity were found on Big Portage Lake. The veery was the most frequently detected species of greatest conservation need, while song sparrows were most frequently detected overall.

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

The ecological model identified three primary sensitive lakeshore areas to be considered for potential resource protection districting by Cass County. In addition, the inlet and outlet of Big Portage Lake, as well as the channel connecting Big Portage and Deep Portage 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 Big Portage Lake and Deep Portage Lake sensitive lakeshore areas.

Lake Descriptions

Big Portage (DOW 11-0308-00) and Deep Portage Lakes (DOW 11-0237-00) are located in Cass County, north-central Minnesota (Figure 1). These lakes are part of the Pine River Watershed. Big Portage Lake receives flow from Norway Creek on the northwest side (Figure 2). The Brook River exits Big Portage Lake on the southwest side and continues south and east before eventually meeting the Mississippi River.

Big Portage Lake has a surface area of 904 acres and eight miles of shoreline. It is comprised of two distinct basins separated by a shallow channel. Deep Portage Lake has a surface area of 129 acres and two miles of shoreline. It is connected to the east basin of Big Portage Lake by a small channel.

The southern shores of both Big Portage and Deep Portage Lakes are privately owned, and have been developed with residential homes. State or county-owned areas occur on the north end. A public access is located on the east shore of Big Portage Lake.

Figure 1. Location of Big Portage and Deep Portage Lakes in Cass County, Minnesota.

Big Portage Lake is primarily shallow. It has a maximum depth of 23 feet, and 95% of the lake is less than 15 feet deep. Deep Portage Lake has a maximum depth of 105 feet, and only 25% of the basin is less than 15 feet in depth (Figure 3).

Both Big Portage Lake and Deep Portage Lake are mesotrophic, or enriched with moderate levels of nutrients. The average Secchi depth (which measures water transparency) of Big Portage Lake between 1986 and 2006 was approximately 8 feet (MPCA 2008). The average Secchi depth of Deep Portage Lake during this same time was nearly 14 feet (MPCA 2008).

Figure 2. Features of Big Portage and Deep Portage Lakes.

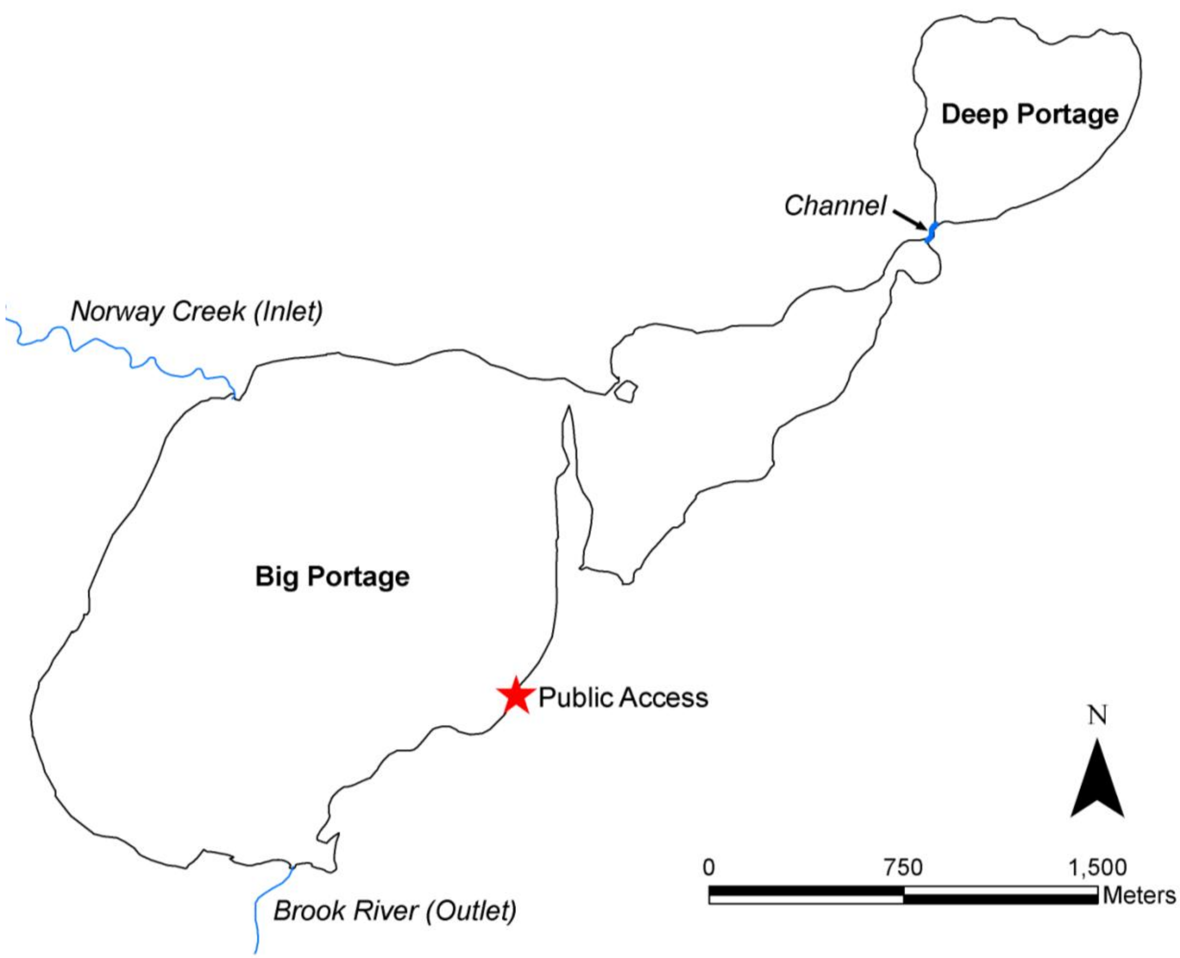
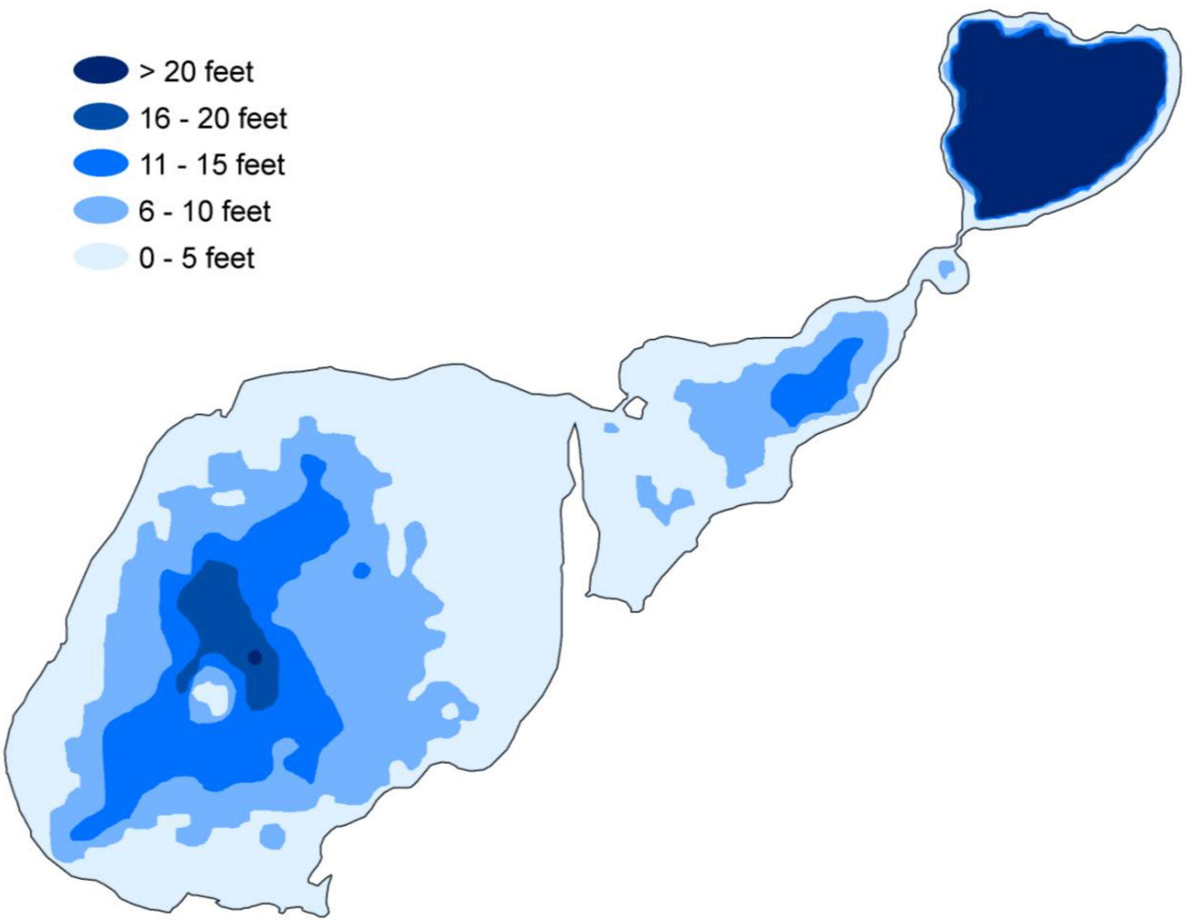


Figure 3. Depth contours of Big Portage and Deep Portage Lakes (based on 2008 survey data).



I. Field Surveys and Data Collection

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

Pugnose shiner photo courtesy of Konrad Schmidt

Wetlands

Objective

1. Map wetlands within the extended state-defined shoreland area (within 1320 feet of shoreline) of Big Portage and Deep Portage 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 Big Portage or Deep Portage Lake ordinary high water marks were excluded from this analysis.

Results

Approximately 155 acres, or 14% of the Big Portage Lake shoreland area (area within 1320 feet of the shoreline), are described as wetlands by NWI. Approximately 21 acres, or five percent of the Deep Portage Lake shoreland area, are described as wetlands. Wetlands were most abundant along the northern shoreline of Big Portage Lake, near the channel connecting the two basins of Big Portage Lake, and along the southwestern edge of Big Portage Lake (Figure 4). Several moderately large wetland complexes also occurred off the northwestern edge of Deep Portage Lake.

The dominant wetland type was the palustrine scrub-shrub system (Cowardin et al. 1979), dominated by deciduous or evergreen shrubs. The water regime in these wetland areas varied from seasonally flooded to saturated. Smaller complexes of emergent wetlands (Cowardin et al. 1979), characterized by herbaceous, emergent wetland vegetation, and forested wetlands, characterized by deciduous and evergreen trees, also occurred within the shoreland areas.

Figure 4. Wetlands within 1320 feet of Big Portage and Deep Portage Lakes shorelines.

Hydric Soils

Objective

1. Map hydric soils within the extended state-defined shoreland area (within 1320 feet of shoreline) of Big Portage and Deep Portage Lakes

Introduction

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

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

Methods

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

Results

Over 20%, or nearly 250 acres, of the shoreland area (area within 1320 feet of the shoreline) of Big Portage Lake was comprised of hydric soils. Some of the largest areas occurred on the northern shore of the lake and near the channel connecting the two lake basins (Figure 5). Soil types ranged from loam to muck to peat, and included combinations of the soil types, such as loamy sand and mucky peat. Most soils were very poorly drained and had a very high organic matter content.

Less than five percent (19 acres) of the Deep Portage shoreland area was comprised of hydric soils. These complexes were scattered around the shoreline, and included muck and muck/loam soil types.

Figure 5. Hydric soils within 1320 feet of Big Portage and Deep Portage Lake shorelines.

Plant Surveys

Objectives

1. Record presence and abundance of all aquatic plant taxa
2. Describe distribution of vegetation in Big Portage and Deep Portage 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 Big Portage and Deep Portage Lakes were conducted in June and September 2008. Surveys included a lakewide assessment of vegetation at over 900 sample stations, characterization of shoal substrate types, and mapping of emergent and floating-leaf plant beds.

Thirty-three native aquatic plant taxa were found, including five emergent, five floating-leaf, and 23 submerged or free-floating taxa. More than 30 shoreline emergent plant taxa were also recorded.

Within the shore to five feet depth zone, 88% of the sample sites in Big Portage Lake and 70% of the sample sites in Deep Portage Lake contained at least one emergent or floating-leaf plant. More than 40% (392 acres) of Big Portage Lake was covered by emergent and floating-leaf plant beds and wild rice (*Zizania palustris*) was the dominant species. Fifteen acres of emergent and floating-leaf beds were mapped in Deep Portage Lake and bulrush (*Schoenoplectus* sp.) was the most common plant.

Submerged plants were found to a depth of 16 feet in Big Portage Lake and to a depth of 20 feet in Deep Portage Lake. In both lakes, plants were most common from shore to ten feet in depth; approximately 95% of the sample sites within this zone contained vegetation. Muskgrass (*Chara* sp.) was the most frequently found submerged plant and occurred in 45% of the Big Portage sites and in 88% of the Deep Portage sites. Other commonly occurring submerged species were flat-stem pondweed (*Potamogeton zosteriformis*), coontail (*Ceratophyllum demersum*), greater bladderwort (*Utricularia vulgaris*), and bushy pondweed (*Najas flexilis/guadalupensis*).

Unique submerged and emergent aquatic plants documented during the surveys included humped bladderwort (*Utricularia gibba*), lesser bladderwort (*U. minor*), flat-leaved bladderwort (*U. intermedia*), water arum (*Calla palustris*) and cottongrass (*Eriophorum* sp.).

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 Big Portage and Deep Portage 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.

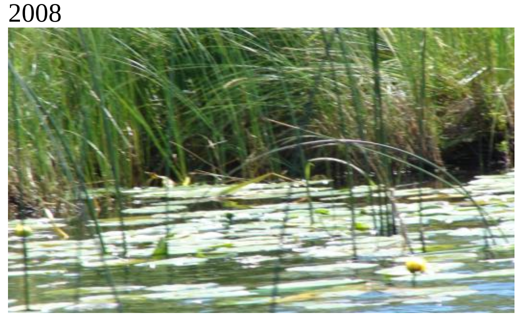
Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant 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.

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. 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.

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 6). 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.

Figure 6. Bulrush bed in Big Portage Lake, 2008



Bulrush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans.

Figure 7. Wild rice

Wild rice (*Zizania palustris*; Figure 7) is an emergent annual plant that reproduces each year from seed set in the previous fall. Wild rice is most commonly found in lakes of central and northern Minnesota. Cass County is one of five Minnesota counties with the highest concentration of lakes supporting natural wild rice stands (MN DNR 2008b). Wild rice generally requires habitat with some water flow, such as lakes with inlets and outlets. This plant most often is found in water depths of 0.5 to three feet in soft substrates (MN DNR 2008b). Wild rice is one of the most important waterfowl foods in North America and is used by more than 17 species of wildlife listed by the Minnesota Department of Natural Resources as "species of greatest conservation need" (MN DNR 2008b). Other ecological benefits associated with wild rice stands include habitat for fish and aquatic invertebrates, shoreline protection and stabilization, and nutrient uptake. This plant also has special cultural and spiritual significance to the Ojibwe people and wild rice harvest provides important economic benefits to local economies (MN DNR 2008b).

Figure 8. White waterlily

Floating-leaf plants may occur in solid beds or mixed with emergent plants. Different species of floating-leaf plants can be distinguished by their leaf shape and flower color. White waterlily (*Nymphaea odorata*; Figure 8) has showy white flowers and round leaves with radiating veins. Yellow waterlily (*Nuphar variegata*; Figure 9) has smaller yellow flowers and oblong leaves with parallel veins.

Figure 9. Yellow waterlily

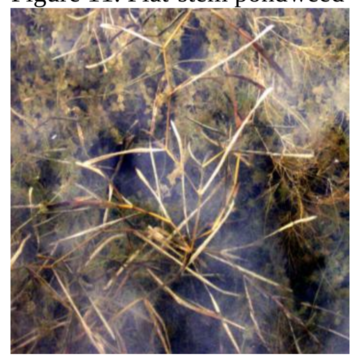
Submerged plants

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.

Figure 10. Muskgrass

Muskgrass (*Chara* sp.; Figure 10) 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 11. Flat-stem pondweed



Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 11) 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 produce flowers that extend above the water. These pondweeds are anchored to the lake bottom by rhizomes and overwinter by winter buds.

Figure 12. Coontail

Coontail (*Ceratophyllum demersum*; Figure 12) 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 13. Greater bladderwort

Greater bladderwort (*Utricularia vulgaris*; Figure 13) is an entirely submerged plant except during bloom when its small, showy yellow flowers extend above the water. This plant is weakly rooted to the substrate and may drift freely through the water column. It reproduces by fragments and winter buds that can float to new areas of the lake. Greater bladderwort is an insectivorous plant and uses its small "bladders" to trap invertebrates. Greater bladderwort prefers soft substrates like muck and silt (Nichols 1999b). Greater bladderwort is one of the most common species throughout Minnesota (Ownbey and Morley 1991).

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, shorebirds 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.

Broad-leaf pondweeds include white-stem pondweed (*Potamogeton praelongus*), large-leaf pondweed (*P. amplifolius*), Illinois pondweed (*P. illinoensis*; Figure 14), 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 14. Illinois pondweed

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

Unique aquatic plants

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

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

Bladderworts (*Utricularia* spp.) are a group of submerged plants that produce roots but do not firmly anchor to the lake bottom. Greater bladderwort (*U. vulgaris)* is found in lakes and ponds throughout Minnesota but several other species are much less common. Unique bladderwort species include humped bladderwort (*Utricularia gibba*), lesser bladderwort (*U. minor*; Figure 15) 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 water column. They also act as "underwater Venus fly-traps" by catching and digesting small insects in their 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).

Figure 15. Lesser bladderwort

Photo by: Paul Skawinski, UW-Stevens Point Herbarium. © 2009

Water arum (*Calla palustris*; Figure 16) is an emergent perennial wetland plant that may grow along marshy lakeshores as well as in wooded swamps, marshes and bogs (Nichols 1999b). The plant is recognizable by its heart-shaped leaves and the showy, white petal-like spathe. This is a species of northern latitudes and Minnesota is the southwestern limit of its range (Flora of North America 2007). Within Minnesota, water arum primarily occurs in the northeast half of the state (Ownbey and Morley 1991).

Figure 16. Water arum

Cottongrass (*Eriophorum* spp.) is an emergent grass-like plant named for its distinctive white seed heads that resemble tufts of cotton (Figure 17). These plants occur in open and forested wet peatlands of Minnesota.

Figure 17. Cottongrass in Big Portage Lake, 2008

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 Big Portage and Deep Portage 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.

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 Global Positioning System (GPS) technology.

Grid point-intercept survey

A grid point-intercept survey was conducted in Big Portage Lake on June 18, 19 and 23, 2008, and in Deep Portage Lake on June 24, 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 20 feet. Points were spaced 65 meters apart on Big Portage Lake. Only the shallow areas (less than 25 feet depth) of Deep Portage Lake were surveyed and survey points were placed closer (30 meters) on this lake to ensure that sufficient sample points were included in the vegetated zone. A total of 965 sites were sampled within the shore to 20 feet depth interval. An additional four sites were surveyed in Deep Portage Lake within the 21 to 25 feet depth zone but since no vegetation was found, these deeper water sites were not used in analyses. Surveyors navigated to each site using a handheld 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.

Near-shore vegetation survey

Near-shore vegetation surveys were conducted at four plots on Deep Portage 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 Big Portage and Deep Portage 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 Big Portage and Deep Portage 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 in Big Portage Lake was conducted by the Minnesota County Biological Survey (MCBS) Program on July 15, 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 several other species, and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Results

Distribution of plants by water depth

Aquatic plants occurred around the entire perimeter of each lake. Big Portage Lake had a broad vegetated zone that, in many areas, extended the entire width of the lake while Deep Portage Lake had a narrow vegetated zone of about 75 meters (Figure 18). Approximately 407 acres of emergent and floating-leaf beds were mapped and occurred around the entire perimeter of both lakes. Submerged plants occurred along shore as well as in offshore shallow areas. The vegetated zone extended from shore to about 15 feet in depth. This area included about 901 acres in Big Portage Lake (about three-quarters of the lake) and 30 acres in Deep Portage Lake (about one-third of the lake). Within this area, nearly 90% of the survey sites contained vegetation.

Plants were found to a water depth of 16 feet in Big Portage Lake and 20 feet in Deep Portage Lake. Beyond depths of 15 feet, only one or two sites in each lake contained vegetation. In both lakes, vegetation was most common from shore to the ten feet depth where about 95% of the sample sites contained vegetation.

Aquatic plant species observed

A total of 33 aquatic plant taxa were recorded in Big Portage and Deep Portage Lakes. These included 23 submerged or free-floating taxa (Table 1), five floating-leaf and five emergent taxa (Table 2). At selected sites, surveyors also recorded shoreline emergent plants (Appendix 1).

Figure 18. Aquatic plant distribution in Big Portage and Deep Portage Lakes, 2008.

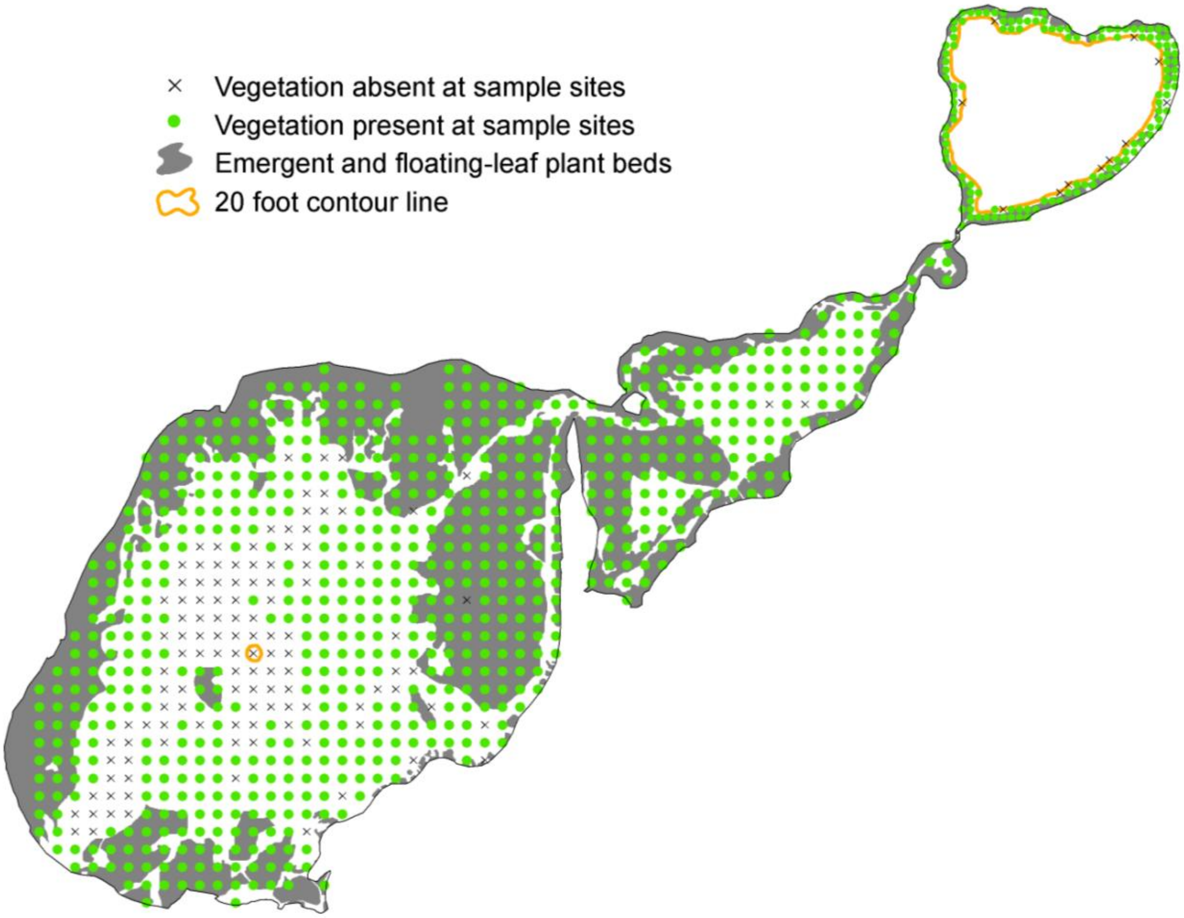


Table 1. Submerged and free-floating aquatic plants recorded in Big Portage and Deep Portage Lakes, 2008.

Description			Common Name	Scientific Name	Frequency of Occurrence[a]	
					Big Portage	Deep Portage
SUBMERGED and/or FREE-FLOATING	Algae		Muskgrass	*Chara* sp.	45	88
	Rooted plants	Grass-leaf plants	Flat-stem pondweed	*Potamogeton zosteriformis*	28	11
		Dissected-leaf plants	Coontail	*Ceratophyllum demersum*	15	9
			Northern watermilfoil	*Myriophyllum sibiricum*	1	1
		Narrow-leaf plants	Bushy pondweed	*Najas flexilis/guadalupensis*[b]	14	3
			Canada waterweed	*Elodea canadensis*	2	1
			Sago pondweed	*Stuckenia pectinata*	1	3
			Narrow-leaf pondweed	*Potamogeton* sp.[c]	2	–
			Fries' pondweed	*Potamogeton friesii*	1	2
		Broad-leaf plants	White-stem pondweed	*Potamogeton praelongus*	2	5
			Illinois pondweed	*Potamogeton illinoensis*	2	2
			Clasping-leaf pondweed	*Potamogeton richardsonii*	<1	–
			Large-leaf pondweed	*Potamogeton amplifolius*	<1	–
			Variable pondweed	*Potamogeton gramineus*	<1	–
	Free-drifting		Greater bladderwort	*Utricularia vulgaris*	20	–
			Humped bladderwort	*Utricularia gibba*	3	–
			Lesser bladderwort	*Utricularia minor*	2	–
			Flat-leaved bladderwort	*Utricularia intermedia*	1	–
			Watermoss	*Not identified to genus*	<1	–
			Greater duckweed	*Spirodela polyrhiza*	<1	–
			Lesser duckweed	*Lemna minor*	<1	–
			Star duckweed	*Lemna trisulca*	–	1

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations at Big Portage Lake (N = 833) and Deep Portage Lake(N = 132). They represent the percent of the sample stations that contained a plant taxon.

[b]Two species of bushy pondweed (*Najas flexilis* and *Najas guadalupensis*) were recorded in these lakes but plants were identified to only the genus level at each individual sample site.

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

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

Nomenclature follows MNTaxa 2009.

Table 2. Floating-leaf and emergent aquatic plants recorded in Big Portage and Deep Portage Lakes, 2008.

Description	Common Name	Scientific Name	Frequency of Occurrence[a]	
			Big Portage	Deep Portage
FLOATING-LEAF	Yellow waterlily	*Nuphar variegata*	7	49
	White waterlily	*Nymphaea odorata*	13	9
	Floating-leaf pondweed	*Potamogeton natans*	5	9
	Watershield	*Brasenia schreberi*	1	–
	Water smartweed	*Persicaria amphibia*	–	Present[b]
EMERGENT	Wild rice	*Zizania palustris*	47	18
	Hard-stem bulrush	*Schoenoplectus acutus*	6	39
	Giant burreed	*Sparganium eurycarpum*	–	1
	Broad-leaved arrowhead	*Sagittaria latifolia*	MCBS[c]	–
	Spikerush	*Eleocharis palustris*	MCBS	–

[a]Frequency values are provided for taxa that were observed within point-intercept survey sample stations at Big Portage Lake (N = 833) and Deep Portage Lake (N = 132). 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, 15 July 2008.

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

Nomenclature follows MNTaxa 2009.

Emergent and floating-leaf plants

Emergent and floating-leaf plants occurred in water depths of ten feet and less. About 392 acres, or 40%, of Big Portage Lake and 15 acres of Deep Portage Lake were covered by emergent plants and the most common taxa were bulrush and wild rice (Figure 19).

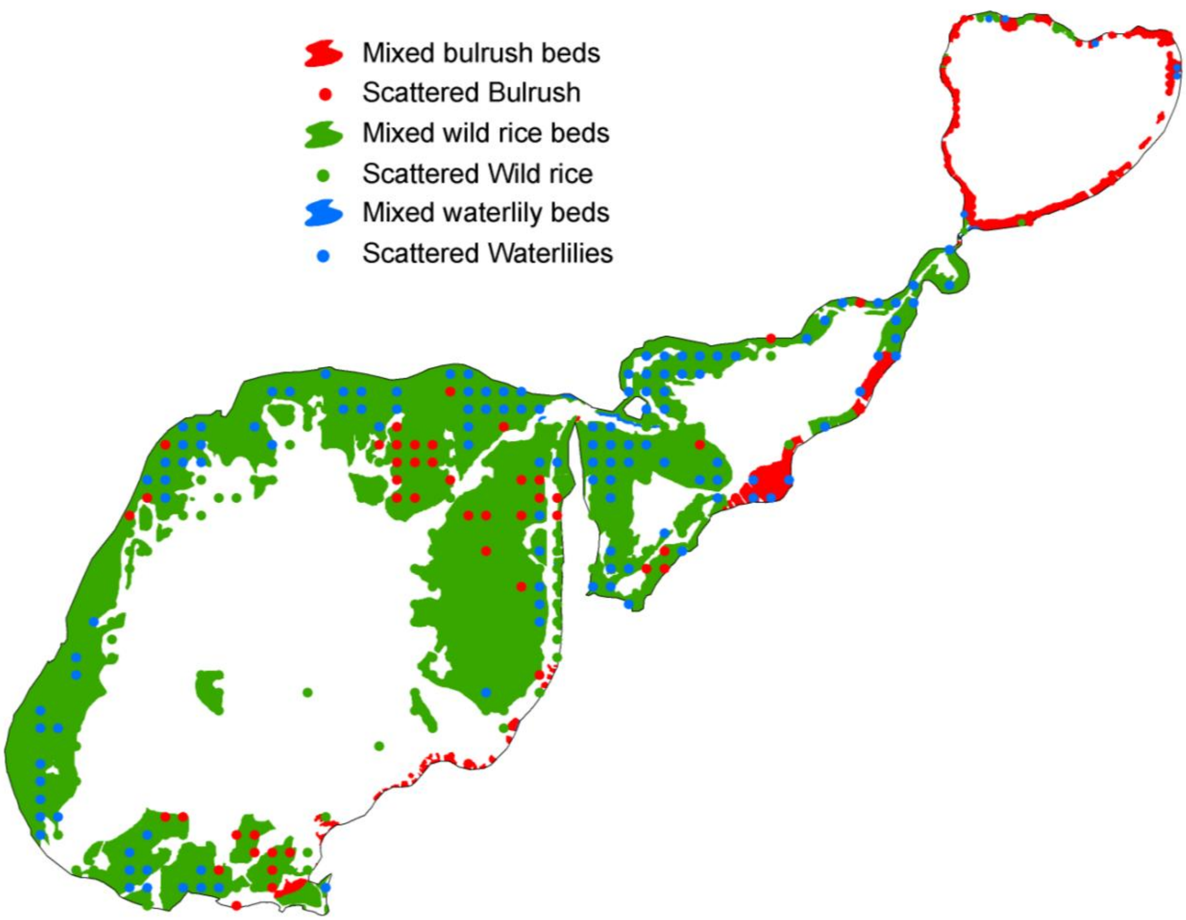
Bulrush in Big Portage Lake, 2008

Other emergent plants occurred at scattered locations around the lake and included arrowhead and burreed. Many of these emergent plants occupied the transitional zone between the lake and adjacent wetlands. Numerous additional native emergents occurred in these adjacent wetlands but this survey did not include an exhaustive wetland species inventory.

Waterlily beds covered about one acre in Big Portage Lake and less than one acre in Deep Portage Lake. The largest beds occurred in the channel between the east basin and the west basin of Big Portage Lake (Figure 19). The most common floating-leaf species were white waterlily, yellow waterlily and floating-leaf pondweed (*Potamogeton natans*). Because surveyors avoided motoring into floating-leaf plant beds, the frequency values obtained for these taxa (Table 2) were 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 wild rice and bulrush plants as well as submerged plants and were usually associated with muck sediments.

Waterlilies in Big Portage Lake, 2008

Figure 19. Distribution of emergent and floating-leaf plant beds in Big Portage and Deep Portage Lakes, 2008.



Submerged plants
Within the shore to 20 feet depth zone, submerged plants occurred in 86% of the Big Portage Lake sites, and 95% of the Deep Portage Lake sites. A mixture of submerged plant types was found and the most commonly occurring taxa were muskgrass, flat-stem pondweed, coontail, and greater bladderwort.

Muskgrass was found in about 45% of the sites in Big Portage Lake and 88% of the sites in Deep Portage Lake (Table 1). It was widespread around the vegetated zones of each lake (Figure 20A) 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 of less than ten feet in Big Portage Lake and less than 15 feet in Deep Portage Lake. It was the most common submerged plant found in all depths up to 20 feet in Deep Portage Lake.

Nine different pondweed species (*Potamogeton* spp. and *Stuckenia* spp.) were found in the two lakes and were most common in depths of ten feet and less. The most common pondweed species was flat-stem pondweed, which occurred with a frequency of 28% in Big Portage Lake and 11% in Deep Portage Lake (Table 1). Flat-stem pondweed had a widespread distribution (Figure 20B) and often co-occurred with muskgrass and coontail. Broad-leaf pondweeds were scattered around both lakes (Figure 20E) and included clasping-leaf, large-leaf, white-stem, Illinois, and variable pondweeds.

Coontail was found in 15% of Big Portage sample sites and nine percent of Deep Portage sample sites. It occurred throughout the vegetated zone, but was most abundant on the west end of Big Portage Lake. Coontail was most common within the six to ten feet depth zone in Big Portage Lake, and within the six to 20 feet depth zone in Deep Portage Lake (Figure 20C).

Greater bladderwort was only found in Big Portage Lake. Surveyors detected this species at 20% of the sample sites. It occurred throughout the vegetated zone (Figure 20D) and was most common from shore to ten feet in depth.

Unique plants
In addition to the commonly occurring plants in Big Portage and Deep Portage Lakes, five unique plant species were documented at 37 locations during the survey (Figure 21). These species are not widespread in Minnesota but their presence is indicative of relatively undisturbed native plant beds in Big Portage and Deep Portage Lakes. Unique submerged aquatic plants found in Big Portage and Deep Portage Lakes included humped bladderwort, lesser bladderwort, flat-leaved bladderwort, water arum and cottongrass.

Humped bladderwort, lesser bladderwort and flat-leaved bladderwort were scattered around the east basin of Big Portage Lake and also occurred at several sites in the west basin of Big Portage Lake. Flat-leaved bladderwort was the only bladderwort species found in Deep Portage Lake and was located in the channel between Big Portage Lake and Deep Portage Lakes. Water arum was found on the northeast side of Deep Portage Lake. Cottongrass occurred in the wetland of the channel between the two lakes.

Figure 20. Distribution of common aquatic plants in Big Portage and Deep Portage Lakes, 2008.

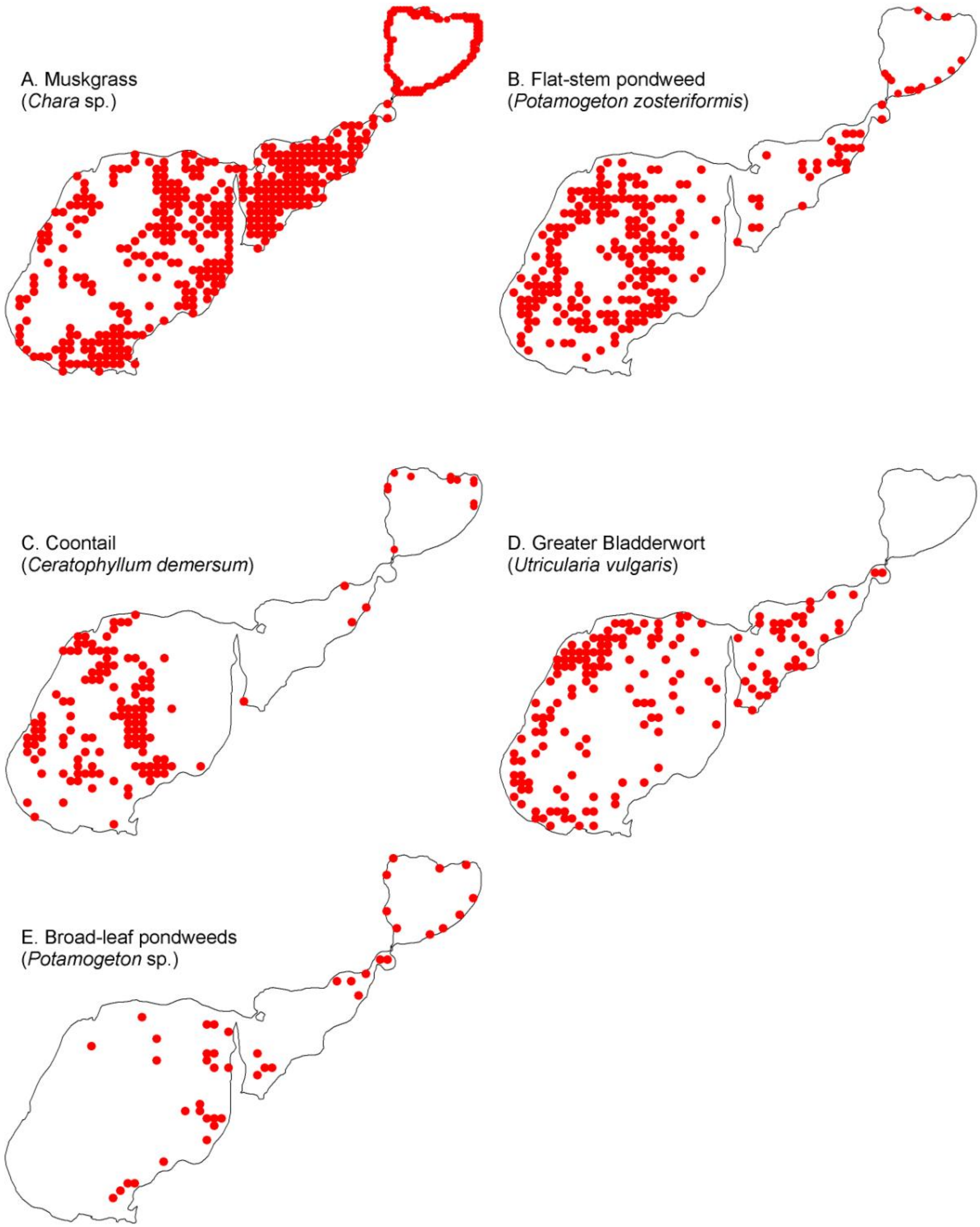
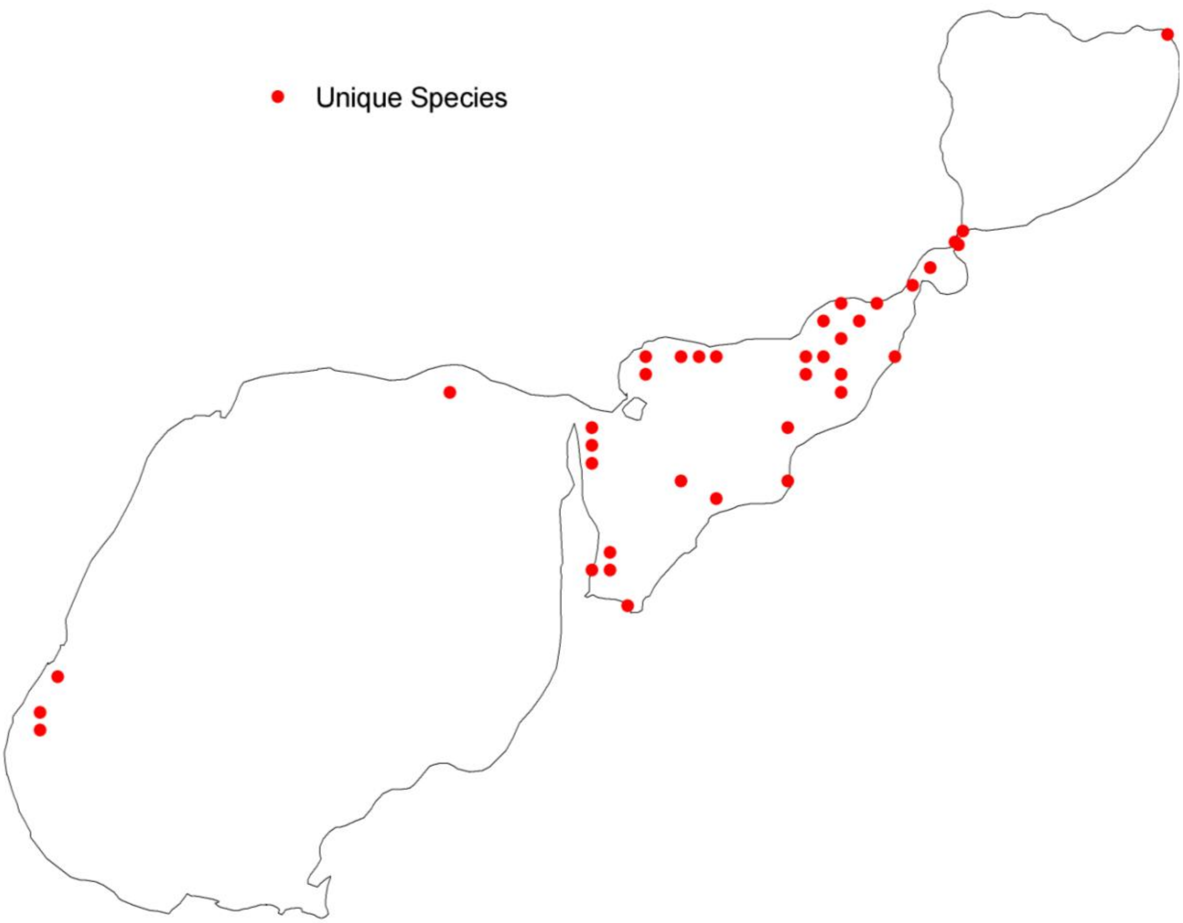


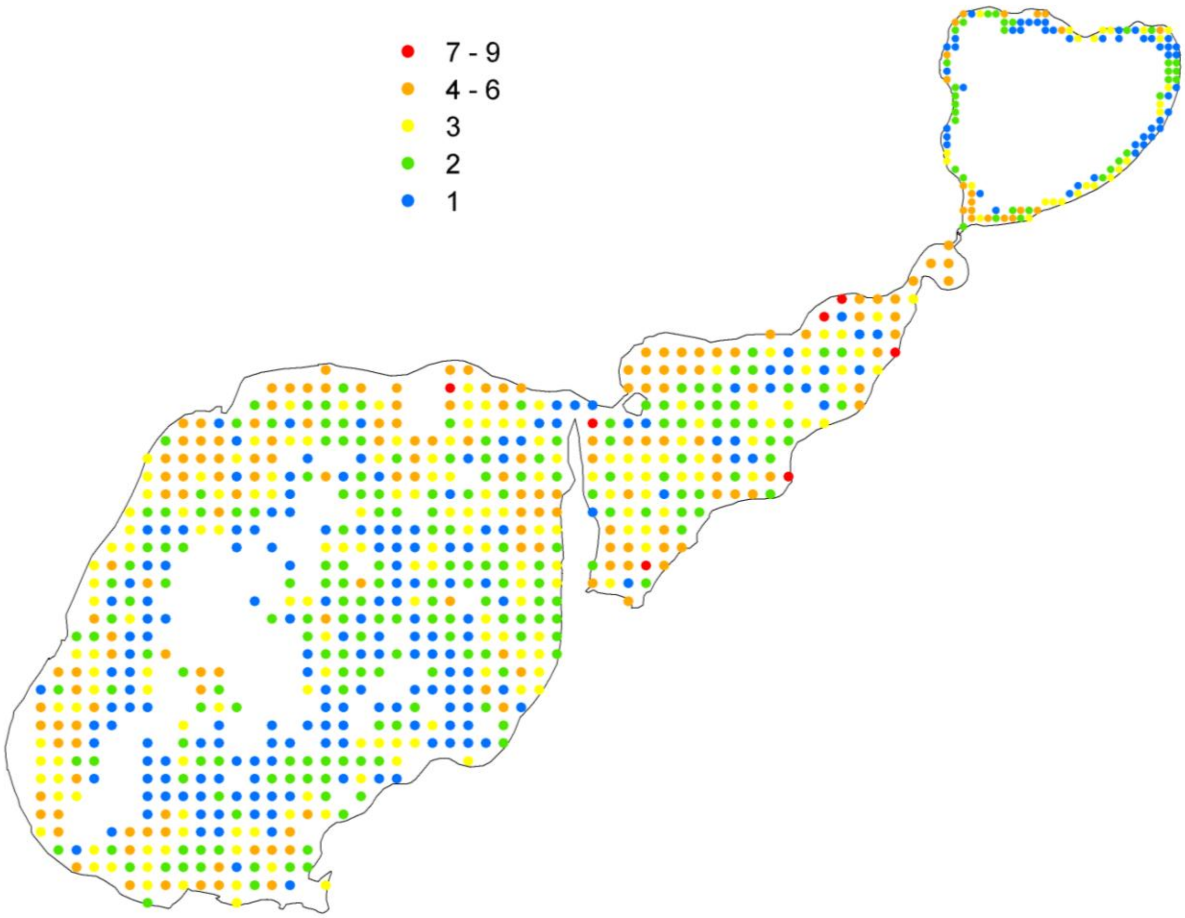
Figure 21. Distribution of unique aquatic plants in Big Portage and Deep Portage Lakes, 2008.



Species richness

The number of plant taxa found in each one square meter sample site ranged from zero to nine (Figure 22). Sites with the highest number of taxa occurred near shore, within mixed beds of emergent, floating-leaf and submerged plants. In depths greater than ten feet most sites contained fewer than three taxa.

Figure 22. Aquatic plant richness (number of taxa per sampling station) in Big Portage and Deep Portage Lakes, 2008.



Near-shore Substrates

Objective

1. Describe and map the near-shore substrates of Big Portage and Deep Portage Lakes

Introduction

Substrate type can have an effect on species make-up and richness. Some fish, including 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 larger diameter, such as gravel and rubble. A diverse substrate will also allow plants with different habitat requirements to exist within a system. For example, bulrush may occur on sand or gravel whereas yellow waterlily prefers soft substrates (Nichols 1999b).

White waterlilies in muck substrate (Big Portage Lake)

Methods

Near-shore substrate in Big Portage and Deep Portage Lakes was evaluated at a total of 652 sampling stations set up in the grid point-intercept aquatic plant surveys and near-shore fish surveys. Plant sample stations on Big Portage Lake were 65 meters apart and were placed across the entire lake. Plant sample stations on Deep Portage Lake were 30 meters apart, and occurred in a grid from shore to a depth of 25 feet. On both lakes, 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 fish sample stations. Fish sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 31 of these stations on Big Portage Lake and seven stations on Deep Portage Lake.

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

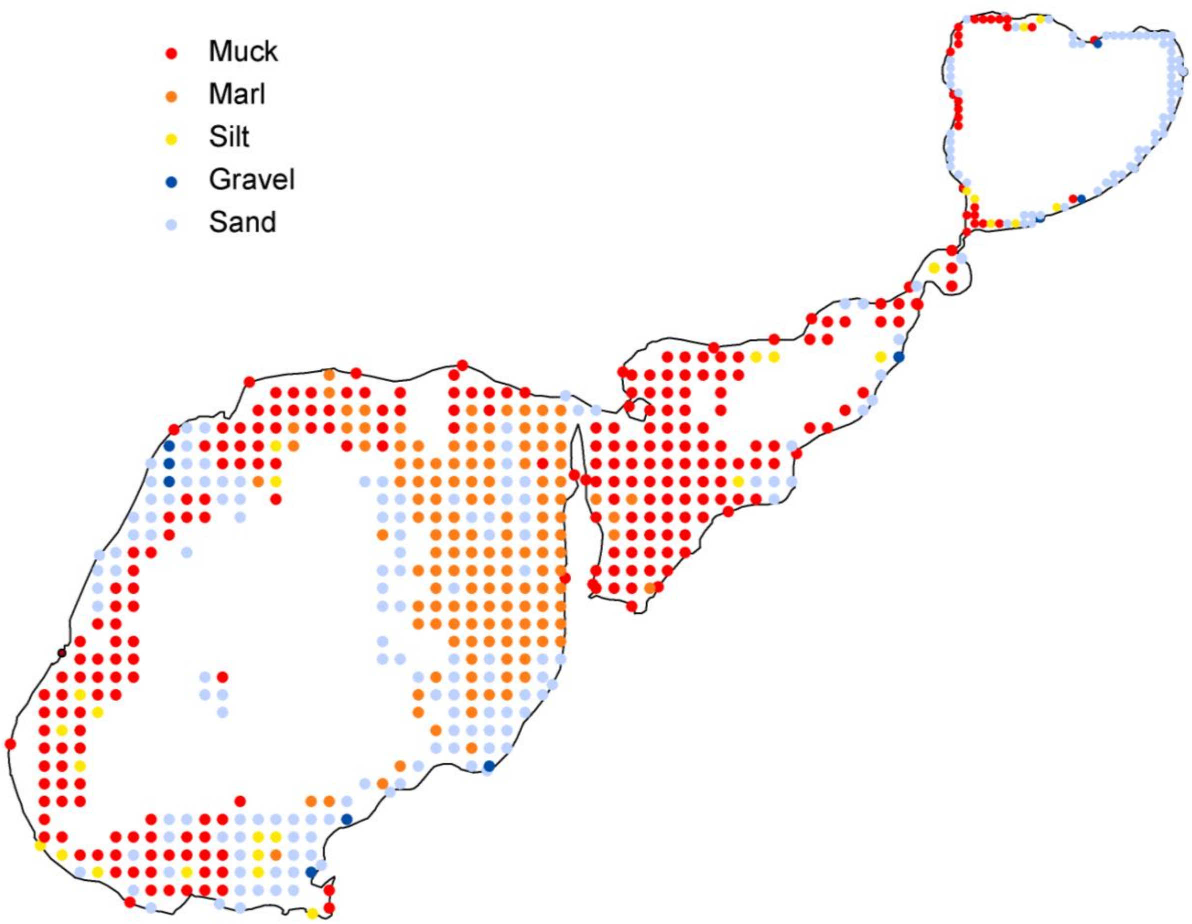
Substrate Group	Type	Description
Hard Bottom	Boulder	Diameter over 10 inches
	Rubble	Diameter 3 to 10 inches
	Gravel	Diameter 1/8 to 3 inches
	Sand	Diameter less than 1/8 inch
Soft Bottom	Silt	Fine material with little grittiness
	Marl	Calcareous material
	Muck	Decomposed organic material

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 was not feasible, substrate was evaluated by visual observation.

Results

Soft substrates of muck and marl dominated both basins of Big Portage Lake (Figure 23). Sand was present in large quantities in the western basin, and in scattered areas along the shoreline of the eastern basin. Sand was also the most common substrate in Deep Portage Lake, although soft substrates such as muck and silt were also present.

Figure 23. Distribution of Big Portage and Deep Portage Lake near-shore substrates, 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). Eighteen of these species were identified at Big Portage and Deep Portage Lakes.

Figure 24. American white pelican

Photo by: Carrol Henderson

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

Figure 25. Bald eagle

Photo by: Carrol Henderson

Bald eagles (*Haliaeetus leucocephalus*; Figure 25) are an increasingly common sight in Minnesota. Once listed as an endangered species, bald eagle numbers have rebounded due to effective environmental protection laws and conservation efforts. Adult bald eagles are easily identified by the white head and tail, although these colors don't appear until birds are 4 or 5 years old. Prior to that, eagles are generally dark brown with white feathers scattered along the wings, head, tail and back. With a wingspan of up to 7 feet, bald eagles are one of the largest birds in North America. They are found in forested areas near large, open bodies of water. Although bald eagle numbers are increasing, these birds still face threats from environmental contaminants and destruction of habitat. Bald eagles are listed as a species of Special Concern in the state of Minnesota.

Black-billed cuckoos (*Coccyzus erythropthalmus*; Figure 26) are one of two cuckoo species regularly found in Minnesota. These slender, long-tailed birds summer and breed in Minnesota and the east-central United States before heading south to spend the winter in South America. Black-billed cuckoos have a brown back and white underside, and may be distinguished by a curved black bill and red ring around the eye. They inhabit deciduous forests and thickets, and are often found near water. The black-billed cuckoo is listed as a species of Regional Concern on the Partners in Flight watchlist.

Figure 26. Black-billed cuckoo

Photo source: U.S. Fish and Wildlife Service

Black terns (*Chlidonias niger*; Figure 27) are distinguished by a black head and chest with gray wings, back, and tail. The nonbreeding plumage is lighter in color, and much of the black is replaced with white or gray. The bill is long and slightly curved. Black terns are loosely colonial, and often are found in freshwater marshes or wetlands. They may also occur along lake edges with abundant emergent vegetation. Black tern populations have declined dramatically since the 1960s. Habitat loss, environmental contamination, and human disturbance are often cited as causes of the decline.

Figure 27. Black tern

Photo by: Carrol Henderson

Common loons (*Gavia immer*; Figure 28) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. These large diving birds possess red eyes and a large, dark pointed bill that is well-adapted for catching fish. Loons spend most of their time in water, and go ashore only to mate and incubate eggs. Summer plumage is spotted black and white, while in winter the colors are gray above and white below. Loon populations are closely monitored in Minnesota; however, these birds still face threats, particularly in the form of human disturbance and lead poisoning.

Figure 28. Common loon

Photo by: Carrol Henderson

Common nighthawks (*Chordeiles minor*; Figure 29) 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 29. Common nighthawk

Photo by: Carrol Henderson

Common terns (*Sterna hirundo*; Figure 30) are the most widespread terns in North America. In the breeding season common terns have a solid black cap with gray back and underparts. The gray wings have dark edges. The rump is white, and the legs and bill are orange-red in color. Common terns nest in colonies, often on islands or peninsulas of larger lakes with sandy substrates. Populations of common terns declined in the late 1800s, when their feathers were used to adorn clothing, and again in the 1970s, likely due to poisoning by pesticides. Habitat loss, nest predation, and disturbance by humans may also negatively affect common terns.

Figure 30. Common tern

Photo bv: Carrol Henderson

Eastern wood-pewees (*Contopus virens*; Figure 31) 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 and decrease the lower-canopy foraging area available to the pewee.

Figure 31. Eastern wood-pewee

Photo bv: J.A. Spendelow

Golden-winged warblers (*Vermivora chrysoptera*; Figure 32) 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 32. Golden-winged warbler

Photo by: Carrol Henderson

Least flycatchers (*Empidonax minimus*; Figure 33) 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 33. Least flycatcher

Photo by: J.A. Spendelow

Ovenbirds (*Seiurus aurocapillus*; Figure 34) 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 34. Ovenbird

Photo courtesy of: U.S. Fish and Wildlife Service

Rose-breasted grosbeaks (*Pheucticusludovicianus*; Figure 35) are summer visitors to Minnesota bird feeders. The males are easily identified by a red triangle on a white breast, with a black head and back and a large bill. Females are more difficult to identify, and resemble a large sparrow with brown and white streaks. Rose-breasted grosbeaks are found in open woodlands near water, edges of marshes, meadows and woodlands, and suburban parks and gardens. The winter range spans from southern Mexico to South America and the Caribbean. Significant regional declines in rose-breasted grosbeak populations have been noted. Protection of large, unfragmented areas of hardwood forest is beneficial to the rose-breasted grosbeak.

Figure 35. Rose-breasted grosbeak

Photo by: J.A. Spendelow

Northern rough-winged swallows (*Stelgidopteryx serripennis*; Figure 36) are small, fairly common songbirds. They are brown on the head and back with a pale brown throat and white belly. The outer wing feathers, or primaries, have “hooks” on the edge, giving them a rough feel. These swallows are insectivorous and feed in the air, often over water. They will nest either singly or colonially near rocky or exposed banks of clay or sand. Open habitat is preferred for breeding. Northern rough-winged swallows are fairly adaptable and are even increasing in parts of their range. Continued monitoring is important to help maintain this trend.

Figure 36. Northern rough-winged swallow

Photo by: Dave Herr

Sedge wrens (*Cistothorus platensis*; Figure 37) are small, brown wrens with buffy underparts and white streaks on the back and crown. They have an indistinct white eye stripe, and often hold their short tails in a cocked, upright position. As their name implies, they prefer marshes and meadows with abundant dense sedges and grasses. The nest is often made of sedges, as well. Sedge wrens are unpredictable in their migration patterns, and may be abundant in an area one year and completely absent the next. Human development of wetlands is the primary reason for the recent notable declines in sedge wren populations.

Figure 37. Sedge wren

Photo by: Berlin Heck

The swamp sparrow's (*Melospiza georgiana*; Figure 38) 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 38. Swamp sparrow

Photo by: Jim Stasz

The trumpeter swan (*Cygnus buccinator*; Figure 39) is the largest of the North American waterfowl. It inhabits lakes, ponds, and large rivers, feeding on roots and stems of aquatic vegetation. Adult trumpeter swans are all white with a black bill and face. Juveniles are whitish-gray with a mottled bill. Historically, trumpeter swans nested across much of North America. However, excessive hunting in the 19th and early 20th centuries led to large population declines, and by 1880 trumpeter swans had disappeared from Minnesota. Captive breeding programs and habitat protection efforts have been successful, and the Minnesota population now numbers over 2000. However, habitat loss and lead poisoning still pose threats to trumpeter swan populations. This bird is listed as Threatened in Minnesota.

Figure 39. Trumpeter swan

Photo by: Dave Herr

The veery (*Catharus fuscescens*; Figure 40) is one of the most easily identifiable thrushes. It has faint dark spots on a buffy breast and a reddish brown back and head. The legs are pink and the eyes are dark with an indistinct light eye ring. The veery was named after its most common call, a "vee-er" sound. Riparian areas with dense vegetation and wetlands within large forests are good places to find the veery. The veery is suffering declines throughout many parts of its range. Destruction of winter habitat and parasitism by brown-headed cowbirds are major reasons cited for the decline.

Figure 40. Veery

Photo by: Deanna Dawson

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

Figure 41. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Surveyors used several techniques to collect information on bird species. Point counts were conducted at 38 stations, located 400 meters apart along the lakeshore. Surveyors listened for five minutes per station and recorded all species detected (heard or seen) within that time. Point count surveys were conducted in the early morning hours, when species were most likely to be singing. Call-playback surveys were conducted at survey stations that had appropriate habitat. At each station, surveyors played a tape that included the calls of six marsh birds (least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), American bittern (*Botaurus lentiginosus*), and pied-billed grebe (*Podilymbus podiceps*)) and listened for a response. Call-playback surveys generally took place in the early evening. Both survey techniques were dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or on the lakeshore were also recorded.

Results

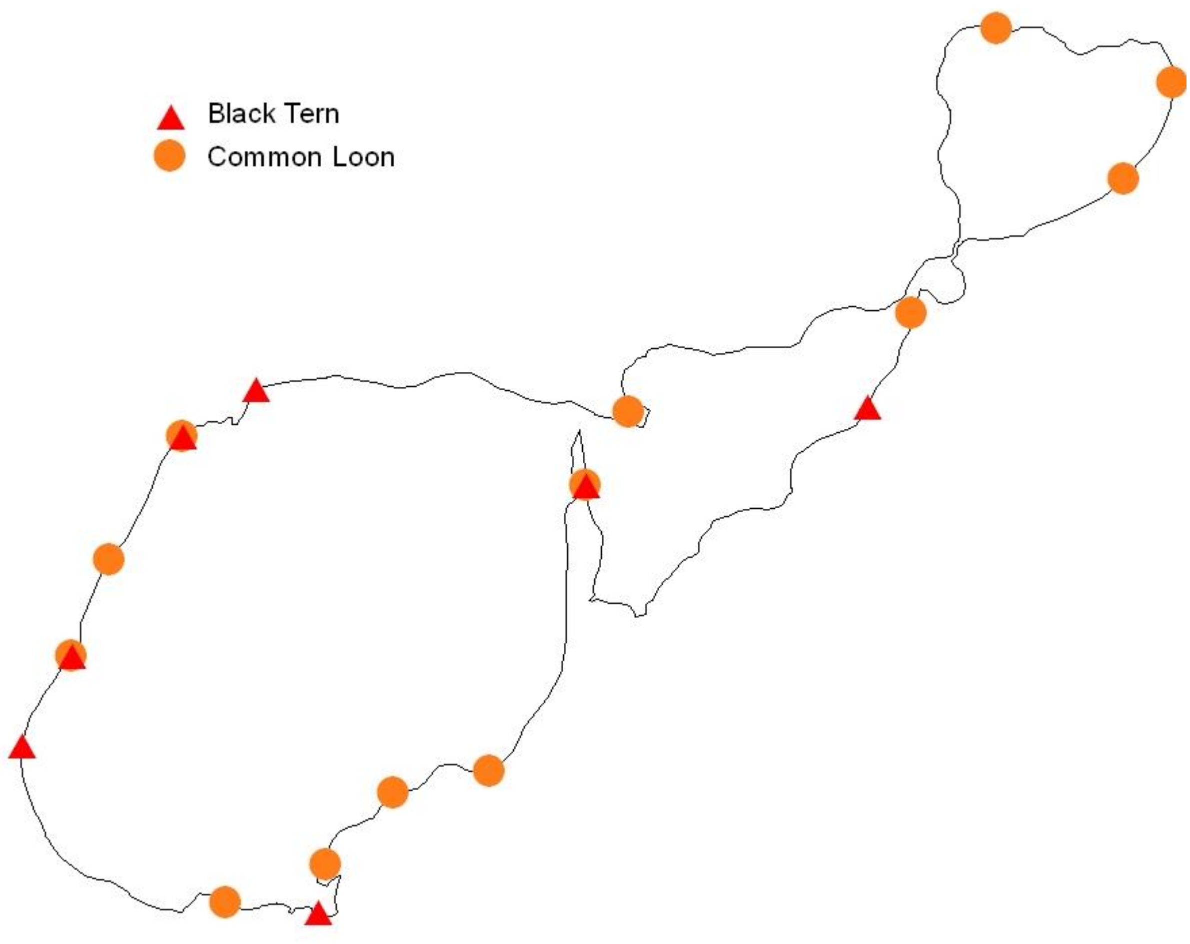
Eighteen bird species of greatest conservation need were documented on Big Portage and Deep Portage Lakes. Fifteen of these species were heard during the point count or call-playback surveys, and three (American white pelican, common tern, and trumpeter swan) were found through casual observation. Overall, the veery was the most frequently detected species of greatest conservation need, observed at 17 survey stations (13 on Big Portage Lake and four on Deep Portage Lake). On Big Portage Lake, bald eagles, black terns, common loons, ovenbirds, rose-breasted grosbeaks, and swamp sparrows were each documented at five or more survey stations. On Deep Portage Lake, least flycatchers were detected at four survey stations, while bald eagles and common loons were each observed at three stations.

Not all species of greatest conservation need were found on both lakes. Species detected at both Big Portage and Deep Portage Lakes include the bald eagle, common loon, eastern wood-pewee, least flycatcher, ovenbird, and veery. Yellow-bellied sapsuckers were found only on Deep Portage Lake. Additional species of greatest conservation need observed only on Big Portage Lake were the American white pelican, black-billed cuckoo, black tern, common nighthawk, common tern, golden-winged warbler, rose-breasted grosbeak, northern rough-winged swallow, sedge wren, swamp sparrow, and trumpeter swan.

Overall, sixty-five species were recorded during the Big Portage and Deep Portage Lake point count and call playback surveys (Table 3). An additional 11 species were documented during casual observation of the lakes, for a total of 76 species (Appendix 2). The song sparrow was the most frequently observed species on Big Portage Lake, as well as both lakes overall; surveyors documented song sparrows at more than 70% of survey stations. In addition to song sparrows, other common species on Big Portage Lake included yellow warblers, red-winged blackbirds, red-eyed vireos, common yellowthroats, and the veery. On Deep Portage Lake, yellow warblers were the most frequently detected species, identified at 6 of 7 survey stations, followed by least flycatchers, red-eyed vireos, the veery, bald eagles, common loons, and red-winged blackbirds.

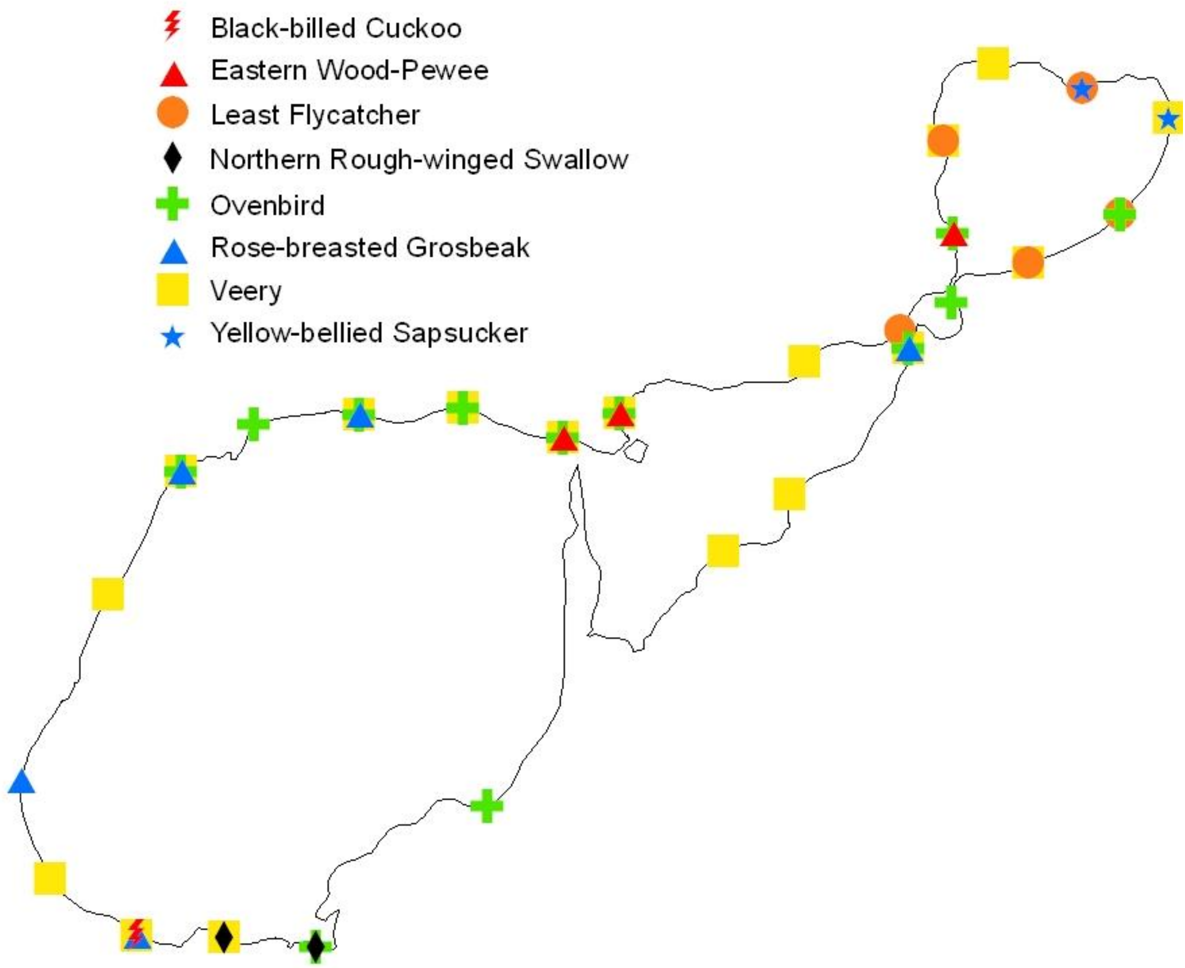
One of the aquatic habitat-dependent species of greatest conservation need, the common loon, was found on both Big Portage Lake and Deep Portage Lake (Figure 42). This species was encountered on all parts of both lakes. Black terns were found only on Big Portage Lake, associated with emergent and floating-leaf vegetation.

Figure 42. Distribution of aquatic habitat-dependent bird species of greatest conservation need in Big Portage and Deep Portage Lakes, May – June 2009.



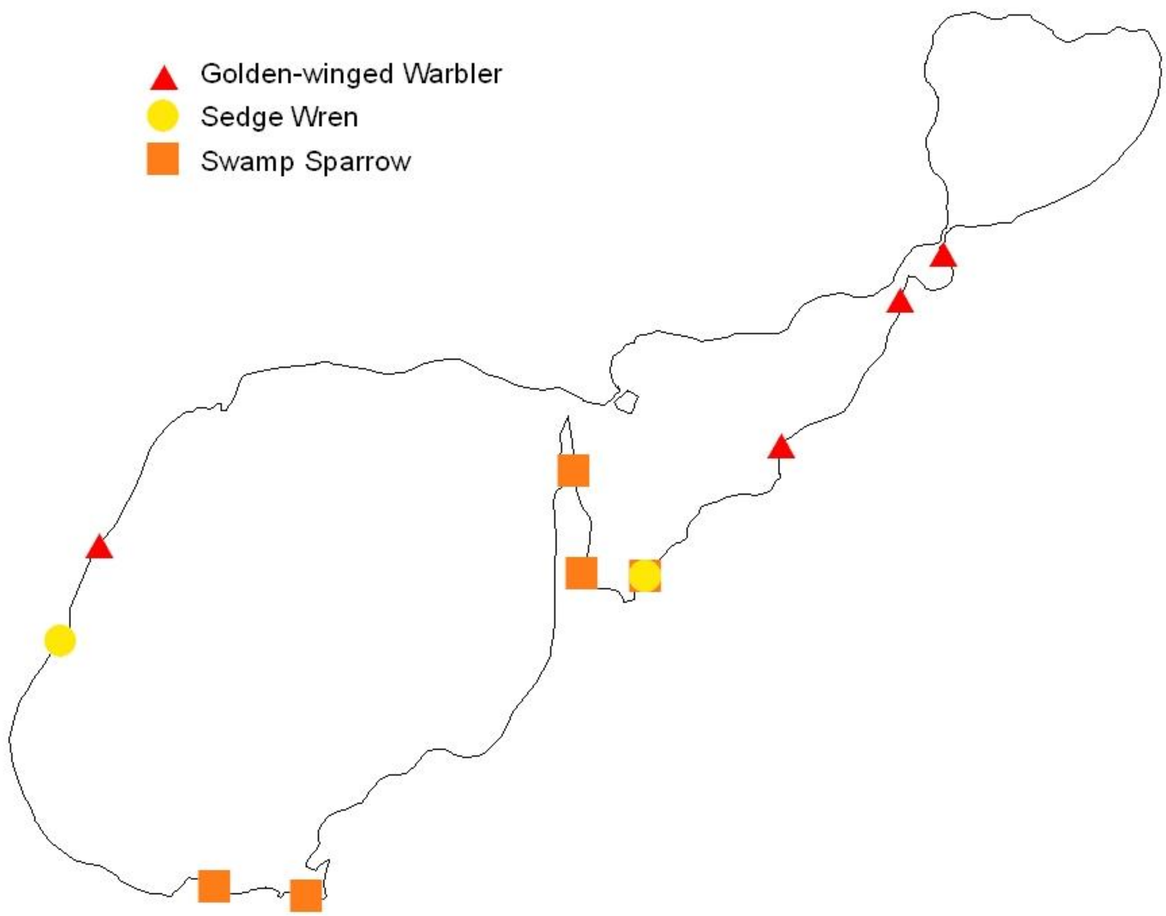
Forest habitat-dependent species of greatest conservation need were found at various locations along the shorelines of both study lakes (Figure 43). Several species, like the veery and ovenbird, were scattered along much of the shoreline. Other species were more restricted in their distribution. The eastern wood-peewee was limited to the north-central shoreline of Big Portage Lake and the west shoreline of Deep Portage Lake.

Figure 43. Distribution of forest habitat-dependent bird species of greatest conservation need in Big Portage and Deep Portage Lakes, May – June 2009.



Wetland-dependent species of greatest conservation need that were documented on Big Portage Lake included golden-winged warblers, sedge wrens, and swamp sparrows, all found within wetland habitats along the south and northwest shorelines (Figure 44). On Deep Portage Lake, no wetland-dwelling species of greatest conservation need were found.

Figure 44. Distribution of wetland habitat-dependent bird species of greatest conservation need in Big Portage and Deep Portage Lakes, May – June 2009.



Bald eagles and common nighthawks, species of greatest conservation need that occupy other habitats, were found at multiple survey stations (Figure 45). Bald eagles were present on both Big Portage and Deep Portage Lakes, concentrated within three distinct areas. Common nighthawks were observed only within the west basin of Big Portage Lake.

Figure 45. Distribution of bird species of greatest conservation need that occupy other habitats in Big Portage and Deep Portage Lakes, May – June 2009.

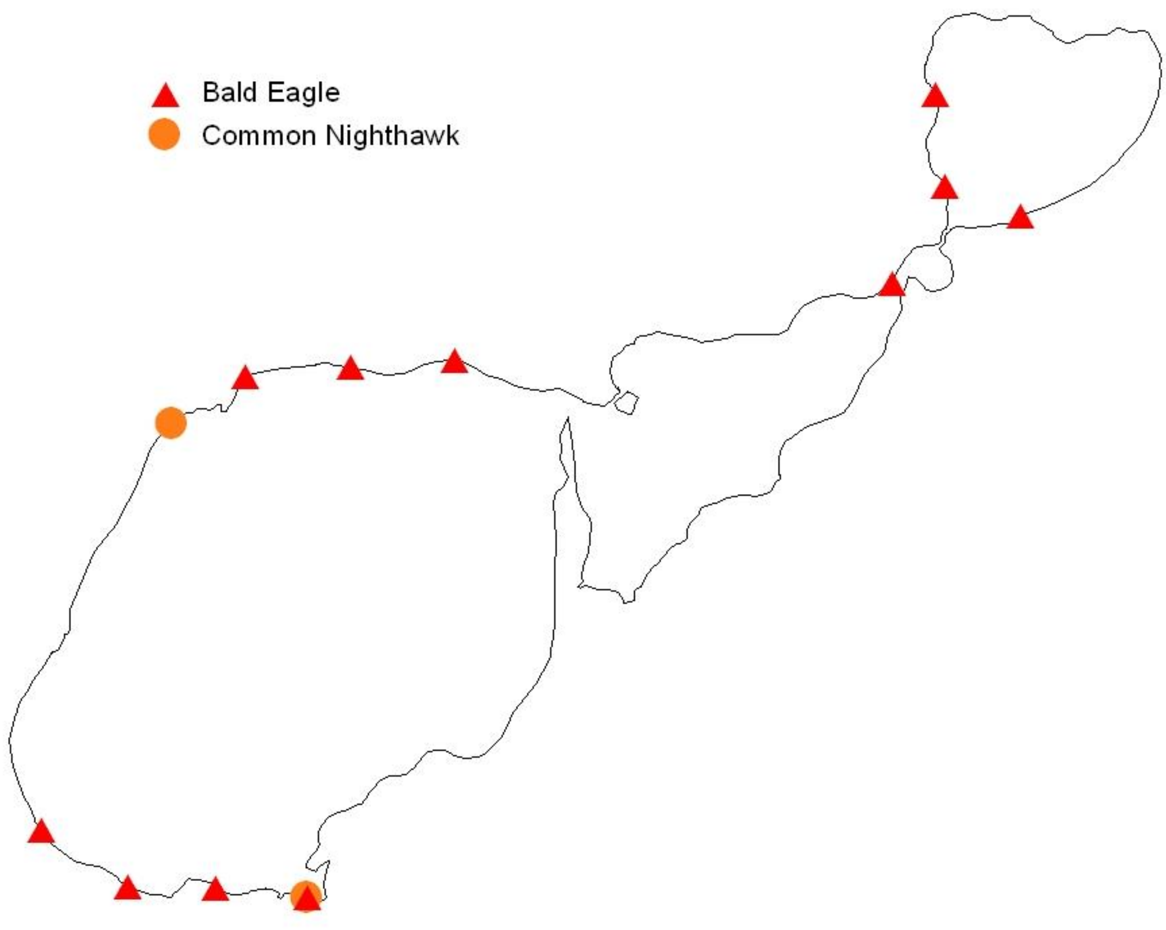


Table 3. Species list and frequency of occurrence of bird species identified during point count and call-playback surveys, May – June 2009. * denotes a species of greatest conservation need.

Description	Common Name	Scientific Name	Frequency of occurrence[a]		
			Total N=38	Big Portage N=31	Deep Portage N=7
Waterfowl	Canada goose	*Branta canadensis*	16	19	0
	Wood duck	*Aix sponsa*	18	19	14
	Mallard	*Anas platyrhynchos*	21	23	14
	Common goldeneye	*Bucephala clangula*	13	13	14
Loons	Common loon*	*Gavia immer*	34	32	43
Herons/bitterns	Great blue heron	*Ardea herodias*	8	10	0
	Green heron	*Butorides virescens*	5	6	0
Hawks/eagles	Osprey	*Pandion haliaetus*	3	3	0
	Bald eagle*	*Haliaeetus leucocephalus*	29	26	43
	Broad-winged hawk	*Buteo platypterus*	3	3	0
Falcons	Merlin	*Falco columbarius*	3	3	0
Rails/gallinules	Sora	*Porzana carolina*	3	3	0
Gulls/terns	Caspian tern	*Hydroprogne caspia*	3	3	0
	Black tern*	*Chlidonias niger*	18	23	0
Pigeons/doves	Mourning dove	*Zenaida macroura*	21	23	14
Cuckoos	Black-billed cuckoo*	*Coccyzus erythropthalmus*	3	3	0
Goatsuckers	Common nighthawk*	*Chordeiles minor*	5	6	0
Woodpeckers	Red-bellied woodpecker	*Melanerpes carolinus*	11	6	29
	Yellow-bellied sapsucker*	*Sphyrapicus varius*	5	0	29
	Hairy woodpecker	*Picoides villosus*	3	3	0
	Northern flicker	*Colaptes auratus*	3	3	0
	Pileated woodpecker	*Dryocopus pileatus*	3	3	0
Flycatchers	Eastern wood-pewee*	*Contopus virens*	8	6	14
	Alder flycatcher	*Empidonax alnorum*	29	35	0
	Least flycatcher*	*Empidonax minimus*	13	3	57
	Eastern phoebe	*Sayornis phoebe*	13	16	0
	Great crested flycatcher	*Myiarchus crinitus*	18	16	29
	Eastern kingbird	*Tyrannus tyrannus*	18	23	0
Vireos	Warbling vireo	*Vireo gilvus*	24	26	14
	Red-eyed vireo	*Vireo olivaceus*	58	58	57
Jays/crows	Blue jay	*Cyanocitta cristata*	18	19	14
	American crow	*Corvus brachyrhynchos*	18	23	0

Table 3, continued.

Description	Common Name	Scientific Name	Frequency of occurrence[a]		
			Total N=38	Big Portage N=31	Deep Portage N=7
Swallows	Purple martin	*Progne subis*	5	6	0
	Tree swallow	*Tachycineta bicolor*	26	26	29
	Northern rough-winged*	*Stelgidopteryx serripennis*	5	6	0
	Bank swallow	*Riparia riparia*	3	3	0
	Barn swallow	*Hirundo rustica*	5	6	0
Chickadees	Black-capped chickadee	*Poecile atricapilla*	3	3	0
Nuthatches	Red-breasted nuthatch	*Sitta canadensis*	3	3	0
	White-breasted nuthatch	*Sitta carolinensis*	8	10	0
Wrens	House wren	*Troglodytes aedon*	5	6	0
	Sedge wren*	*Cistothorus platensis*	5	6	0
Thrushes	Veery*	*Catharus fuscescens*	45	42	57
	American robin	*Turdus migratorius*	18	19	14
Mockingbirds	Gray catbird	*Dumetella carolinensis*	21	19	29
Waxwings	Cedar waxwing	*Bombycilla cedrorum*	8	10	0
Warblers	Golden-winged warbler*	*Vermivora chrysoptera*	11	13	0
	Nashville warbler	*Vermivora ruficapilla*	5	6	0
	Yellow warbler	*Dendroica petechia*	68	65	86
	Chestnut-sided warbler	*Dendroica pensylvanica*	26	26	29
	Yellow-rumped warbler	*Dendroica coronata*	11	13	0
	Pine warbler	*Dendroica pinus*	3	3	0
	Black-and-white warbler	*Mniotilta varia*	3	3	0
	American redstart	*Setophaga ruticilla*	16	19	0
	Ovenbird*	*Seiurus aurocapilla*	32	32	29
	Common yellowthroat	*Geothlypis trichas*	37	42	14
Sparrows/allies	Chipping sparrow	*Spizella passerina*	13	13	14
	Song sparrow	*Melospiza melodia*	71	81	29
	Swamp sparrow*	*Melospiza georgiana*	13	16	0
Cardinals/allies	Northern cardinal	*Cardinalis cardinalis*	3	3	0
	Rose-breasted grosbeak*	*Pheucticus ludovicianus*	13	16	0
Blackbirds	Red-winged blackbird	*Agelaius phoeniceus*	58	61	43
	Common grackle	*Quiscalus quiscula*	21	26	0
	Baltimore oriole	*Icterus galbula*	34	49	14
Finches	American goldfinch	*Pinus tristis*	24	23	29

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

Bird Species Richness

Objective

1. Calculate and map bird richness around the shoreline of Big Portage and Deep Portage Lakes

Introduction

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

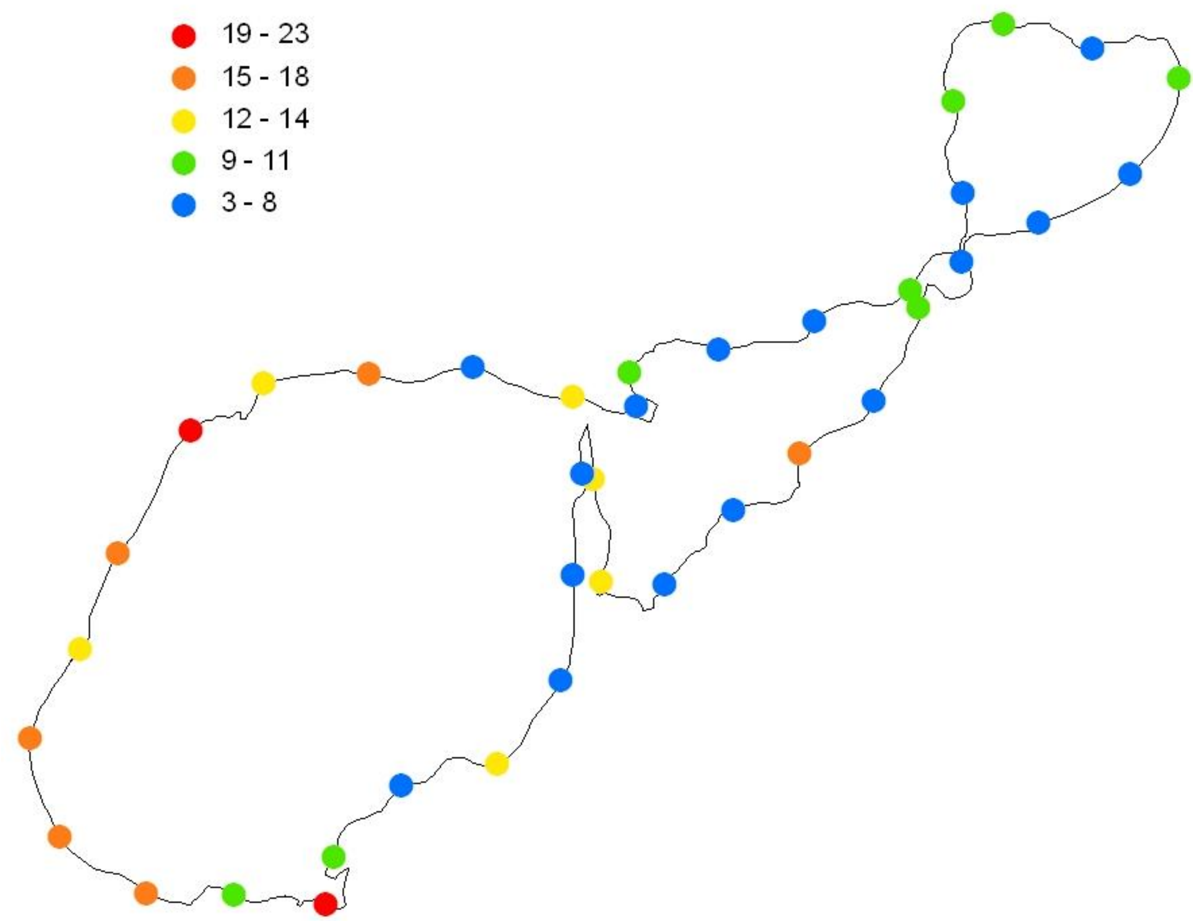
Methods

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

Results

Maximum bird species diversity was 23 species at a single survey station (Figure 46). One additional site had 20 or more species, and 20 additional sites had 10 or more species. The minimum number of bird species identified at a single survey station was three. The site with the highest diversity was located near the outlet on the south side of the west basin of Big Portage Lake. The survey station with the second highest bird diversity was located on the north side of Big Portage Lake, adjacent to the inlet. Additional sites with high diversity were found around all parts of Big Portage Lake, with relative diversity increasing from east to west. The number of bird species of greatest conservation need at a single survey station ranged from zero to six. The two sites with the highest general bird diversity, located near the inlet and outlet in the west basin of Big Portage Lake, also supported the highest number of bird species of greatest conservation need with six SGCN recorded at each site.

Figure 46. Bird species richness (number of species per sample site) in Big Portage and Deep Portage 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 nest on Big Portage Lake, 2009

Photo by: Andrea Lambrecht

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

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.

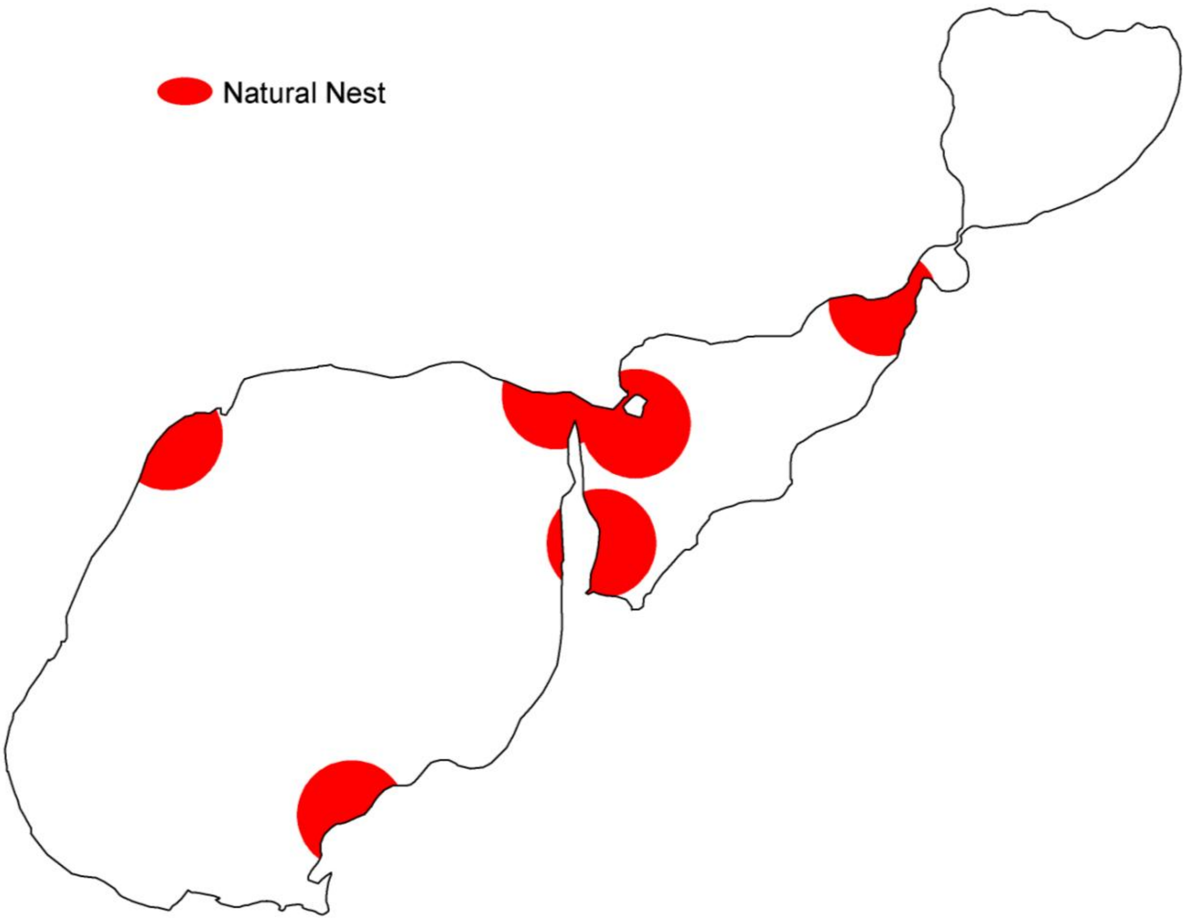
Methods

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 Big Portage and Deep Portage Lakes loon nesting areas in 1981.

Results

Since 1981, six probable loon nesting areas have been identified on Big Portage Lake (Figure 47). Two of the nesting areas are within the west basin of Big Portage Lake, three are near the channel connecting the two basins of Big Portage Lake, and one nesting area is located near the channel connecting Big Portage Lake to Deep Portage Lake. One of these nests was documented as active in 2009. There are no records of loon nests on Deep Portage Lake.

Figure 47. Location of natural loon nests recorded on Big Portage and Deep Portage Lakes between 1981 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 green frog (*Rana clamitans*) and 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 48) 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 48. Green frog

Photo by: Jeff LeClere, www.herpnet.net

Mink frogs (Figure 49) are typically green in color with darker green or brown mottling. They emit an odor similar to that of a mink when handled. They inhabit quiet waters near the edges of wooded lakes, ponds, and streams, and are considered the most aquatic of the frogs found in Minnesota. Populations of mink frogs have potentially been declining recently, and the numbers of observed deformities have been increasing.

Figure 49. 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 shoreline of each lake, spaced 400 meters apart. Surveys were conducted between sunset and 1:00 AM. At each station surveyors listened for up to five minutes for all frog and toad calls. An estimate of abundance and a calling index were recorded for both green and mink frogs. For other species, only calling index was recorded. If survey conditions such as rain or wind noticeably affected listening ability, the survey was terminated.

Results

Target species
Both green frogs and mink frogs were identified during the Big Portage Lake frog surveys. Green frogs were heard more frequently than mink frogs, and were documented at nearly half (15 of 31) of the survey stations (Figure 50). Green frogs were also recorded at six stations on Deep Portage Lake. Estimates of abundance at these stations ranged from one to between 10 and 20 individuals.

Mink frogs were documented at seven survey stations on Big Portage Lake (Figure 51). The majority of these survey stations were located along the western shoreline. Surveyors heard between 10 and 20 males calling at one of these stations, but abundance estimates at the other six stations were less than 10 individuals. Mink and green frogs co-occurred at four stations on Big Portage Lake (Figure 52). Mink frogs were not recorded on Deep Portage Lake.

Other species
Two additional species were documented during the Portage Lakes frog surveys. Gray treefrogs (*Hyla versicolor*) were heard at 16 stations on Big Portage Lake and at four stations on Deep Portage Lake. Index values at these stations ranged from one (individual frog calls were distinct) to two (individual frog calls were still distinct, but calls overlapped). Spring peepers (*Pseudacris crucifer*) were also heard at one station on the Big Portage Lake shoreline. Other frog or toad species that may be found near these lakes, such as wood frogs (*Rana sylvatica*) and chorus frogs (*Pseudacris triseriata*), tend to breed earlier in the year and are not strongly associated with larger lakes.

Figure 50. Abundance of green frogs heard during Big Portage and Deep Portage Lakes frog surveys, June 2009.

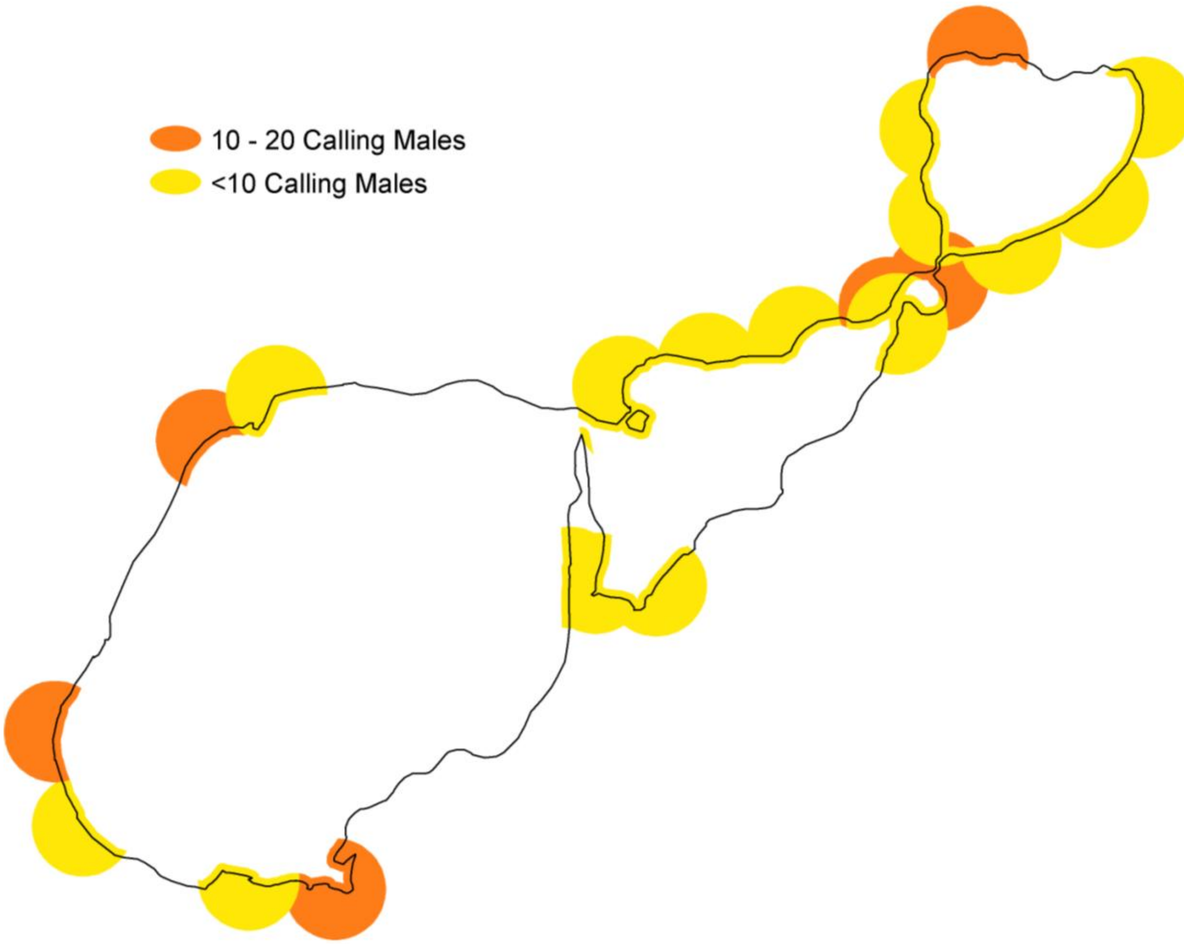


Figure 51. Abundance of mink frogs heard during Big Portage and Deep Portage Lakes frog surveys, June 2009.

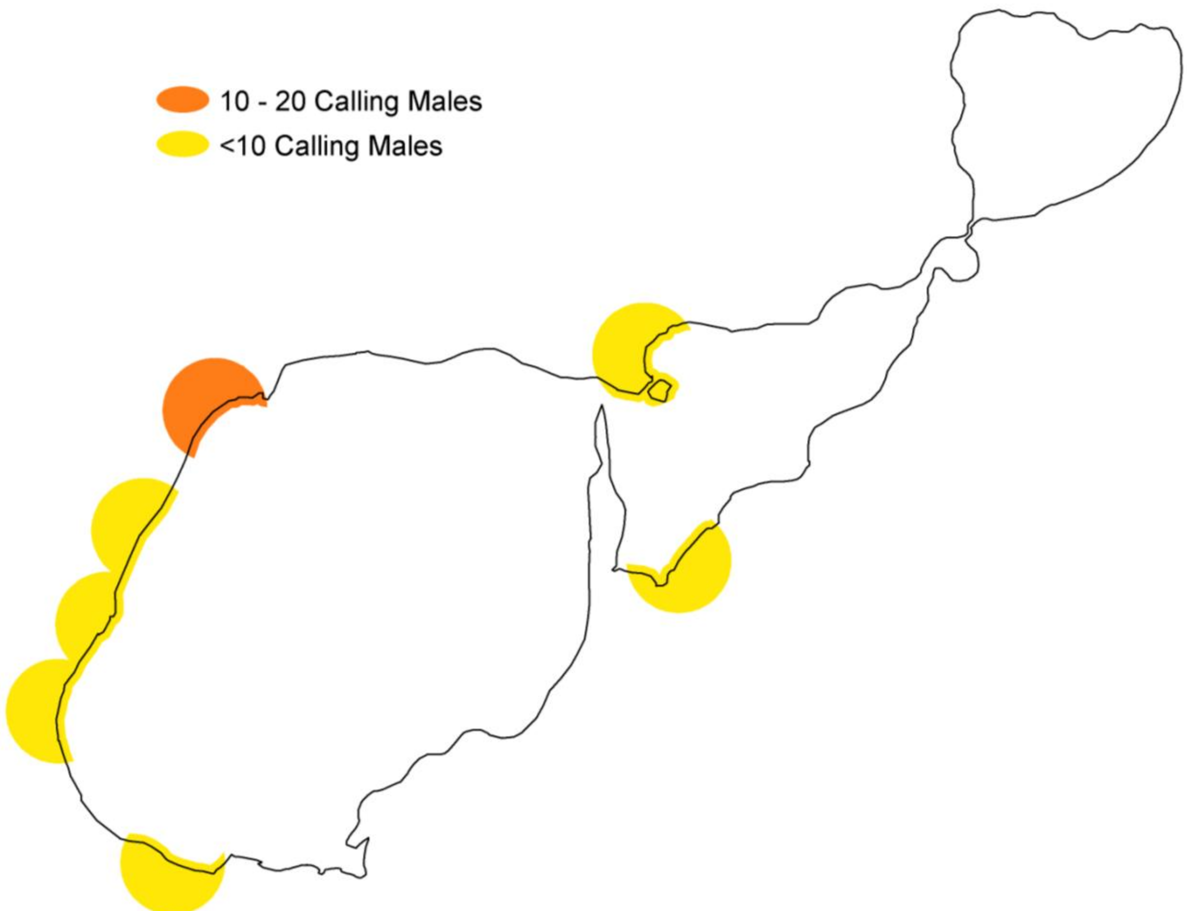
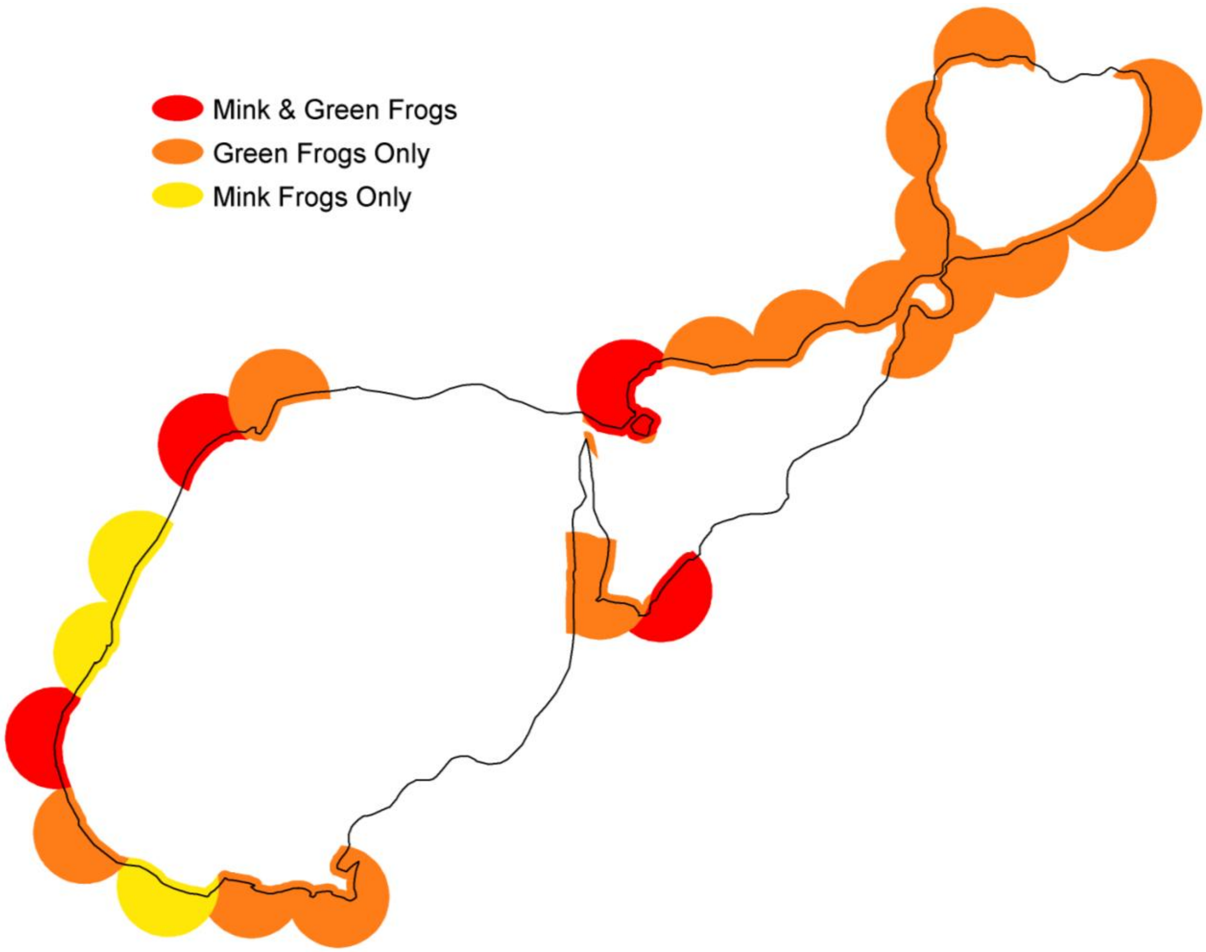


Figure 52. Distribution of green and mink frogs heard during Big Portage and Deep Portage Lakes frog surveys, June 2009.



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 53) 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 minnows 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 53. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (*Etheostoma microperca*; Figure 54) 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 54. Least darter

Photo by: Konrad Schmidt

Longear sunfish (*Lepomis megalotis*; Figure 55) 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 55. 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 56) 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 56. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (*Notropis heterolepis*; Figure 57) 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 57. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (*Fundulus diaphanus*; Figure 58) 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 58. Banded killifish

Photo by: Konrad Schmidt

Methods

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

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

Results

Two near-shore fish species of greatest conservation need were documented during the 2008 nongame fish surveys. Longear sunfish were found at five of seven survey stations on Deep Portage Lake (Figure 59); surveyors recorded 11 individuals at these five sites. In addition, one pugnose shiner was identified at one survey station on Big Portage Lake.

All three proxy species were also documented in Big Portage and Deep Portage Lakes (Figure 60). In Big Portage Lake, blacknose shiners were found with the greatest frequency and in the greatest numbers. Surveyors found approximately 50 individuals at 8 survey stations (Table 4). They also documented 14 individuals at two survey stations on Deep Portage Lake. Blackchin shiners were found in the greatest numbers on Deep Portage Lake. Nearly 75 individuals were recorded at four sites on this lake. An additional 39 individuals were detected at three stations in Big Portage Lake. Banded killifish were found at three stations (N = 28 individuals) in Big Portage Lake and six stations (N = 58) in Deep Portage Lake.

Aquatic plant biovolume was generally higher at sites that contained fish species of greatest conservation need than at sites that did not. Biovolume was similar between sites that contained proxy species and sites that did not. Substrate type at sites where species of greatest conservation need or proxy species were detected was generally small in diameter, and included sand, muck, and silt.

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

Twenty-eight fish species were documented during the 2008 surveys (Table 4). Overall, bluegills and largemouth bass were found most frequently; they were recorded at 100% of the survey stations on Deep Portage Lake and at nearly 90% of the stations on Big Portage Lake. Rock bass and bluntnose minnows were also identified at all survey stations on Deep Portage Lake. In Big Portage Lake, yellow perch were recorded in the greatest numbers. Over 1000 individuals were documented at 25 of 31 survey stations. In Deep Portage Lake, mimic shiners were most abundant. Surveyors counted approximately 5000 fish at four survey sites. Six fish species (white sucker, emerald shiner, pugnose shiner, black bullhead, brown bullhead, and tadpole madtom) that were recorded in Big Portage Lake were not detected in Deep Portage Lake during the 2008 surveys. The longear sunfish, brook stickleback, and mottled sculpin were documented in Deep Portage Lake but not in Big Portage Lake.

In 2008, surveyors recorded five fish species not previously documented in Big Portage Lake. These species were black bullhead, emerald shiner, golden shiner, pugnose shiner, and tadpole madtom. Eleven new species were recorded in Deep Portage Lake. These species were blackchin shiner, banded killifish, blacknose shiner, brook stickleback, central mudminnow, golden shiner, Iowa darter, johnny darter, longear sunfish, mimic shiner, and mottled sculpin. These newly documented species brought the total historical observed fish community in Big Portage Lake to 26 species, and the total historical observed fish community in Deep Portage Lake to 27 species.

Figure 59. Distribution of fish species of greatest conservation need documented during Big Portage and Deep Portage Lakes fish surveys, July 2008.

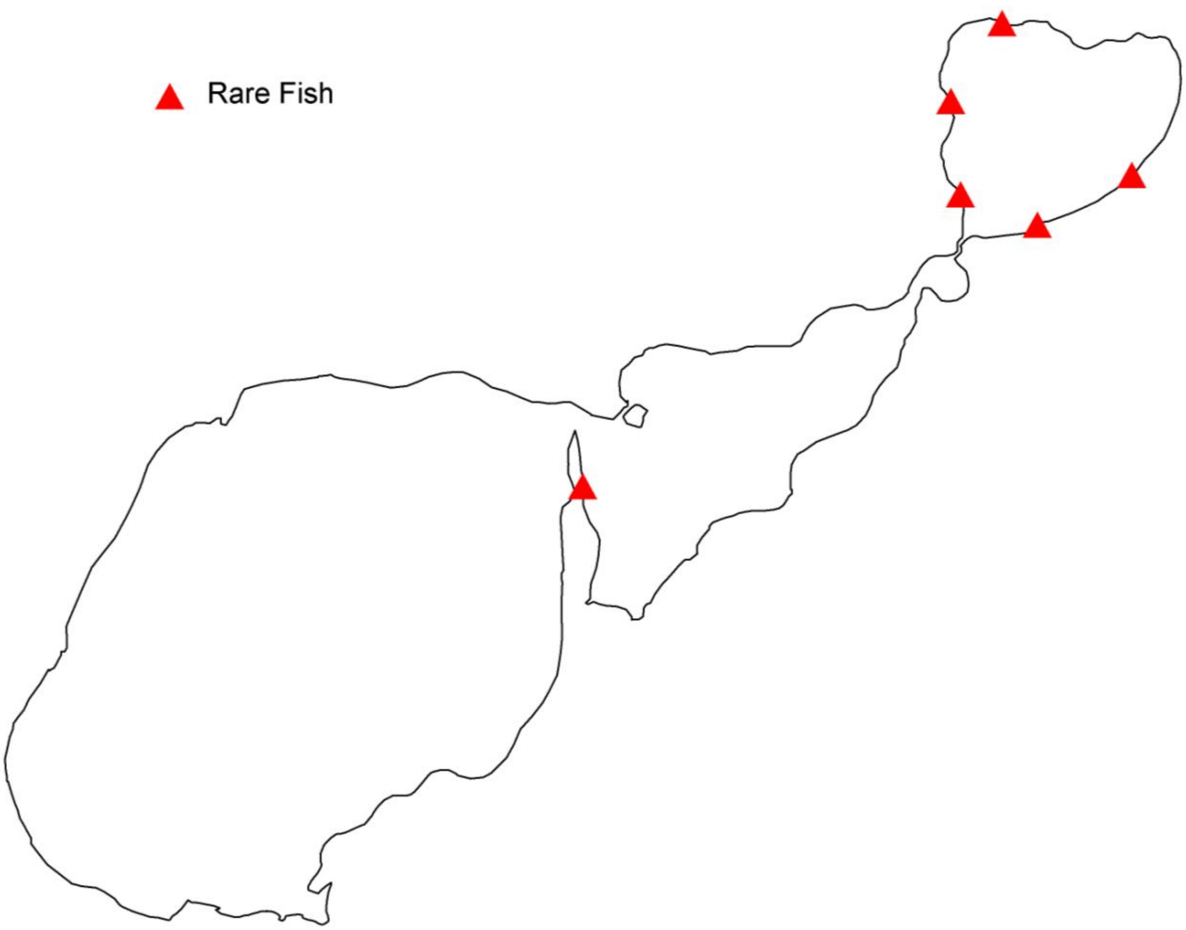


Figure 60. Distribution of fish proxy species documented during Big Portage and Deep Portage Lakes fish surveys, July 2008.

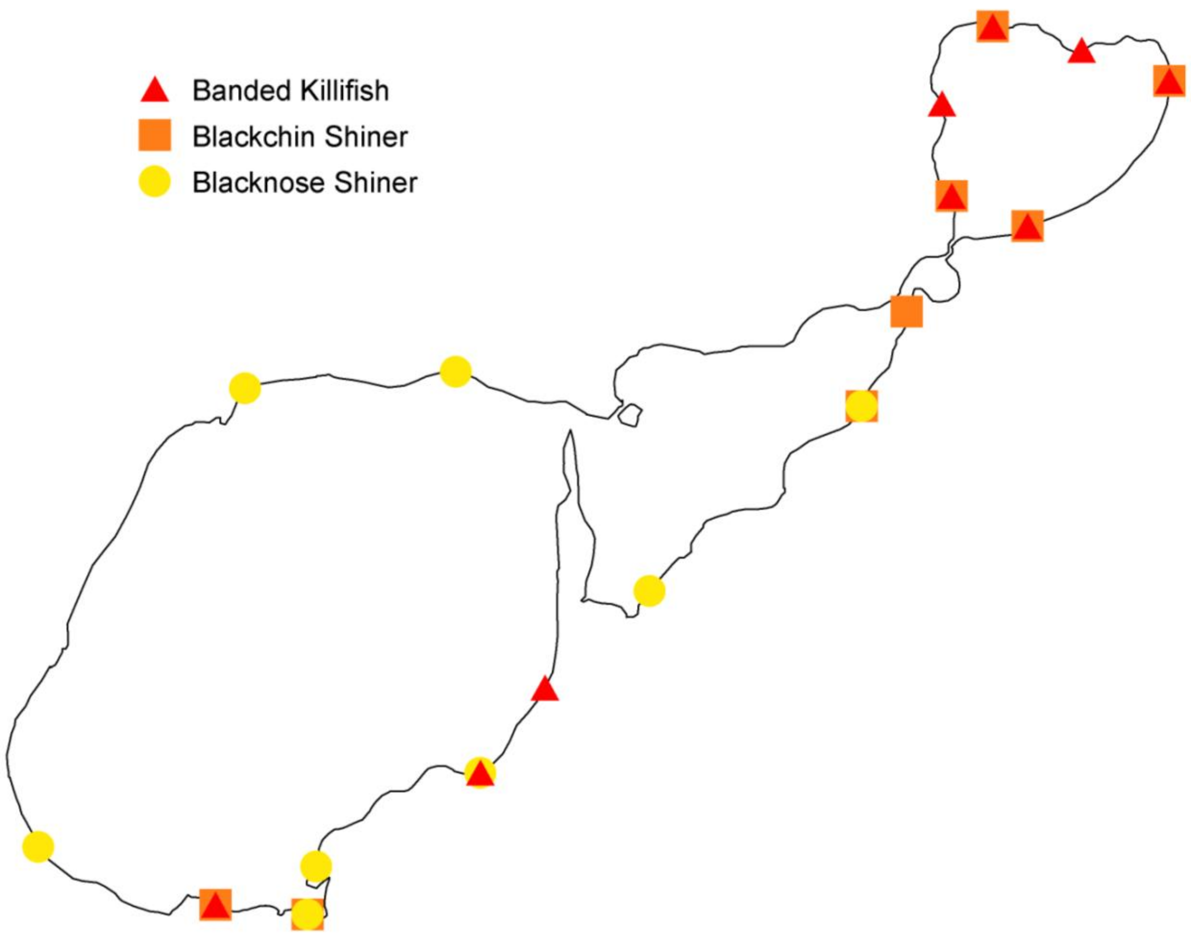


Table 4. Abundance and frequency of fish species identified during Big Portage and Deep Portage Lakes fish surveys, July 2008. * denotes species of greatest conservation need

Description	Common Name	Scientific Name	Big Portage		Deep Portage	
			# [a]	% [b]	#	%
Bowfins	Bowfin	*Amia calva*	40	48	3	29
Suckers	White sucker	*Catostomus commersonii*	2	6	–	–
Sunfishes	Black crappie	*Pomoxis nigromaculatus*	26	45	11	71
	Bluegill	*Lepomis macrochirus*	370	87	91	100
	Longear sunfish*	*Lepomis megalotis*	–	–	11	71
	Largemouth bass	*Micropterus salmoides*	973	87	~1200	100
	Pumpkinseed	*Lepomis gibbosus*	13	29	3	43
	Rock bass	*Ambloplites rupestris*	10	19	24	100
Minnows	Blackchin shiner	*Notropis heterodon*	39	13	73	57
	Blacknose shiner	*Notropis heterolepis*	46	26	14	29
	Bluntnose minnow	*Pimephales notatus*	142	35	361	100
	Emerald shiner	*Notropis atherinoides*	1	3	–	–
	Golden shiner	*Notemigonus crysoleucas*	14	3	5	14
	Mimic shiner	*Notropis volucellus*	10	13	~5000	57
	Pugnose shiner*	*Notropis anogenus*	1	3	–	–
Pikes	Northern pike	*Esox lucius*	16	35	7	43
Killifishes	Banded killifish	*Fundulus diaphanus*	28	10	58	86
Sticklebacks	Brook stickleback	*Culaea inconstans*	–	–	1	14
Sculpins	Mottled sculpin	*Cottus bairdi*	–	–	1	14
North American freshwater catfishes	Black bullhead	*Ameiurus melas*	4	13	–	–
	Brown bullhead	*Ameiurus nebulosus*	2	6	–	–
	Tadpole madtom	*Noturus gyrinus*	1	3	–	–
	Yellow bullhead	*Ameiurus natalis*	72	65	5	29
Perches	Iowa darter	*Etheostoma exile*	33	19	14	71
	Johnny darter	*Etheostoma nigrum*	28	10	5	29
	Walleye	*Sander vitreus*	12	29	1	14
	Yellow perch	*Perca flavescens*	~1200	81	107	86
Mudminnows	Central mudminnow	*Umbra limi*	10	19	36	57

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

[b] % – Percent of surveyed sample sites in which a species occurred on Big Portage Lake (N = 31) and Deep Portage Lake (N = 7)

Aquatic Vertebrate Richness

Objective

1. Calculate and map aquatic vertebrate richness around the shoreline of Big Portage and Deep Portage 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

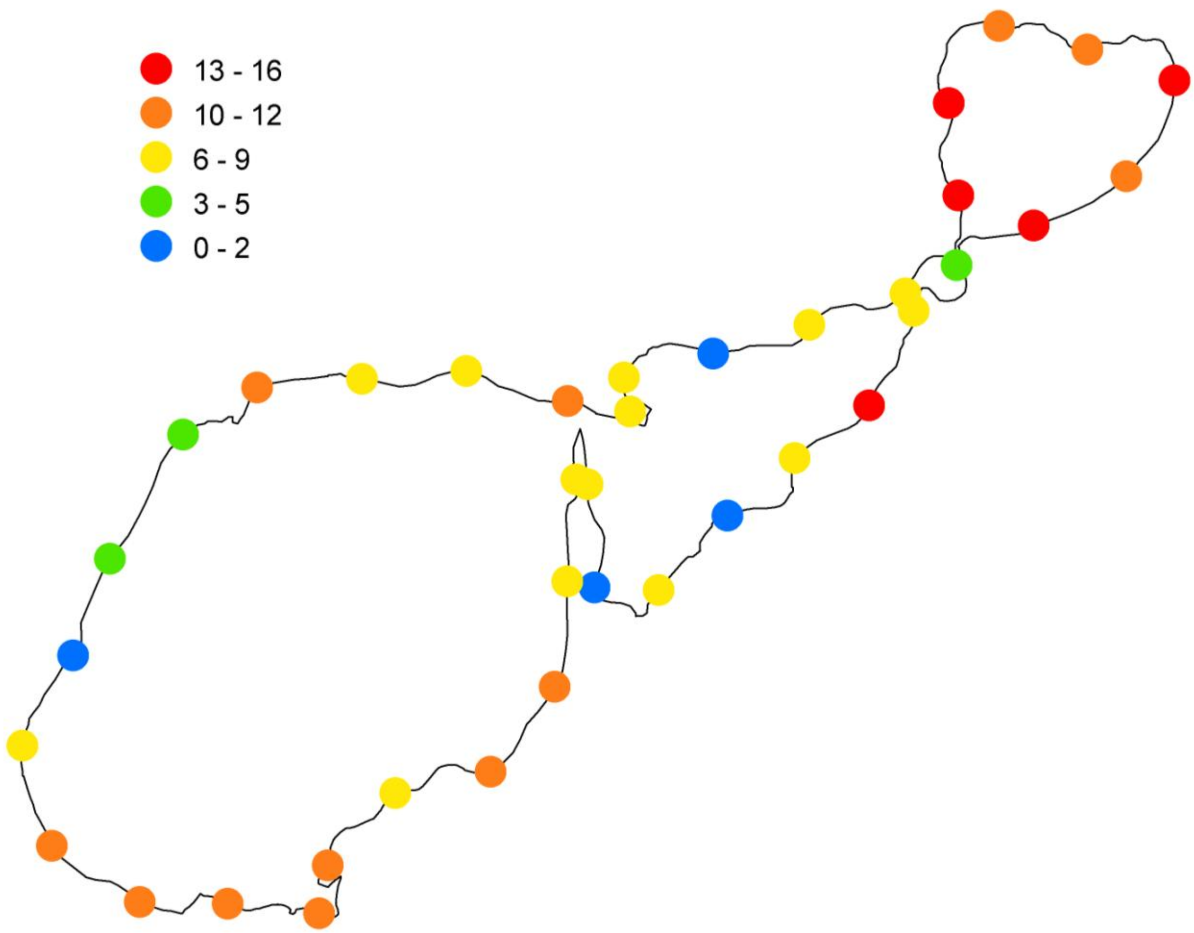
Aquatic vertebrate species were documented during the nongame fish sampling surveys. All aquatic vertebrates, including fish, frogs, and turtles, captured during trapnetting, seining, and electrofishing surveys were identified to the species level. Young-of-year animals that could not be identified to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

Results

Survey stations on Big Portage and Deep Portage Lakes contained between zero and 16 aquatic vertebrate species (Figure 61). Two survey stations along the western shoreline of Deep Portage Lake contained 16 species, and no fewer than eleven aquatic vertebrate species were recorded at any Deep Portage Lake survey site. One survey station along the northeastern shoreline of Big Portage Lake contained 15 aquatic vertebrate species, and an additional nine stations contained between 10 and 12 species.

The majority of the documented species were fish, although green frogs, mink frogs, painted turtles, snapping turtles, and beaver were also recorded. Painted turtles were documented at all seven survey stations on Deep Portage Lake and at nearly half of the stations on Big Portage Lake. Hybrid sunfish were identified on both lakes, but were not included in the analysis.

Figure 61. Aquatic vertebrate species richness (number of species per sample site) documented during Big Portage and Deep Portage Lakes fish surveys, July 2008.



Other Rare Features

Objective

1. Map rare features occurring within the extended state-defined shoreland area of Big Portage and Deep Portage 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

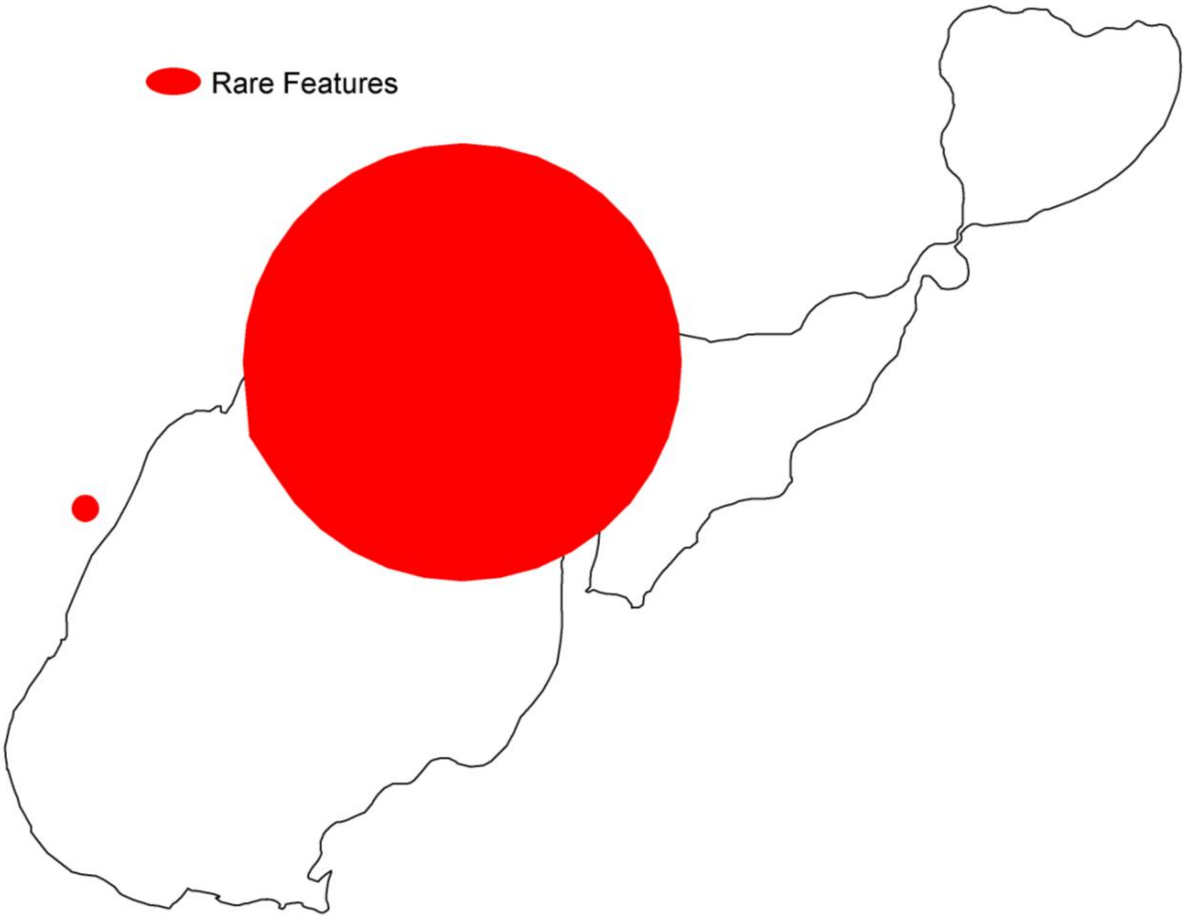
Researchers obtained locations of rare features from the Rare Features Database. Only “listed” plant and animal species (Federal or State endangered, threatened, or special concern) were considered in this project; non-listed unique plant species were included in the “Unique Plant Species” section of 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

Rare features in Big Portage Lake included two locations of a bird species of Special Concern (Figure 62). The publication of exact descriptive and locational information is prohibited in order to help protect this rare species. Rare features were not documented in Deep Portage Lake.

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

Figure 62. Natural Heritage Database rare features (Federal or State-listed endangered, threatened, or special concern species) located within 1320 feet of Big Portage and Deep Portage 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

No defined bays were identified on Big Portage or Deep Portage Lakes.

II. Ecological Model Development

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

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

Scores for each of the layers were summed (Figure 63). This map represents an index of sensitivity; those points with higher total scores are highly sensitive, whereas points with lower total scores have lower sensitivity.

Once the total score index was developed for the shoreline, clusters of points along the shoreline with similar values were identified using GIS (Figure 64). The clusters with high values (i.e., areas of highly sensitive shoreline) were buffered by ¼ mile. These buffered areas were defined as most likely highly sensitive lakeshore areas. These areas will be forwarded to the local government for potential designation as resource protection areas (Figure 65).

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

Variable	Score	Criteria
Wetlands	3	> 25% of analysis window contains wetlands
	2	12.5 – 25% contains wetlands
	1	< 12.5% comprised contains wetlands
	0	No wetlands present
Hydric Soils	3	> 25% of analysis window contains hydric soils
	2	12.5 – 25% hydric soils
	1	< 12.5% hydric soils
	0	No hydric soils present
Near-shore Plant Occurrence	3	Frequency of occurrence is > 75% (> 75% of points within analysis window contained vegetation)
	2	Frequency of occurrence is 25 – 75%
	1	Frequency of occurrence < 25%
	0	No vegetation present
Aquatic Plant Richness	3	Total number of plant taxa per analysis window > 10
	2	Total number of plant taxa 5 – 10
	1	Total number of plant taxa 1 – 4
	0	No vegetation present
Presence of Emergent and Floating-leaf 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 Plant Species	3	Presence of 2 or more unique plant species within analysis window
	2	Presence of 1 unique plant species
	0	No unique plant species present
Near-shore Substrate	3	Frequency of occurrence is > 50% soft substrate (> 50% of points within analysis window consist of soft substrate)
	2	Frequency of occurrence is 25 – 50% soft substrate
	1	Frequency of occurrence < 25% soft substrate
	0	No soft substrate present
Birds	3	Presence of 3 or more SGCN within analysis window
	2	Presence of 2 SGCN
	1	Presence of 1 SGCN
	0	No SGCN present

Table 5, continued.

Variable	Score	Criteria
Bird Richness	3	Total number of bird species within analysis window > 25
	2	Total number of bird species 11 – 25
	1	Total number of bird species 1 – 10
	0	No bird species observed
Loon Nesting Areas	3	Presence of natural loon nest within analysis window
	2	Presence of artificial loon nest (nesting platform)
	0	No loon nesting observed
Frogs	3	Presence of both mink frogs and green frogs within analysis window
	2	Presence of mink frogs or green frogs
	0	Neither mink frogs nor green frogs present
Fish	3	Presence of one or more species of greatest conservation need within analysis window
	2	Presence of one or more proxy species
	0	Neither SGCN nor proxies observed
Aquatic Vertebrate Richness	3	Total number of aquatic vertebrate species within analysis window > 10
	2	Total number of aquatic vertebrate species 5 – 10
	1	Total number of aquatic vertebrate species 1 – 4
	0	No aquatic vertebrate species observed
Rare Features	3	Presence of multiple Natural Heritage features within analysis window
	2	Presence of one Natural Heritage feature
	0	No Natural Heritage feature present
Bays	3	Isolated bay within analysis window
	2	Non-isolated bay
	0	Not a distinctive bay

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

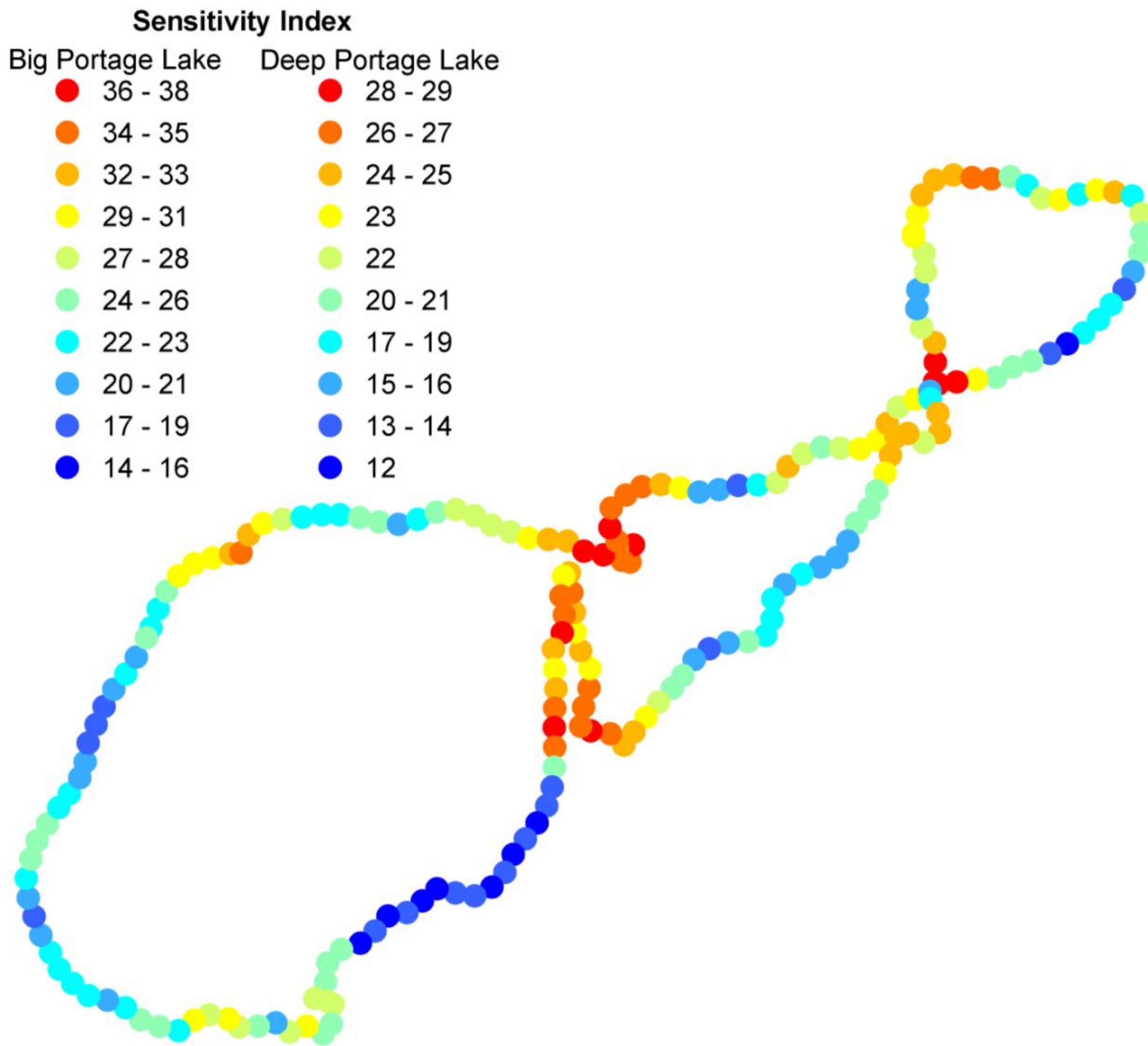
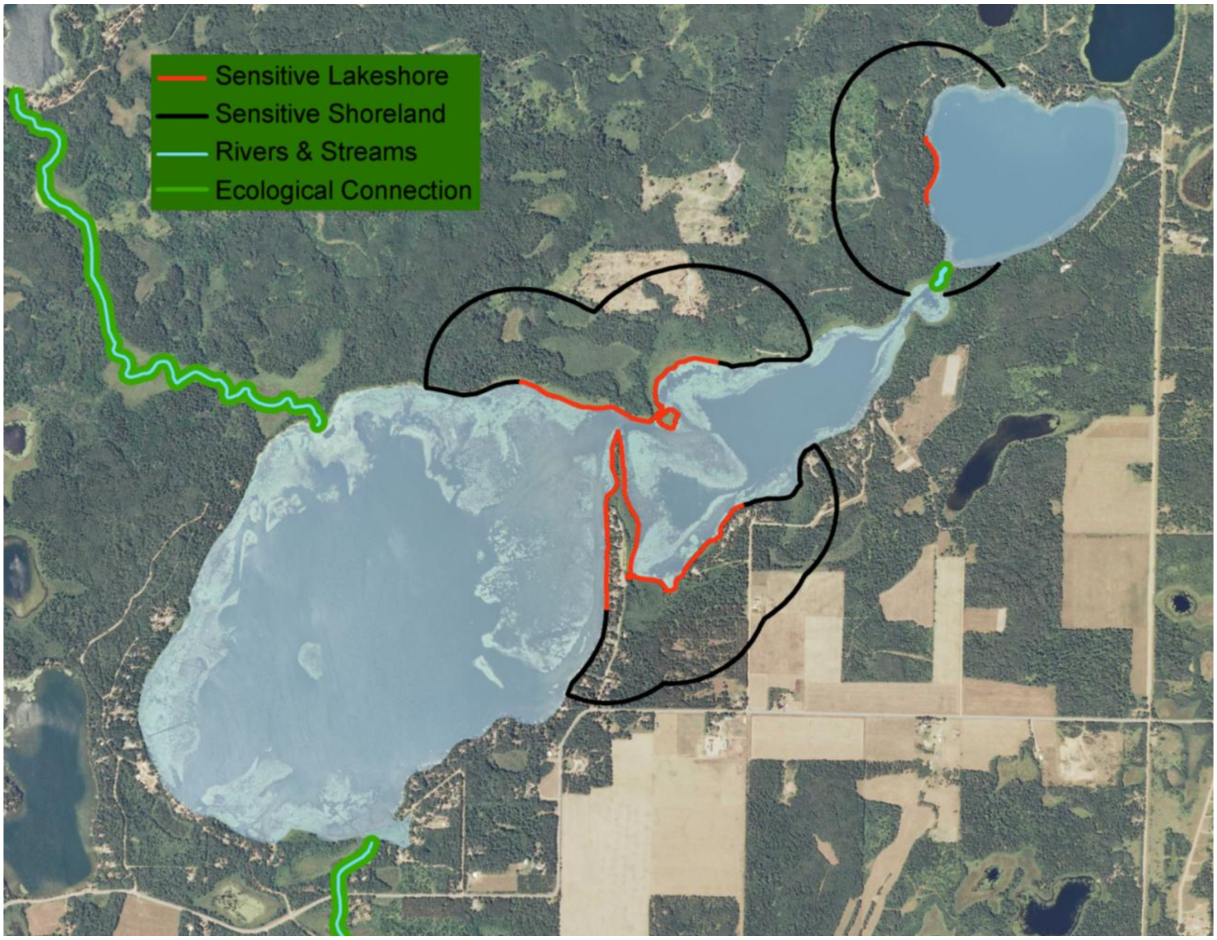


Figure 64. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland).

Figure 65. The sensitive lakeshore areas identified by the ecological model.



Habitat Connectivity

In addition to the sensitive shoreline identified through the GIS model, surveyors considered adjacent river shorelines that provide habitat connectivity to and from the lake shorelands. Aquatic habitat connectivity allows for the movement of aquatic organisms within a watershed, and the benefits are numerous. Organisms can move between existing habitats, colonize new areas or re-colonize former habitat in the wake of local extinctions. Connectivity allows organisms to move between multiple waterbodies and access various food sources. It allows animals with different vegetation requirements during different life stages to access those habitats. It allows movement of animals from various populations, increasing diversity. The inlet and outlet of Big Portage Lake, as well as the channel between Big Portage Lake and Deep Portage Lake, were identified as important ecological connections. Depending on the existing shoreland classification of these shorelines, the County may use this recommendation to consider reclassifying to a more protective class.

Other Areas of Ecological Significance

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

Emergent and floating-leaf plant beds that occur outside of the sensitive shoreland districts are areas of ecological significance. Extensive stands of wild rice and hardstem bulrush occur in Big Portage Lake. Many of these stands have already been fragmented by boat channels. Scattered stands of hardstem bulrush are present on Deep Portage Lake. Further destruction of bulrush plants would be particularly detrimental because attempts to restore these types of plants have had limited success.

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

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

Sensitive Lakeshore

Several stretches of shoreline along Big and Deep Portage Lakes were identified as sensitive by the ecological model. These stretches supported the greatest diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such as wetland habitat, was also present in the highest quantities near these areas. The ecological model displays these areas both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby has significant negative effects on many species. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. The rivers and streams connected to Big and Deep Portage Lakes are also an important part of the ecosystem. They provide valuable connectivity between the lakes and nearby habitat. Protection of these important corridors will help minimize fragmentation, and will help maintain the health of the lake ecosystem. Protection of both the shoreline itself and the habitat surrounding the shoreline will be the most effective way to preserve the plant and animal communities in and around Big and Deep Portage Lakes, and the value of the lakes themselves.

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Appendix 1. Shoreline plants identified in Big Portage and Deep Portage Lakes, 2008.

Description	Common Name	Scientific Name	Survey type
SHORELINE EMERGENT	Swamp milkweed	*Asclepias incarnata*	a
	Purple-flowered aster	*Aster* sp.	a
	Canada bluejoint grass	*Calamagrostis canadensis*	a
	Water arum	*Calla palustris*	a
	Marsh bellflower	*Campanula aparinoides*	a
	Narrow-leaved sedge	*Carex* sp.	a
	Water sedge	*Carex aquatilis*	a
	Bottlebrush sedge	*Carex comosa*	b
	Lake sedge	*Carex lacustris*	b
	Pennsylvania sedge	*Carex pensylvanica*	a
	Spotted water hemlock	*Cicuta maculata*	a
	Spotted joe-pye weed	*Eutrochium maculatum*	a
	Bedstraw	*Galium* sp.	a
	Jewelweed	*Impatiens capensis*	a,b
	Blue flag iris	*Iris versicolor*	a
	Water horehound	*Lycopus uniflorus*	a
	Wild mint	*Mentha arvensis*	a
	Coltsfoot	*Petasites frigidus*	a
	Reed canary grass	*Phalaris arundinacea*	b
	Giant cane	*Phragmites australis*	a
	Bluegrass	*Poa* sp.	a
	Swamp five-finger	*Potentilla palustris*	a
	Marsh skullcap	*Scutellaria galericulata*	a
	Northern marsh fern	*Thelypteris palustris*	a
	Western poison ivy	*Toxicodendron rydbergii*	a
	Stinging nettle	*Urtica dioica*	a
SHORELINE SHRUBS	Speckled alder	*Alnus incana*	a
	Bog birch	*Betula pumila*	a
	Round-leaf dogwood	*Cornus rugosa*	a
	Red-osier dogwood	*Cornus sericea*	a
	Wild honeysuckle	*Lonicera dioica*	a
	Cherry	*Prunus* sp.	a
	Blackberry	*Rubus* sp.	a
	Wild rose	*Rosa* sp.	a

a. Perleberg, D. and Loso, S. August 7, 2008 (nearshore vegetation plots)
b. Myhre, K. July 15, 2008 (Minnesota County Biological Survey)

Nomenclature follows MNTaxa 2009.

Appendix 2. Bird species list. Includes all species recorded at Big Portage and Deep Portage Lakes during surveys and casual observation, May – June 2009. * denotes species of greatest conservation need.

Common Name	Scientific Name
Canada goose	*Branta canadensis*
Trumpeter swan*	*Cygnus buccinator*
Wood duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Common loon*	*Gavia immer*
American white pelican*	*Pelecanus erythrorhynchos*
Great blue heron	*Ardea herodias*
Green heron	*Butorides virescens*
Turkey vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald eagle*	*Haliaeetus leucocephalus*
Broad-winged hawk	*Buteo platypterus*
Merlin	*Falco columbarius*
Sora	*Porzana carolina*
Ring-billed gull	*Larus delawarensis*
Caspian tern	*Hydroprogne caspia*
Black tern*	*Chlidonias niger*
Common tern*	*Sterna hirundo*
Mourning dove	*Zenaida macroura*
Black-billed cuckoo*	*Coccyzus erythropthalmus*
Common nighthawk*	*Chordeiles minor*
Ruby-throated hummingbird	*Archilochus colubris*
Red-bellied woodpecker	*Melanerpes carolinus*
Yellow-bellied sapsucker*	*Sphyrapicus varius*
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*

Appendix 2, continued.

Common Name	**Scientific Name**
Purple martin	*Progne subis*
Tree swallow	*Tachycineta bicolor*
Northern rough-winged swallow*	*Stelgidopteryx serripennis*
Bank swallow	*Riparia riparia*
Barn swallow	*Hirundo rustica*
Black-capped chickadee	*Poecile atricapilla*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*Sitta carolinensis*
House wren	*Troglodytes aedon*
Sedge wren*	*Cistothorus platensis*
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*
Chestnut-sided warbler	*Dendroica pensylvanica*
Yellow-rumped warbler	*Dendroica coronata*
Pine warbler	*Dendroica pinus*
Blackpoll warbler	*Dendroica striata*
Black-and-white warbler	*Mniotilta varia*
American redstart	*Setophaga ruticilla*
Ovenbird*	*Seiurus aurocapilla*
Common yellowthroat	*Geothlypis trichas*
Wilson's warbler	*Wilsonia pusilla*
Chipping sparrow	*Spizella passerina*
Clay-colored sparrow	*Spizella pallida*
Song sparrow	*Melospiza melodia*
Swamp sparrow*	*Melospiza georgiana*
Northern cardinal	*Cardinalis cardinalis*
Rose-breasted grosbeak*	*Pheucticus ludovicianus*
Red-winged blackbird	*Agelaius phoeniceus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Baltimore oriole	*Icterus galbula*
American goldfinch	*Pinus tristis*