Final Report
Sensitive Lakeshore Survey
Woman Lake (11-0201)
Cass County, MN

July 2008

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

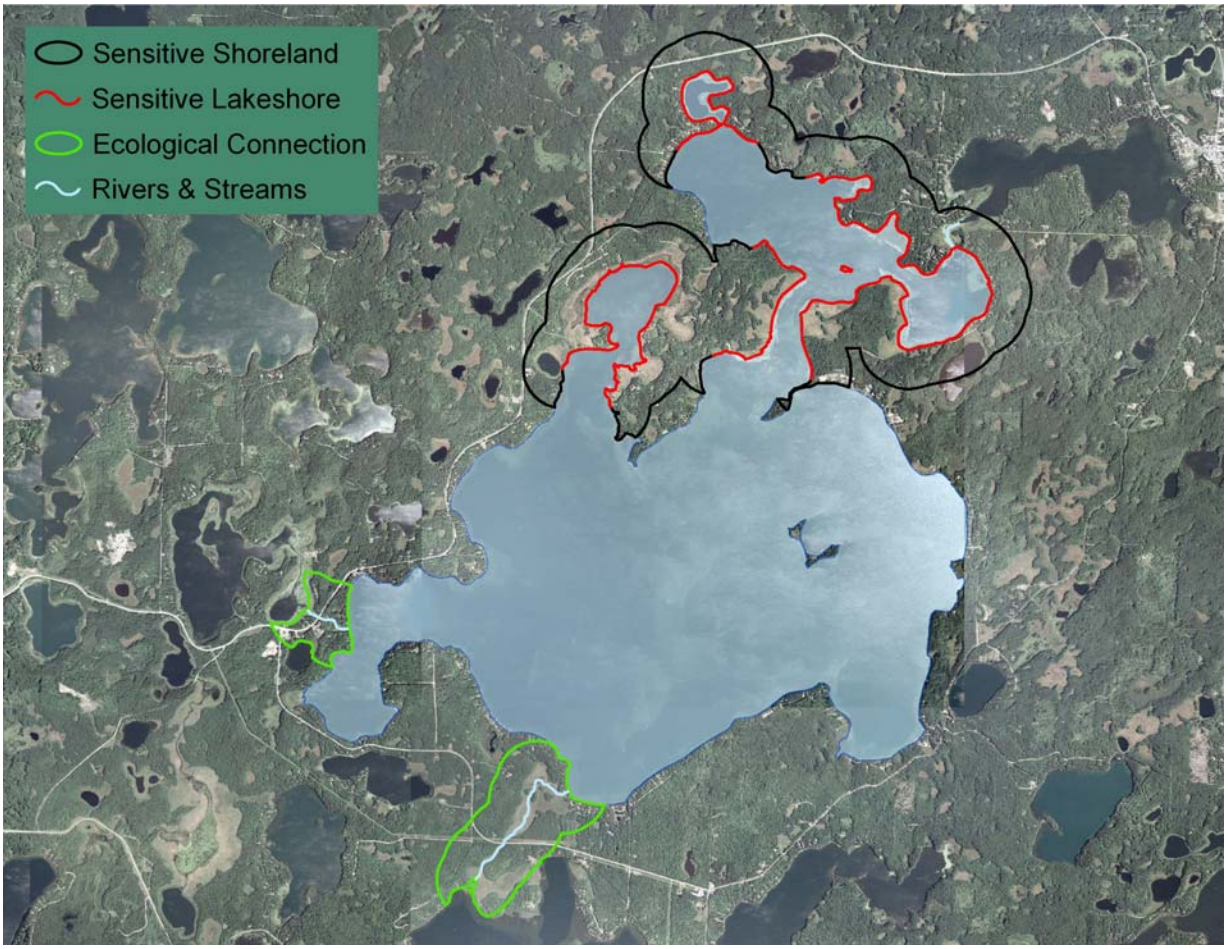
Plant surveys revealed a rich, diverse plant community. A total of 41 native aquatic plant taxa were recorded, making Woman Lake among the richest lake plant communities in the state. Plant growth was sparse in the main lake but within Broadwater Bay, Lantern Bay and Bungey Bay, 70% of the sites were vegetated. Common submerged plants included muskgrass, narrow-leaf and broad-leaf pondweeds, wild celery, Canada waterweed, and coontail. Approximately 180 acres of wild rice, 17 acres of bulrush and 16 acres of mixed waterlily beds occurred within Lantern Bay and Broadwater Bay. Unique aquatic plants were identified at 18 sampling stations. Plants included small bladderwort species (*Utricularia intermedia, U. gibba, and U. minor*), water arum (*Calla palustris*), and wiregrass sedges (*Carex oligosperma* and *C. lasiocarpa*). Five of these species were documented for the first time in Woman Lake.

Two fish species of greatest conservation need (pugnose shiner and longear sunfish) were documented in Woman Lake. A total of 30 fish species were found during the 2006 surveys, bringing the total documented fish community at Woman Lake to 39 species. Surveyors identified four species (blacknose shiner, pugnose shiner, spotfin shiner, and central mudminnow) not previously documented at Woman Lake. Both mink and green frogs were observed, with the vast majority found in the sheltered bays. Surveyors documented 62 species of birds, including 11 species of greatest conservation need. Red-eyed vireos were the most abundant bird species overall, whereas the veery was the most commonly detected species of greatest conservation need. Although distribution of several species was restricted to the bays, others were found along the shoreline of the main basin as well.

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

The ecological model identified several primary sensitive shoreland areas to be considered for a potential resource protection district by Cass County. Two rivers were

also identified as important ecological connections. The County may use this information in making decisions about districting and reclassification of lakeshore areas. 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 Woman Lake sensitive lakeshore areas.

Lake Description

Woman Lake (DOW 11-0201-00) is located about nine miles east of the city of Hackensack, in Cass County, north-central Minnesota (Figure 1). Woman Lake is part of a chain of lakes along the Boy River. The Boy River enters the west side of Woman Lake from Child Lake and exits on the east side into Girl Lake and before continuing north to Leech Lake.

Figure 1. Location of Woman Lake in Cass County, Minnesota.

Woman Lake has a surface area of 4,782 acres, making it one of the larger lakes in the state and the sixth largest in Cass County. The lake includes a central basin and several large bays (Figure 2); Broadwater Bay is the largest with an area of about 1000 acres. Horseshoe Island, a forested island on the east side of the main basin, is approximately 11 acres in area.

Woman Lake has a maximum depth of 54 feet and about 40 percent of the lake is less than 15 feet in depth. Most of the shallow areas are located in the northern end of the lake, including Broadwater and Lantern Bays (Figure 3). The shoreline of Woman Lake is primarily forested but also heavily developed with residential homes. There is a public boat launch on the northwest shore and on the north shore between Lantern Bay and Broadwater Bay.

I. Field Surveys and Data Collection

Survey and data collection followed Minnesota's Sensitive Lakeshore Area Identification Manual protocol (MN DNR 2008a). 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.

Figure 2. Features of Woman Lake

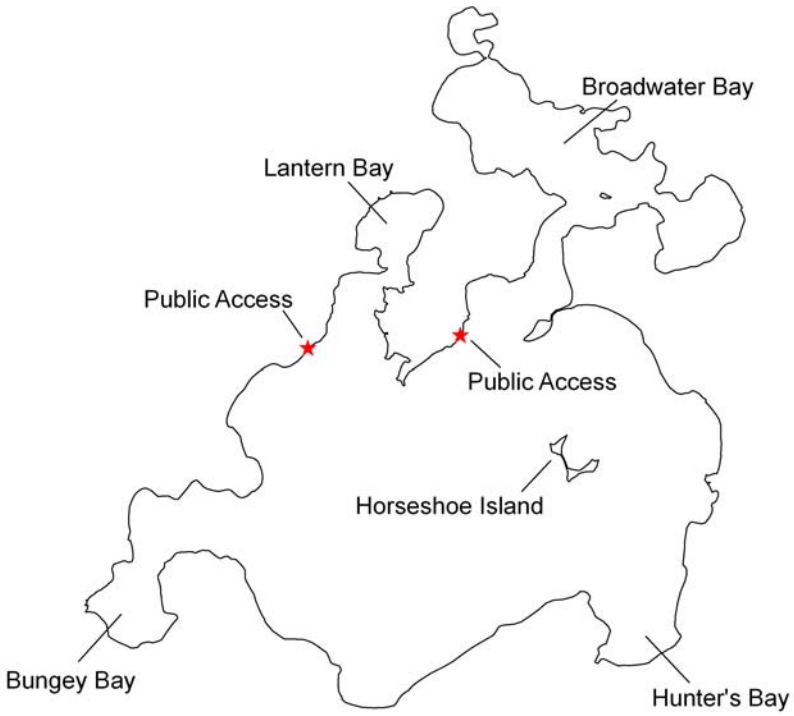
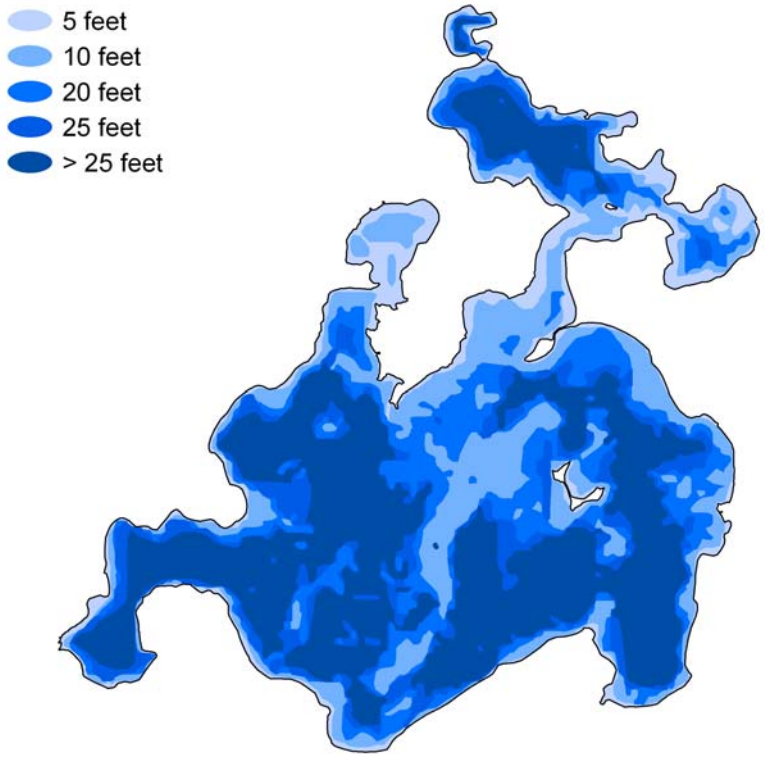


Figure 3. Depth contours of Woman Lake.



Wetlands

Objectives

1. Map wetlands within the state-defined shoreland area of Woman Lake

Summary

Wetlands were distributed along the majority of the Woman Lake shoreline.

Introduction

Wetland in northwest corner of Broadwater Bay, Woman Lake

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 non-soil and 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

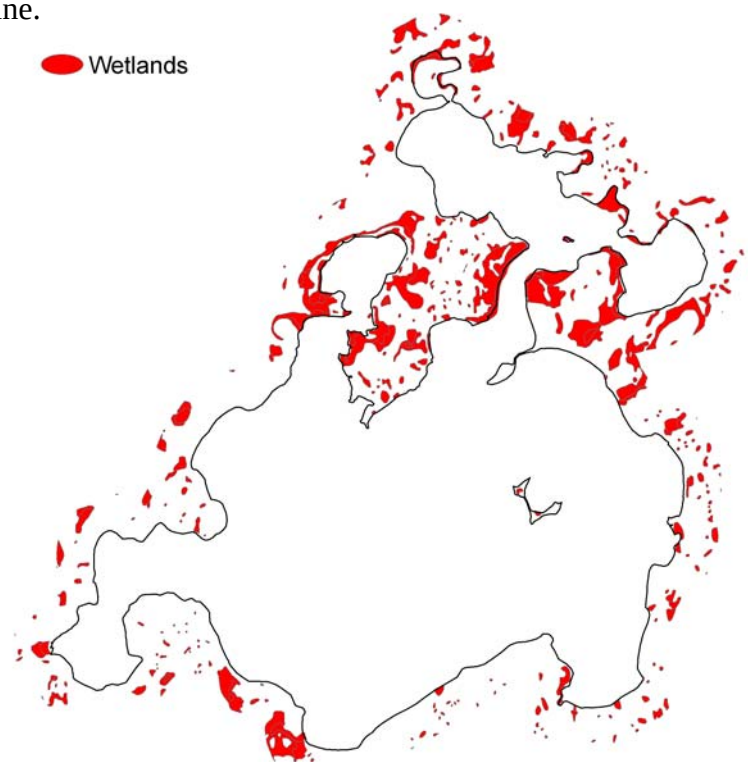
Wetland data were obtained from the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS). The NWI project was conducted between 1991 and 1994 using aerial photography from 1979 – 1988. Wetland polygons obtained from the NWI were mapped in a GIS (Geographic Information Systems)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

Results

Approximately 700 acres, or about 15 percent of the Woman Lake shoreland (the area within 1320 feet of the shoreline), are described as wetlands by NWI. About 500 of these wetland acres (70%) were near the northern bays, including Broadwater Bay and Lantern Bay (Figure 4). The largest connected wetland complexes ranged in area from 30 to 70 acres and occurred in these northern bays and at the inlet from Blackwater Lake at the south end of the lake. Most of the other wetlands found around the lake were less than an acre in area.

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

Figure 4. Distribution of wetlands within 1320 feet of Woman Lake shoreline.



Hydric Soils

Objectives

1. Map hydric soils within the state-defined shoreland area of Woman Lake

Summary

Hydric soils were present along much of the shoreline of Woman Lake.

Introduction

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

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

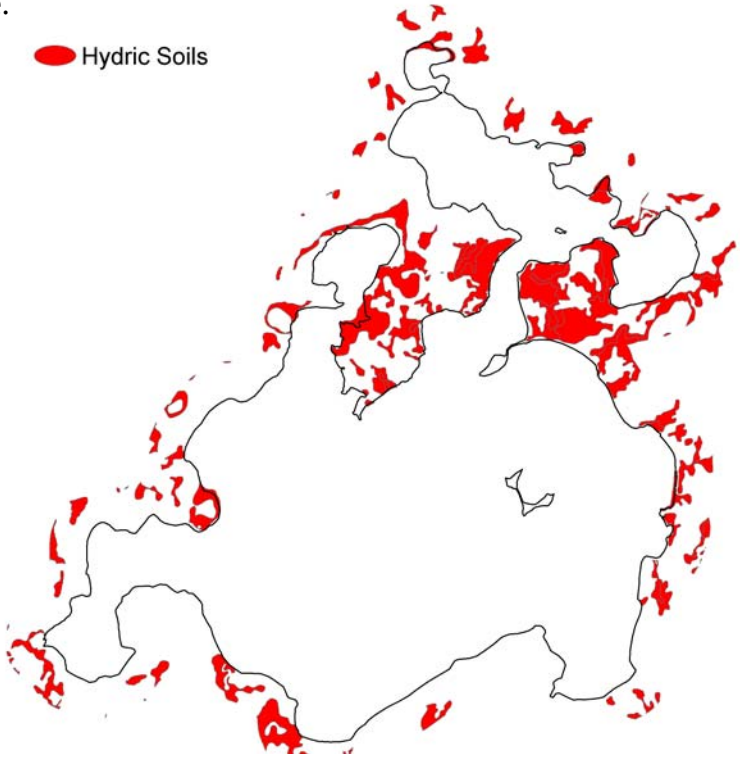
Methods

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

Results

Hydric soils were widespread along the shoreline of Woman Lake (Figure 5). Specific hydric soil types varied, but were dominated by muck and peat. Hydric soils were most abundant near the channel to Broadwater Bay and near Lantern Bay.

Figure 5. Distribution of hydric soils within 1320 feet of Woman Lake shoreline.



Plant Surveys

Objectives

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

Plant growth was sparse in the main lake but within Broadwater Bay, Lantern Bay and Bungey Bay, 70% of the sites were vegetated. Plant species richness was also highest within the bays. A total of 41 native aquatic plant taxa were recorded, making Woman Lake among the richest lake plant communities in the state. Non-native aquatic plants were not found.

Submerged plants occurred to a depth of 23 feet but were most common from shore to a depth of 15 feet. Common submerged plants included muskgrass (*Chara* sp.), narrow-leaf and broad-leaf pondweeds (*Potamogeton* sp.), wild celery (*Vallisneria americana*), Canada waterweed (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*).

Most emergent and floating-leaf plant beds were within Lantern Bay and Broadwater Bay. Surveyors delineated approximately 180 acres of wild rice (*Zizania palustris*), 17 acres of bulrush (*Scirpus* sp.) and 16 acres of waterlily (*Nymphaea* and *Nuphar*) beds in these bays.

Unique aquatic plants were identified at 18 sampling stations. Plants included small bladderwort species (*Utricularia intermedia, U. gibba, and U. minor*), water arum (*Calla palustris*), and wiregrass sedges (*Carex oligosperma* and *C. lasiocarpa*). Five of these species were documented for the first time in Woman Lake.

Introduction

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity, water chemistry, depth, substrate and wave activity. Deep or wind-swept areas are often lacking in aquatic plant growth, whereas sheltered shallow areas can 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 taxa,

introductions of non-native plant or animal taxa, and human activities in and around the lake.

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

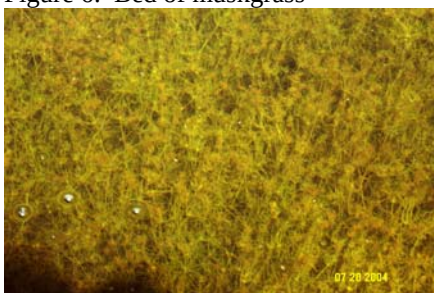
Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant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

Submerged plants

A wide variety of native plant species were found within Woman Lake. The most common submerged plants were muskgrass (*Chara* sp.), narrow-leaf pondweeds (*Potamogeton* sp.), broad-leaf pondweeds (*Potamogeton* sp.), wild celery (*Vallisneria americana*), Canada waterweed (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*).

Muskgrass (Figure 6) is a macroscopic, or large, algae that is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important habitat for fish spawning and nesting.

Figure 6. Bed of muskgrass



Nine different native submerged "pondweed" (*Potamogeton* sp.) taxa occur in Woman Lake and most are named for their unique leaf structure. The fruits of pondweeds are a favorite duck food and the leaves provide food and shelter for fish.

Figure 7. Flat-stem pondweed

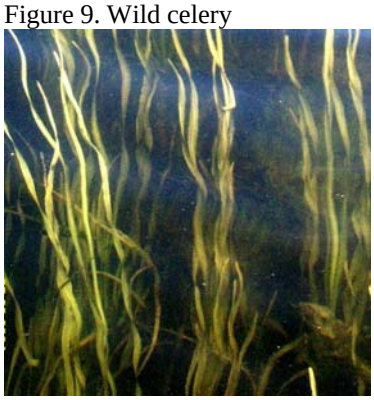
Narrow-leaf pondweeds include flat-stem pondweed (*Potamogeton zosteriformis*; Figure 7) and Fries' pondweed (*Potamogeton friesii*). These

plants have 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 8. Large-leaf pondweed

Broad-leaf pondweeds in Woman Lake included large-leaf pondweed (*Potamogeton amplifolius*), variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, white-stem pondweed (*P. praelongus*), and clasping-leaf pondweed (*P. richardsonii*). These rooted, perennial plants with wide leaves are often called "cabbage" plants by anglers. They often grow in patches or beds, and have spiked seed heads that grow above the water during the summer. These plants are primarily submerged but many will form floating leaves in shallower water (Figure 8). Broad-leaf pondweeds provide habitat for several fish species, including muskie, northern pike, largemouth bass, and bluegills. Walleye also frequently use broad-leaf pondweeds for cover.

Figure 9. Wild celery



Wild celery (Figure 9) is a rooted, perennial plant with long, dark green grass-like leaves. It grows beneath the water surface, though the leaves sometimes reach to the water surface. In summer, small pods or flowers may be present at the end of long, coiled stalks. Beds of wild celery provide food and shelter for fish and all parts of the plant are consumed by waterfowl, shorebirds and muskrats. Wild celery is a particularly important food source for canvasback ducks.

Figure 10. Canada waterweed
Photo: Vic Ramey, U of Florida

Canada waterweed (Figure 10) is a rooted, perennial submerged species that is widespread throughout Minnesota and is adapted to a variety of conditions. It is tolerant of low light and prefers soft substrates. This species can overwinter as an evergreen plant and spreads primarily by fragments. The branching stems of this plant can form thick underwater plant beds that are valuable habitat for a variety of fish and invertebrates.

Coontail (Figure 11) is the most common submerged flowering plant in Minnesota lakes. It grows entirely underneath the water 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 and then begin new growth early in spring.

Because it is only loosely rooted to the lake bottom it may drift between depth zones. 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 11. Coontail

Emergent and floating-leaf plant beds

Information on the spatial distribution of emergent and floating-leaf plants within Woman Lake is important. Emergent aquatic plants, such as wild rice and bulrush, offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. Waterlily beds provide similar benefits and also provide shade for fish and frogs. The root systems of emergent and floating-leaf plants act to stabilize the lake bottom and beds of these plants help buffer the shoreline from wave action.

Figure 12. White waterlily

Floating-leaf plants include white waterlily (*Nymphaea odorata*) (Figure 12) and yellow waterlily (*Nuphar variegata*) (Figure 13). White waterlily has showy white flowers and round leaves with radiating veins. Yellow waterlily has smaller yellow flowers and oblong leaves with parallel veins. These species often co-occur in mixed beds but yellow waterlily is generally restricted to depths less than seven feet and white waterlily may occur to depths of ten feet (Nichols 1999b). Waterlilies are perennial and have extensive rhizome systems that overwinter on the lake bottom.

Figure 13. Yellow waterlily

Wild rice (*Zizania palustris*) is an emergent plant 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).

Figure 14. Floating-leaf stage of wild rice

Wild rice is an annual plant and new plants germinate each year from seed. Seedlings begin as submerged plants, transition to floating-leaf

plants (Figure 14) from late May to mid June, and develop emergent growth (Figure 15) for the remainder of the season (MN DNR 2008b). Wild rice plants are weakly rooted to the lake bottom. During the floating-leaf stage, wild rice plants are particularly vulnerable to uprooting by water level changes or heavy wave action caused by storms or motorboats.

Figure 15. Emergent stage of wild rice in flower

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

Figure 16. Bulrush flower

Hardstem bulrush (*Scirpus acutus*) is an emergent lake plant that occurs in lakes throughout Minnesota (Ownbey and Morley 1991). Bulrush stems are round in cross section and lack showy leaves. Clusters of small flowers form near at the tips of long, narrow stalks (Figure 16). This perennial emergent may occur from shore to water depths of about six feet and its stems may extend several feet above the water surface.

Bulrush plants can produce high density seed banks but germination is more successful on moist soils than in submerged sites (Smith and Kadlec 1983). In lakes, bulrush reproduce primarily by local spread of underground rhizomes in shallow water (Figure 17). Bulrush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans.

Figure 17. Linear spread of bulrush by underground rhizome

Unique aquatic plants

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

- Rare (endangered, threatened, special concern) plant species
- Plant species that are not listed as rare but are uncommon in the state or locally. These may include species that are proposed for rare listing.

- Plants species with high coefficient of conservatism values (C values). These values range from 0 to 10 and represent the "estimated probability that a plant is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition" (Nichols 1999a, Bourdaghs et al. 2006.). Plant species with assigned C values of 9 and 10 were included as unique species.

Unique bladderwort species include humped bladderwort (*Utricularia gibba*) (Figure 18), lesser bladderwort (*U. minor*) and flat-leaf bladderwort (*U. intermedia*). These small, submerged plants are often confused as algae because of their fine stems and leaves. 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. 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 the bladders. Bladderworts produce small but showy yellow flowers that emerge above the water surface. These bladderwort species may occur in protected, shallow lake areas and have been documented at scattered locations throughout northern Minnesota (Ownbey and Morley 1991).

Figure 18. Humped bladderwort in flower among waterlilies.

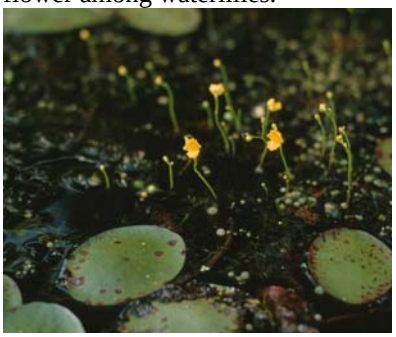
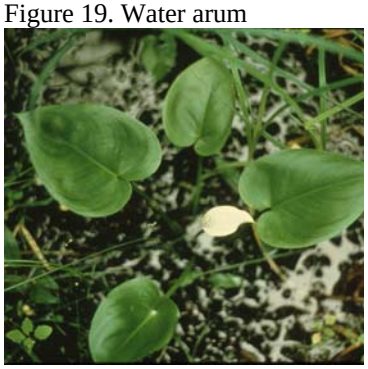


Figure 19. Water arum



Water arum (*Calla palustris*) (Figure 19) 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). Nichols (1999b) reports that this species may be overlooked by lake surveyors and may be more common than indicated by lake survey data. In Cass County, there are four locations of water arum documented by herbarium specimens, including a 1949 collection from swampy ground along the east shore of Woman Lake (John Moore, Univ. of Minnesota Herbarium Accession number 497491)

Figure 20. Three-way sedge

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

Three-way sedge (*Dulichium arundinaceum*) (Figure 20) is an emergent, perennial plant that grows along soft bottom lakeshores and in marshes. This plant does not produce a showy flower but can be identified by its unique three-ranked leaf

arrangement that resembles a three-armed airplane propeller from above (Newmaster et al. 1997). Three-way sedge is found along shores of lower alkalinity lakes (Nichols 1999b) throughout central and northern Minnesota (Ownbey and Morley 1991).

Figure 21. Wiregrass sedge

Wiregrass sedges (*Carex lasiocarpa* and *Carex oligosperma*) (Figure 21) are emergent, perennial plants. As their name implies, they are grass-like in appearance but with long, fine leaves that resemble wire. These plants have extensive rhizome systems that form the framework of floating fen mats (Newmaster et al. 1997). Wiregrass sedges are common in boreal wetlands (Flora of North America 2007) and occur in northeastern Minnesota wetlands (Ownbey and Morley 1991).

Species richness

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

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

Methods

The aquatic plant communities of Woman Lake were described and measured using several techniques as found in Minnesota's Sensitive Lakeshore Area Identification Manual.

Grid point-intercept survey

A grid point-intercept survey was conducted on Woman Lake between June 26 and July 10, 2006 (Perleberg 2007). Aquatic plant survey points were established throughout the

littoral (i.e., vegetated) zone of the lake to a depth of 25 feet. Points were spaced 75 meters apart and 2,126 sites were sampled.

Emergent and floating-leaf bed delineation
Protocol for mapping plant beds were based on the procedures documented in the DNR draft Aquatic Vegetation Mapping Guidelines (MN DNR 2005). They included a combination of aerial photo delineation and interpretation, field delineation, ground-truthing and site specific surveys. Waterlily beds were delineated using 2003-2004 Farm Service Administration (FSA) true color aerial photos. Black and white aerial photos from 1999 were used to help distinguish the true shoreline from mats of perennial vegetation. Field mapping focused on extensive bulrush beds, which were difficult to see on aerial photos. In 2003, MN DNR Fisheries staff mapped extensive bulrush habitat in Woman Lake using Global Positioning System (GPS) technology. In 2006, reconnaissance surveys were conducted of the largest beds to verify species composition and if needed, modify boundary lines.

Near-shore vegetation survey
Six near-shore, in-lake survey plots were sampled in July and August, 2007. Plots were selected based on the presence of nongame fish. Each plot measured 15 meters along the shoreline and 16 meters lakeward and 30 sites were samples within each plot. Surveyors recorded plant species present, water depth, substrate and presence of woody debris.

Shoreline vegetation survey plots
Surveyors inventoried shoreland plants at 52 sites in July and August 2006 and at six sites in July and August 2007. Shoreline vegetation plots were placed systematically in 2006 and adjacent to in-lake vegetation plots in 2007. Plots measured one meter landward by 15 meters along shore. Surveyors sampled at the vegetated zone of the land-water interface, and recorded all plant taxa within the shoreline plot.

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

Surveyors searched for unique plant species in June and August 2006 during the lakewide point intercept survey and while conducting fish surveys, and in July and August 2007 during the near-shore vegetation surveys. At each unique plant location, surveyors recorded the unique plant species found, the location, associated plant species, approximate water depth and substrate type. For plant species that had not previously been recorded in the lake, surveyors collected a voucher specimen.

Results

Distribution of plants by water depth

Plants were found to a maximum depth of 23 feet in Woman Lake but beyond the depth of 20 feet, only one percent of the sites contained vegetation. Plant occurrence was greatest in depths from shore to five feet, where vegetation was found in 87% of the sample sites. All plant types, including rooted, large algae and mosses, decreased in frequency with increasing water depth.

Emergent plants were restricted to water depths of six feet and less and floating-leaf plants were most common to a depth of five feet. Free-floating duckweeds were only found in protected bays and occurred in depths less than six feet. Submerged rooted plants were found to a maximum depth of 23 feet but only two taxa occurred in depths greater than 20 feet.

Distribution of plants in main basin versus bays

Plants occurred around the entire perimeter of Woman Lake but were concentrated within the bays. Lakewide, 40% of the survey sites (in the shore to 25 feet water depth zone) contained plants. Only 20% of the main basin sites contained plants, compared to over 70% of the bay sites. Aquatic plants were most abundant within Broadwater Bay and Lantern Bay.

Of the 41 plant taxa found, all were present in at least one bay but only 21 were found in the main basin. All taxa were found more frequently in the bays than in the main basin. Areas of the main basin that did contain rooted plants were relatively protected shorelines such as the north side of the island and the northwest shore, which receives some protection from the island. Scattered rooted plants occurred along several off-shore shallow reefs and sparse stands of the large algae, muskgrass was found to the west of Horseshoe Island. Emergent plant beds within the main basin were not common but included smaller wild rice beds in Hunter's Bay and Bungey Bay.

Aquatic plant species observed

A total of 41 native aquatic plant taxa were recorded in Woman Lake including nine emergent, four floating-leaf, four free-floating and 24 submerged plants (Table 1). Submerged plants included two types of large algae, an aquatic moss, and numerous flowering plants. An additional 36 native wetland emergent plants were also recorded (Table 1).

Submerged plants

In Woman Lake, muskgrass was the most frequently found submerged plant and occurred in 21% of all survey sites (shore to 25 feet depth zone) (Table 1; Figure 22a). Within the bays, muskgrass was found in 41% of the survey sites, compared to nine percent of the sites in the main basin. Muskgrass occurred to a maximum depth of 23 feet but was most common in depths from shore to 10 feet where it occurred in 36% of the sites. In depths greater than 20 feet, muskgrass was found in less than one percent of the sample sites. Muskgrass was commonly found in Broadwater Bay, Lantern Bay, Bungey Bay and the southwest shore. It was one of the few taxa found on the shallow offshore reef to the west of Horseshoe Island.

As a group, narrow-leaf pondweeds occurred in 15% of all survey sites and in 36% of the bay sites (Figure 22b). Flat-stem pondweed was found in 14% of the sites surveyed and was the most frequently found rooted submerged plant. Fries' pondweed occurred in seven percent of all sites. Both species were most common within the bays where they occurred in 35% and 17% of the sample sites, respectively (Table 1). They were found most frequently in depths of 15 feet and less but were occasionally found in water as deep as 23 feet. These plants were primarily found in sheltered areas including the bays and the north side of Horseshoe Island.

Collectively, broad-leaf pondweeds occurred in nine percent of the Woman Lake sites and in 29% of the sites within bays (Figure 22c). White-stem pondweed was the most abundant broad-leaf pondweed in Woman Lake and was found in four percent of all sample sites and in 11% of the sites within bays (Table 1). Broad-leaf pondweeds were more common in depths of 15 feet and less and often co-occurred with narrow-leaf pondweeds.

In Woman Lake, wild celery occurred primarily in the bays where it was found in 19% of the sample sites (Table 1; Figure 22d). It was most common in depths of 10 feet and less. Large beds of wild celery were found at the south end of the channel to Broadwater Bay, the west side of Broad water Bay, the south end of Lantern Bay, and the north side of Horseshoe Island.

Canada waterweed was present in Woman Lake from shore to a depth of 22 feet. It was found in seven percent of all sample sites and was most common within the bays where it occurred in 15% of the sites (Table 1; Figure 22e). Canada waterweed was one of the few flowering plants found at offshore sites in the main basin of Woman Lake.

In Woman Lake, coontail occurred in only six percent of all survey sites but within the bays it was found in 14% of the sites (Table 1; Figure 22f). Coontail occurred to a depth of 20 feet and was primarily found along north shores of the lake, where its loosely anchored stems were blown into near-shore sites by prevailing winds.

Table 1. Aquatic plants recorded in Woman Lake 2006 – 2007.

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

Present = present in lake but not found at point intercept sample stations.

* This species was confirmed in the lake but there may have been at least one additional taxon present within this genus that could not be identified to the species level.

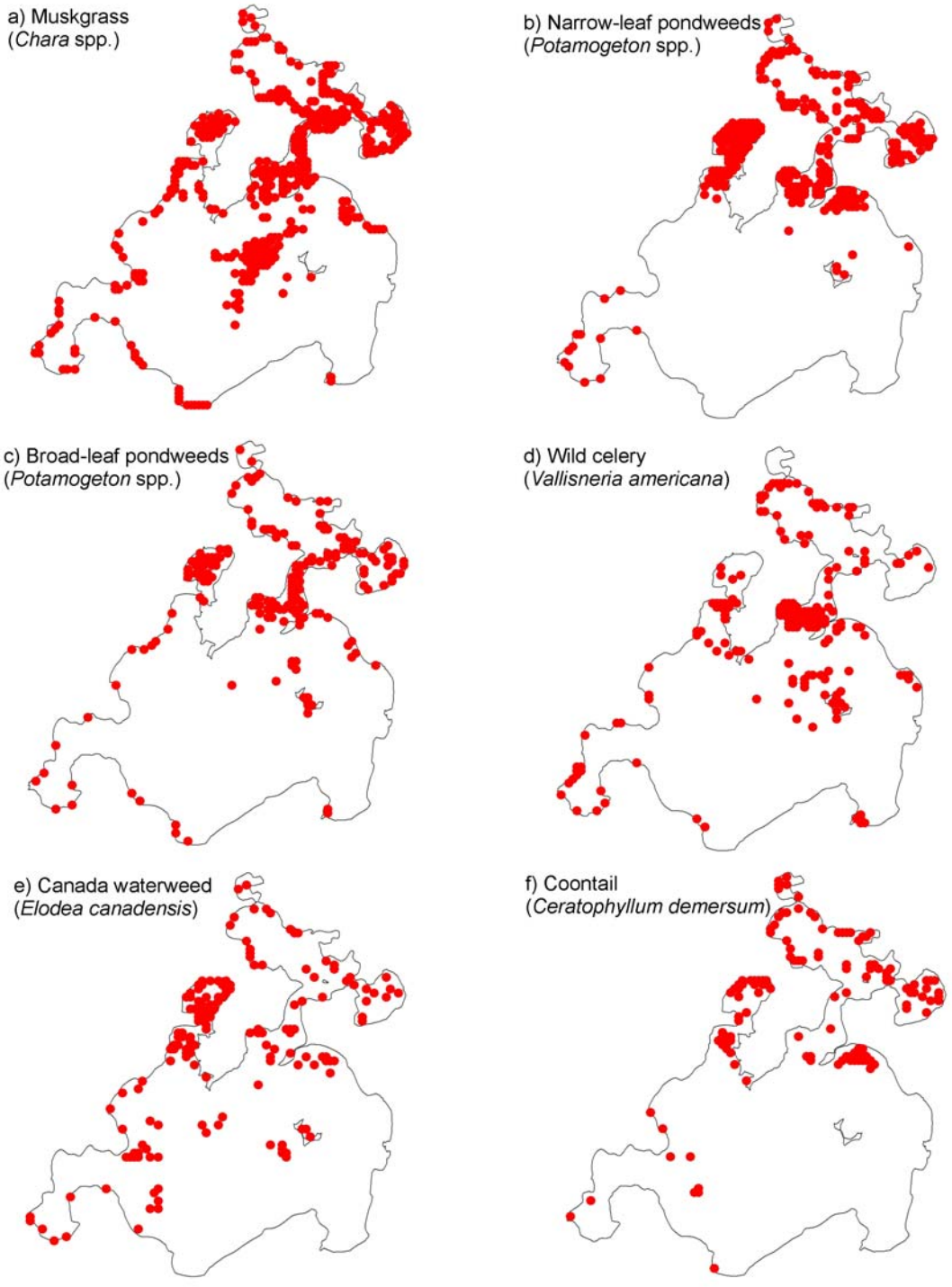
This is a non-native species, escaped from cultivation.

Description			Common name	Scientific name	Frequency of occurrence (N=2126)		
					Bays	Main basin	Lake-wide
Submerged	Non-flowering plants	Algae	Muskgrass	*Chara* sp.	41	9	21
			Stonewort	*Nitella* sp.	1	<1	<1
			Watermoss	*Not identified to genus*	<1	<1	<1
	Perennial	Narrow-leaf pondweeds	Flat-stem pondweed	*Potamogeton zosteriformis*	35	2	14
			Fries' pondweed	*Potamogeton friesii*	17	2	7
			Robbins' pondweed	*Potamogeton robbinsii*	<1	0	<1
			Sago pondweed	*Stuckenia pectinata*	1	<1	<1
		Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	11	<1	4
			Clasping-leaf pondweed	*Potamogeton richardsonii*	5	<1	2
			Large-leaf pondweed	*Potamogeton amplifolius*	4	<1	2
			Illinois pondweed	*Potamogeton illinoensis*	2	<1	1
			Variable pondweed	*Potamogeton gramineus*	1	1	1
			Wild celery	*Vallisneria americana*	19	3	9
			Canada waterweed	*Elodea canadensis*	16	3	8
			Coontail	*Ceratophyllum demersum*	14	2	6
			Northern watermilfoil	*Myriophyllum sibiricum*	6	1	2
			Water marigold	*Megalodonta beckii*	2	<1	1
			White water buttercup	*Ranunculus aquatilis*	<1	<1	<1
			Greater bladderwort	*Utricularia vulgaris*	7	<1	2
			Flat-leaf bladderwort	*Utricularia intermedia*	<1	0	<1
			Bladderwort	*Utricularia minor*	<1	0	<1
			Bladderwort	*Utricularia gibba*			
			Water stargrass	*Heteranthera dubia*	3	2	2
	Annual		Bushy pondweed	*Najas flexilis*	9	<1	3
Free-floating			Star duckweed	*Lemna trisulca*	<1	0	<1
			Lesser duckweed	*Lemna minor*	Present		
			Greater duckweed	*Spirodela polyrhiza*	Present		
			Watermeal	*Wolffia* sp.	Present		
Floating-leaf			Floating-leaf pondweed	*Potamogeton natans*	3	<1	1
			White waterlily	*Nymphaea odorata*	4	0	1
			Yellow waterlily	*Nuphar variegata*	3	0	1
			Watershield	*Brasenia schreberi*	<1	0	<1
In-lake Emergent			Wild rice	*Zizania palustris*	9	0	3
			Hardstem bulrush	*Scirpus acutus**	1	0	<1
			Needlegrass	*Eleocharis cf. acicularis*	<1	0	<1
			Spikerush	*Eleocharis* sp.	<1	0	<1
			Narrow-leaf cattail	*Typha cf. angustifolia*	<1	0	<1
			Broad-leaf cattail	*Typha latifolia*	Present		
			Giant cane	*Phragmites australis*	Present		
			Broad-leaf arrowhead	*Sagittaria latifolia**	Present		
			American burreed	*Sparganium americanum*	Present		

Table 1 (continued). Aquatic plants recorded in Woman Lake 2006 – 2007.

Description	Common name	Scientific name	Frequency of occurrence
Wetland Grasses and Sedges	Canada bluejoint grass	*Calamagrostis canadensis*	Present
	Water sedge	*Carex aquatilis*	Present
	Bottle-brush sedge	*Carex hystricina*	Present
	Lake sedge	*Carex lacustris*	Present
	Wiregrass sedge	*Carex lasiocarpa*	Present
	Wiregrass sedge	*Carex oligosperma*	Present
	Three-way sedge	*Dulichium arundinaceum*	Present
	Rice cut-grass	*Leersia oryzoides*	Present
	Reed canary grass	*Phalaris arundinaceae#*	Present
	Giant cane	*Phragmites australis*	Present
	Wool grass	*Scirpus cyperinus*	Present
Wetland Emergent Forbs	White-flowered aster	*Aster* spp.	Present
	Beggarticks	*Bidens* spp.	Present
	Water arum	*Calla palustris*	Present
	Marsh bellflower	*Campanula aparinoides*	Present
	Bulbiferous water hemlock	*Cicuta bulbifera*	Present
	Giant water hemlock	*Cicuta maculata*	Present
	Nut sedge	*Cyperus* sp.	Present
	Willow herb	*Epilobium cf. ciliatum*	Present
	Joe Pye weed	*Eupatorium* sp.	Present
	Bedstraw	*Galium* sp.	Present
	Bottle gentian	*Gentiana andrewsii*	Present
	Jewelweed	*Impatiens capensis*	Present
	Blue flag iris	*Iris versicolor*	Present
	Water horehound	*Lycopus uniflorus*	Present
	Moneywort	*Lysimachia nummularia#*	Present
	Tufted loosestrife	*Lysimachia thyrsiflora*	Present
	Purple loosestrife	*Lythrum salicaria#*	Present
	Wild mint	*Mentha arvensis*	Present
	Forget-me-nots	*Mysotis scorpiodes #*	Present
	Coltsfoot	*Petasites frigidus*	Present
	Clearweed	*Pilea pumila*	Present
	Swamp five-finger	*Potentilla palustris*	Present
	Water dock	*Rumex* sp.	Present
	Marsh skullcap	*Scutellaria galericulata*	Present
	Northern bog goldenrod	*Solidago uliginosa*	Present
	Marsh hedge nettle	*Stachys palustris*	Present
	Marsh St. John's wort	*Triadenum fraseri*	Present
	Stinging nettle	*Urtica dioica*	Present
	Violet	*Viola* sp.	Present

Figure 22. Distribution of common submerged plants, 2006 – 2007.



Emergent and floating-leaf plants

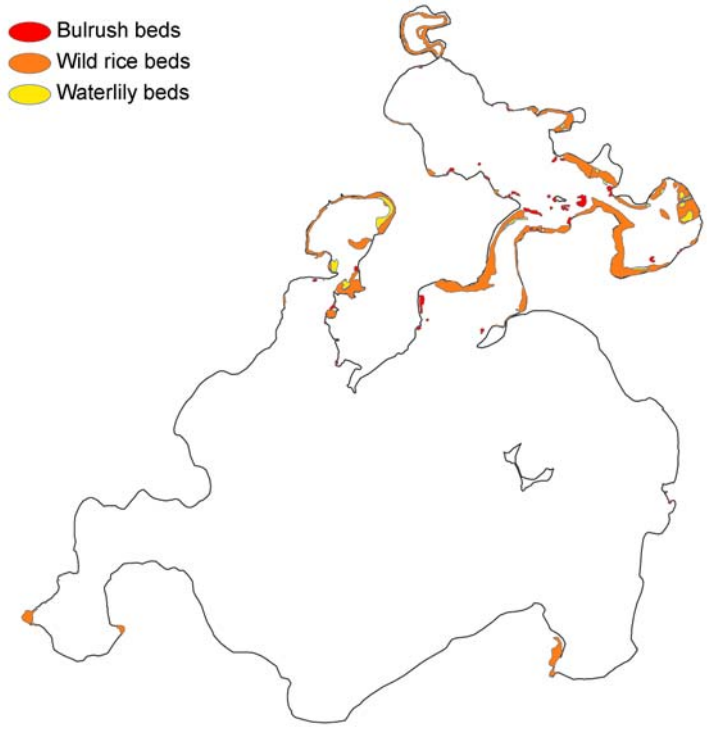
Emergent and floating-leaf plant beds were primarily located in Broadwater Bay and Lantern Bay. The most common emergent plant in Woman Lake was wild rice. Wild rice occurred in shallow areas with muck substrates (Figure 23). Beds of wild rice covered about 180 acres and approximately nine miles of shoreline including areas of Lantern Bay, the channel to Broadwater Bay, and the north and east shores of Broadwater Bay (Figure 24).

Figure 23. Wild rice bed in Woman Lake

Bulrush was the second most common emergent plant and was found in areas with hard substrate to a depth of about six feet. About 17 acres of bulrush were mapped and the largest bulrush beds occurred in Broadwater Bay at the north end of the channel (Figure 22). Other emergent plants occurred in smaller beds or mixed within wild rice and bulrush beds and included spikerush (*Eleocharis* sp.), cattail (*Typha* sp.), arrowhead (*Sagittaria* sp.), and burreed (*Sparganium* sp.)

About 16 acres of waterlily beds were mapped (Figure 22). Floating-leaf pondweed (*Potamogeton natans*), white waterlily and yellow waterlily were the most common species. Waterlily beds often contained scattered bulrush or wild rice plants as well as submerged plants, and were associated with muck sediments.

Figure 24. Distribution of emergent and floating-leaf plant beds.



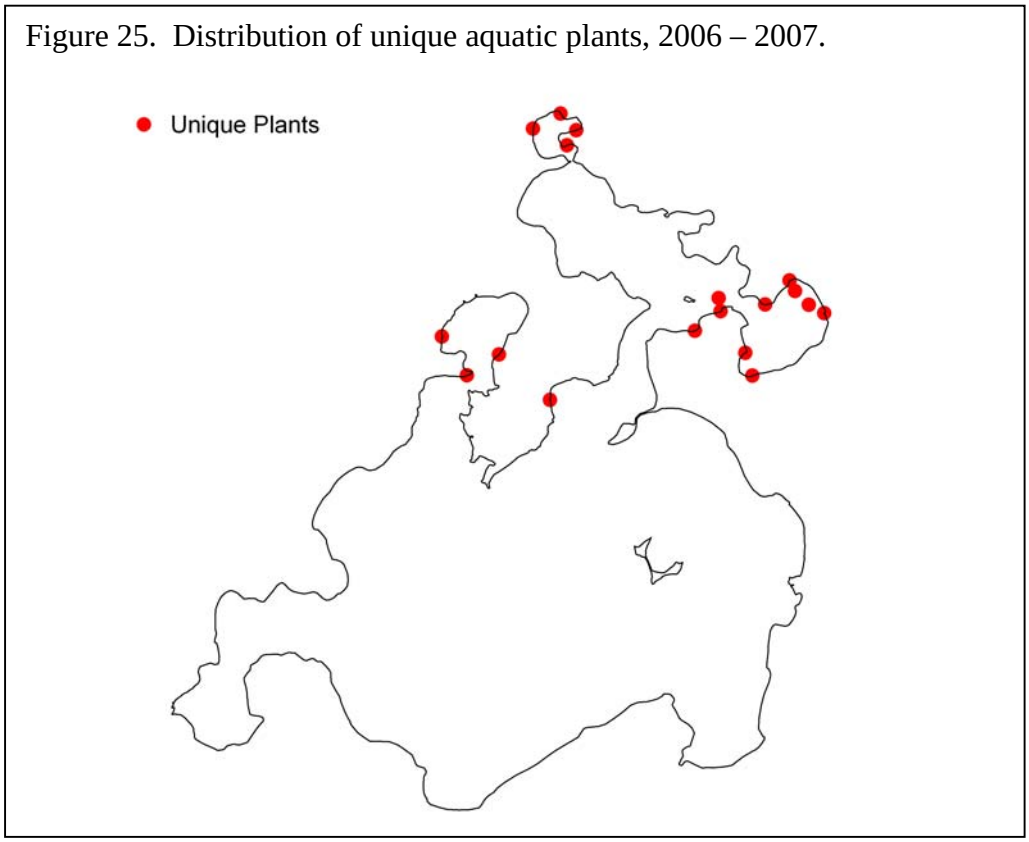
Unique plants

Unique plants were located at 18 sampling stations (Figure 25). All of the unique plant occurrences were within delineated bays. A total of six unique species were located in the lake and the maximum number of unique species found at a site was three.

The unique emergent plants identified in Woman Lake were water arum (*Calla palustris*), wiregrass sedges (*Carex oligosperma* and *C. lasiocarpa*), and three-way sedge (*Dulichium arundinaceum*). These species occurred in wetlands of Lantern and Broadwater Bay and 15 of the 18 sites containing unique plants contained at least one of these emergents. The sites were characterized by sedge mats with mixture of narrow-leaf and broad-leaf sedges (*Carex aquatilis*, *C. hystricina*, *C. lacustris*) and a diversity of wetland forbs and grasses. Wetland sites included narrow wetland borders at the edge of upland forests, extensive open sedge mats, and sedge mats with areas of cattails (*Typha latifolia*), scattered alder (*Alnus incana*), bog birch (*Betula pumila*), shrub willow (*Salix* sp.) and tamarack trees (*Larix laricina*). These sites were characterized by soft substrates and hydric soils with water depths up to several inches. Lakeward, the plant community was often dominated by wild rice beds with pockets of burreed (*Sparganium* sp.), arrowhead (*Sagittaria* sp.) and waterlilies (*Nymphaea odorata* and *Nuphar variegata*).

Unique submerged species found in Woman Lake were flat-leaf bladderwort (*Utricularia intermedia*), humped bladderwort (*U. gibba*) and lesser bladderwort (*U. minor*). These species occurred in three sites on the east side of Broadwater Bay. These sites contained soft substrates and water depths ranged from three to seven feet.. These sites had a mean plant species richness of five species per meter square. Associated species included

Figure 25. Distribution of unique aquatic plants, 2006 – 2007.

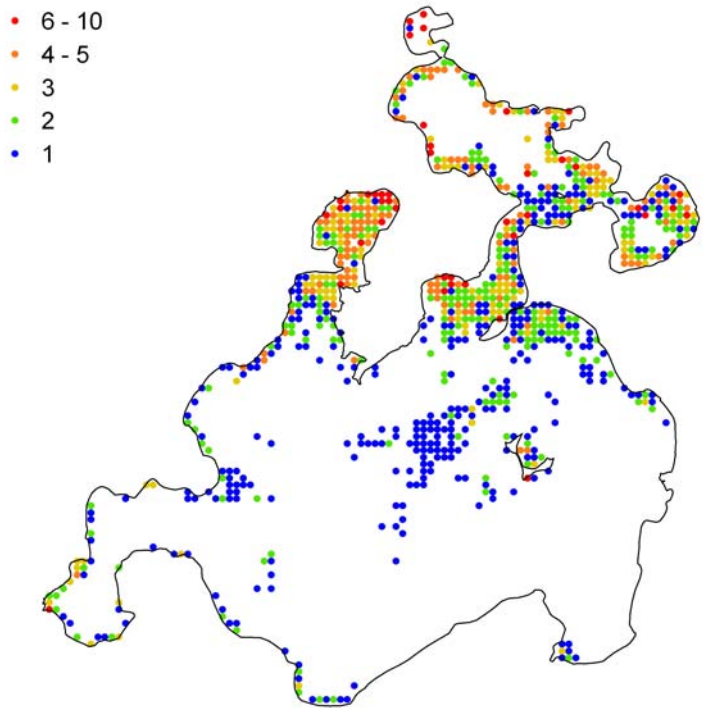


watershield (*Brasenia schreberi*), yellow waterlily, several pondweed species (*Potamogeton* sp.), greater bladderwort (*Utricularia vulgaris*) and muskgrass (*Chara* sp.).

Species richness

Plants occurred around the entire perimeter of Woman Lake but species richness was highest within the bays (Figure 26). The number of different plant taxa found at each survey site ranged from zero to 10. In the main basin, the mean number of plant taxa per site was less than one. The bays contained the greatest number of taxa and several areas contained between six and ten species per square meter. Species richness was highest in shallow water, from shore to a depth of five feet.

Figure 26. Aquatic plant richness (number of taxa per sampling station), 2006 – 2007.



Near-shore Substrates

Objectives

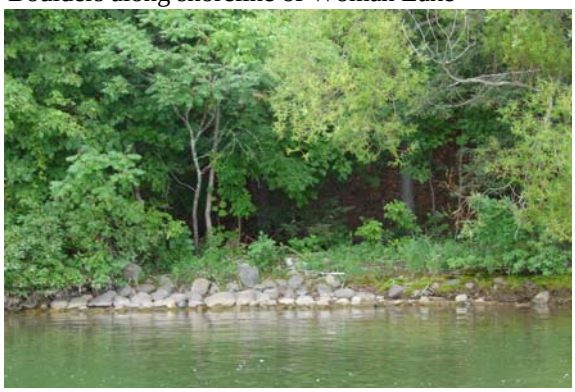
1. Describe and map the near-shore substrates of Woman Lake

Summary

Near-shore substrate included boulders, rubble, gravel, sand, silt, marl, and muck. The bays were characterized by soft bottom substrates, whereas the main basin was dominated by hard bottom substrates.

Introduction

Boulders along shoreline of Woman Lake



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

Methods

Near-shore substrate in Woman Lake was evaluated at a total of 559 sampling stations set up in the grid point-intercept aquatic plant and near-shore fish surveys. Plant sample stations were 75 meters apart and occurred in a grid from shore to a depth of 20 feet. Surveyors described substrate at 471 of these sites that occurred within the shore to the six foot water depth. To increase sample coverage at near-shore sites not covered by the grid sampling, substrate was also evaluated at near-shore vegetation sample stations and near-shore fish sample stations. Near-shore vegetation sample stations were located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 64 of these stations. Fish sample stations were also located every 400 meters around the perimeter of the lakeshore and substrate was evaluated at 24 of these stations.

Substrate was evaluated by visual observation of the lake bottom. If this method was not feasible, 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

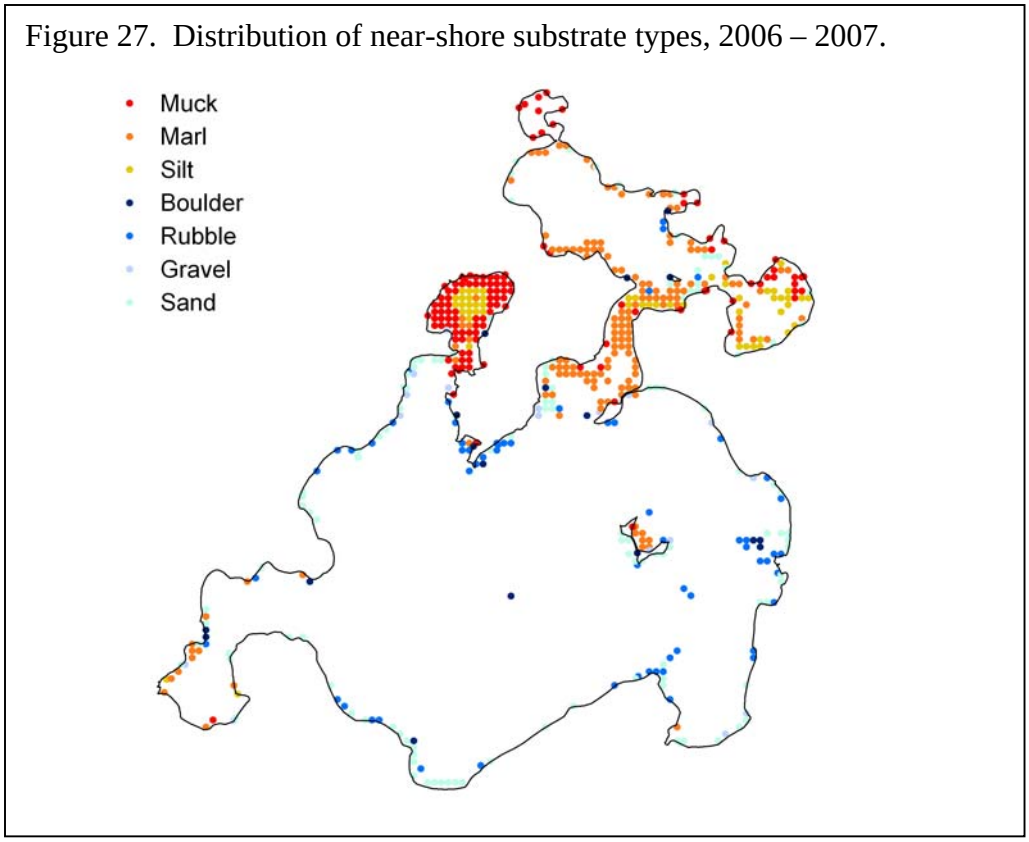
evaluation. Standard lake substrate classes were based on the DNR Fisheries Survey Manual (MN DNR 1993):

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

Results

Shallow water sites (shore to a water depth of six feet) of the main basin had hard substrates including sand, gravel, rubble and boulders (Figure 18). Natural sand beaches occurred along shores of the main basin. Softer substrate types occurred at the north end of Horseshoe Island and in Broadwater Bay, Lantern Bay and Bungey Bay (Figure 27). Lantern Bay was dominated by muck substrates, whereas the channel to Broadwater Bay was mainly marl substrate. Overall, the dominant near-shore substrate type was marl; it was found at over 30% of the sampling sites. Sand and muck were also common, and were documented at approximately 20% of the sites each.

Figure 27. Distribution of near-shore substrate types, 2006 – 2007.



Bird Surveys

Objectives

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

Summary

Bird surveys of Woman Lake were conducted between June 5 and July 16, 2007. Surveyors documented 67 different species of birds, including 11 species of greatest conservation need. Red-eyed vireos (*Vireo olivaceus*) were the most abundant bird species overall, whereas the veery (*Catharus fuscescens*) was the most commonly detected species of greatest conservation need. Although distribution of several species was restricted to the bays, others were found along the shoreline of the main basin as well. Maximum species diversity was 16 species at one survey point.

Introduction

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

Figure 28. Bald eagle

Bald eagles (*Haliaeetus leucocephalus*; Figure 28) 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 8 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.

Common loons (*Gavia immer*; Figure 29) are one of Minnesota's most recognizable birds. They are found from northeastern to central Minnesota, and numbers are higher here than in any other state except Alaska. This large diving bird possesses red eyes and a large, dark pointed bill that is well-adapted for catching fish. 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 29. Common loon

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, in wetland habitat such as marshes. Populations of common terns declined in the 1970s, likely due to poisoning by pesticides. Habitat loss, nest predation, and disturbance by humans may also negatively affect common terns. Common terns are listed as a threatened species in the state of Minnesota.

Figure 30. Common tern

Photo by: Carrol Henderson

Least flycatchers (*Empidonax minimus*; Figure 31) are the smallest flycatchers found in Minnesota. Like many other flycatchers, they are olive or gray in color with two white wingbars and whitish underparts. They have a small bill and a prominent white eye ring. They 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 31. Least flycatcher

Photo by: J.A. Spendelow

Ovenbirds (*Seiurus aurocapillus*; Figure 32) are easily heard, but difficult to see, birds of the forest. 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 32. Ovenbird

Source: U.S. Fish and Wildlife Service

Red-necked grebes (*Podiceps grisegena*; Figure 33) are one of the larger grebe species. The red neck, which distinguishes the bird, is visible only during the breeding season; in the winter it turns to whitish or gray. The back is dark, and the head is characterized by white cheeks and a black cap. Red-necked grebes breed in a variety of water bodies, from marshes to small, shallow lakes to the bays of large lakes. These birds are uncommon in Minnesota, and populations are imperiled by the loss and modification of wetland habitat.

Figure 33. Red-necked grebe

Source: U.S. Fish and Wildlife Service

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

Figure 34. Rose-breasted grosbeak

Photo by: J.A. Spendelow

The swamp sparrow's (*Melospiza georgiana*; Figure 35) 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. 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 35. Swamp sparrow

Photo bv: Jim Stasz

The veery (*Catharus fuscescens*; Figure 36) 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 the major reasons cited for the decline.

Figure 36. Veery

Photo by: Deanna Dawson

White-throated sparrows (*Zonotrichia albicollis*; Figure 37) are common in Minnesota during their spring and fall migrations. They are recognizable by the white patch on the throat and their characteristic "Old Sam Peabody Peabody Peabody" song. The head is striped with black and tan or white, and has a yellow spot above the eye. The chest is gray and the back is streaked with brown and black. They inhabit coniferous or mixed forests, and prefer areas with multiple openings and abundant low-growing vegetation. Although white-throated sparrows are widespread, they are declining over portions of their breeding range. Research into this decline will be important for the future of this species.

Figure 37. White-throated sparrow

Photo by: Dave Herr

The yellow-bellied sapsucker's (*Sphyrapicus varius*; Figure 38) 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 38. Yellow-bellied sapsucker

Photo by: J.A. Spendelow

Methods

Surveyors used several techniques to collect information on bird species. Point counts were conducted at 109 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 were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or lakeshore were also recorded.

Results

Surveyors identified eleven species of greatest conservation need at Woman Lake. The veery was found at the greatest number of locations, with surveyors identifying this species at 16 stations. Common loons, ovenbirds, and swamp sparrows were all documented at 10 or more survey stations, and bald eagles, least flycatchers, and rose-breasted grosbeaks were identified at 5 or more survey stations. The other species of greatest conservation need found at Woman Lake were the common tern, red-necked grebe, white-throated sparrow and yellow-bellied sapsucker. With the exception of the common tern and red-necked grebe, which were recorded when casually observing the lake, all species of greatest conservation need were identified during point count surveys.

Species of greatest conservation need were distributed around a variety of areas of the shoreline. Those common loon was found along both the northern and southern shorelines (Figure 39), as was the bald eagle (Figure 42). Forest-dwelling SGCNs were present along the southern shoreline, but most occurrences were in Broadwater and

Lantern Bays (Figure 40). The one wetland-dwelling species of greatest conservation need, the swamp sparrow, was also found primarily in Broadwater Bay (Figure 41).

Surveyors recorded a total of 62 bird species at Woman Lake (Table 2) during the point count and call-playback surveys. Five additional species were recorded through casual observation, for a total of 67 species (Appendix 1). Red-eyed vireos were the most common species overall, and were found at nearly 70% of the survey sites. Red-winged blackbirds were second in abundance, and were identified at 65 of the 109 stations. Song sparrows, American crows, and yellow warblers rounded out the top five most common species.

Maximum species diversity was 16 species at a single sample location. Twenty-five additional sites contained 10 or more species. The maximum number of SGCNs found at a single site was three.

Figure 39. Distribution of aquatic habitat-dwelling bird species of greatest conservation need, June – July 2007.

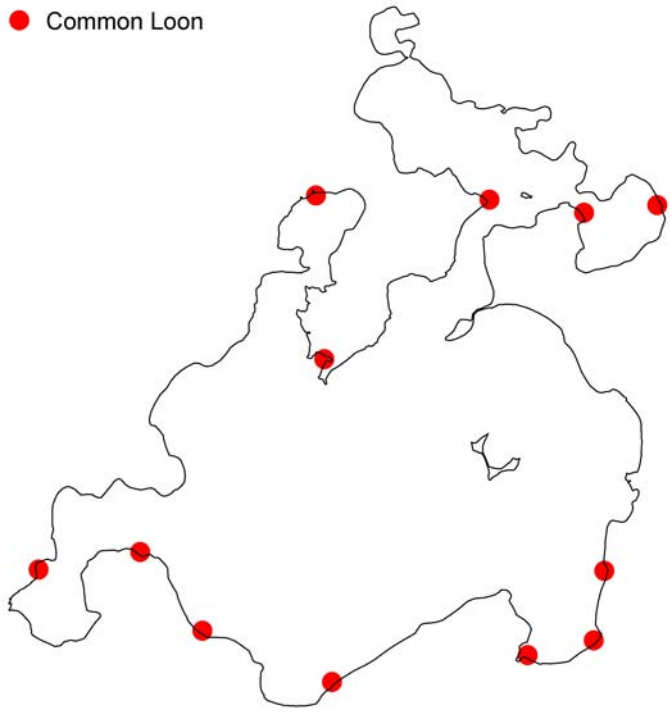


Figure 40. Distribution of forest habitat-dwelling bird species of greatest conservation need, June – July 2007.

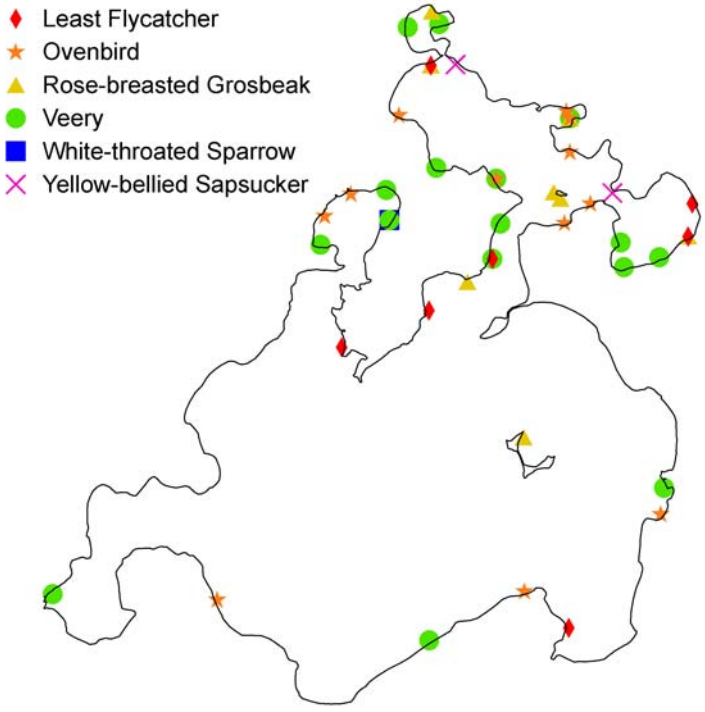


Figure 41. Distribution of wetland habitat-dwelling bird species of greatest conservation need, June – July 2007.

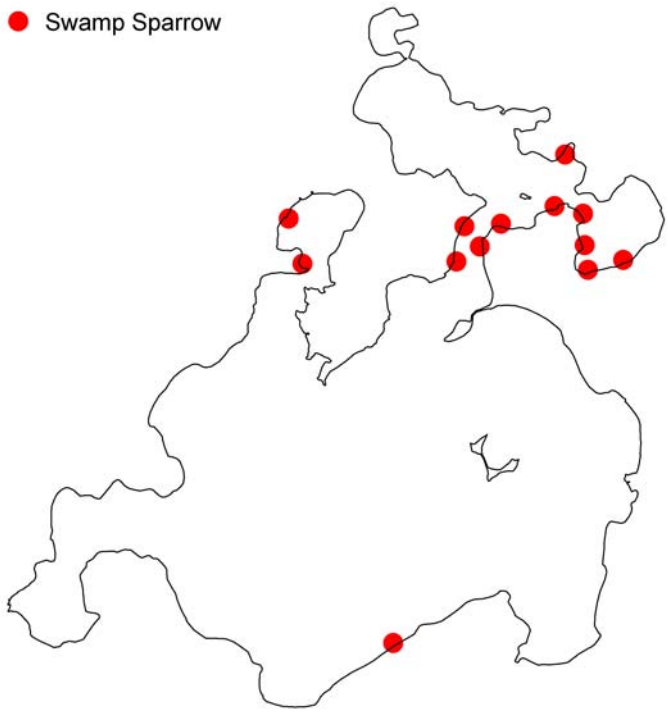


Figure 42. Distribution of bird species of greatest conservation need that occupy a variety of habitats, June – July 2007.

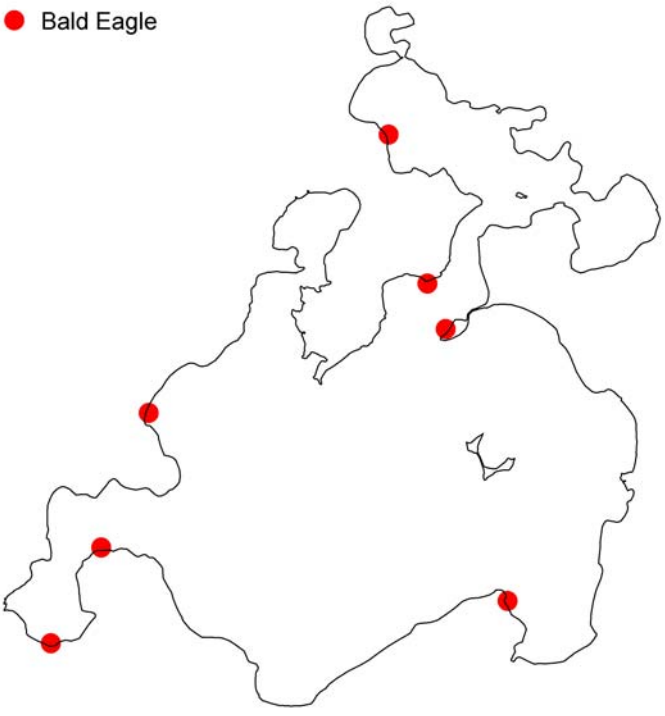


Table 2. Species list and frequency of occurrence of bird species identified during point count and call-playback surveys, June – July 2007. * denotes a species of greatest conservation need.

[a] % – the percent of surveyed sample sites in which a bird species was documented

Family	Description	Common Name	Scientific Name	[a] %
Accipitridae	Hawks	Bald eagle*	*Haliaeetus leucocephalus*	6
Alcedinidae	Kingfishers	Belted kingfisher	*Megaceryle alcyon*	3
Anatidae	Waterfowl	Canada goose	*Branta canadensis*	2
		Common goldeneye	*Bucephala clangula*	17
		Common merganser	*Mergus merganser*	3
		Mallard	*Anas platyrhynchos*	22
		Red-breasted merganser	*Mergus serrator*	6
		Wood duck	*Aix sponsa*	4
Ardeidae	Herons/bitterns	Great blue heron	*Ardea herodias*	15
		Green heron	*Butorides virescens*	5
Bombycillidae	Waxwings	Cedar waxwing	*Bombycilla cedrorum*	4
Cardinalidae	Grosbeaks/buntings	Rose-breasted grosbeak*	*Pheucticus ludovicianus*	7
Cathartidae	New World vultures	Turkey vulture	*Cathartes aura*	1
Charadriidae	Plovers/lapwings	Killdeer	*Charadrius vociferus*	2
Corvidae	Jays/crows	American crow	*Corvus brachyrhynchos*	48
		Blue jay	*Cyanocitta cristata*	14
		Common raven	*Corvus corax*	1
Emberizidae	Warblers/sparrows	Chipping sparrow	*Spizella passerina*	18
		Song sparrow	*Melospiza melodia*	53
		Swamp sparrow*	*Melospiza georgiana*	12
		White-throated sparrow*	*Zonotrichia albicollis*	1
Fringillidae	Finches	American goldfinch	*Carduelis tristis*	2
		Red crossbill	*Loxia curvirostra*	1
Gaviidae	Loons	Common loon*	*Gavia immer*	11
Hirundinidae	Swallows	Barn swallow	*Hirundo rustica*	17
		Purple martin	*Progne subis*	4
		Tree swallow	*Tachycineta bicolor*	22
Icteridae	Blackbirds/orioles	Baltimore oriole	*Icterus galbula*	17
		Brown-headed cowbird	*Molothrus ater*	5
		Common grackle	*Quiscalus quiscula*	31
		Red-winged blackbird	*Agelaius phoeniceus*	60
		Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	1
Laridae	Gulls/terns	Ring-billed gull	*Larus delawarensis*	3
Mimidae	Mockingbirds/thrashers	Gray catbird	*Dumetella carolinensis*	7
Paridae	Chickadees/titmice	Black-capped chickadee	*Poecile atricapilla*	11

Table 2, cont.

Family	Description	Common Name	Scientific Name	%
Parulidae	Warblers	American redstart	*Setophaga ruticilla*	10
		Black-and-white warbler	*Mniotilta varia*	8
		Common yellowthroat	*Geothlypis trichas*	21
		Chestnut-sided warbler	*Dendroica pensylvanica*	22
		Ovenbird*	*Seiurus aurocapilla*	11
		Pine warbler	*Dendroica pinus*	1
		Yellow warbler	*Dendroica petechia*	47
Picidae	Woodpeckers	Hairy woodpecker	*Picoides villosus*	3
		Pileated woodpecker	*Dryocopus pileatus*	1
		Red-bellied woodpecker	*Melanerpes carolinus*	8
		Yellow-bellied sapsucker*	*Sphyrapicus varius*	2
		Northern flicker	*Colaptes auratus*	2
Scolopacidae	Sandpipers/snipes	Wilson's snipe	*Gallinago delicata*	1
Sittidae	Nuthatches	White-breasted nuthatch	*Sitta carolinensis*	11
Thraupidae	Tanagers	Scarlet tanager	*Piranga olivacea*	2
Trochilidae	Hummingbirds	Ruby-throated hummingbird	*Archilochus colubris*	1
Troglodytidae	Wrens	House wren	*Troglodytes aedon*	3
Turdidae	Thrushes	American robin	*Turdus migratorius*	28
		Veery*	*Catharus fuscescens*	15
Tyrannidae	Flycatchers	Alder flycatcher	*Empidonax alnorum*	14
		Eastern kingbird	*Tyrannus tyrannus*	8
		Eastern phoebe	*Sayornis phoebe*	16
		Great-crested flycatcher	*Myiarchus crinitus*	7
		Least flycatcher*	*Empidonax minimus*	6
Vireonidae	Vireos	Red-eyed vireo	*Vireo olivaceus*	69
		Warbling vireo	*Vireo gilvus*	4
		Yellow-throated vireo	*Vireo flavifrons*	2

Bird Species Richness

Objectives

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

Summary

Species richness varied from one to 16 species at a single sampling station.

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 a number of bird species.

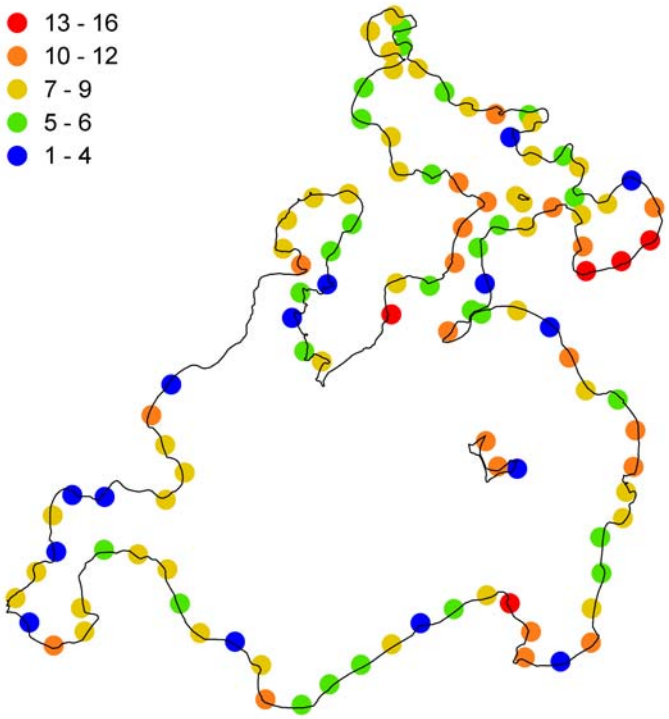
Methods

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 species diversity was 16 species at a single sample location. Twenty-five additional sites contained 10 or more species. Less than 15% of the stations contained fewer than five species. Species richness was generally higher in the bays (Figure 43). Over 80% of the SGCN occurrences were within bays, as were over 60% of the total species occurrences.

Figure 43. Bird species richness (number of species per sampling station) at Woman Lake, June-July 2006.



Loon Nesting Areas

Objectives

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

Summary

Volunteer loon watchers have been reporting Woman Lake loon nests since 1980. Since that time, they have documented 25 probable different nesting sites.

Introduction

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

Loon pair with chick

Photo by: Paul Bolstad

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

Methods

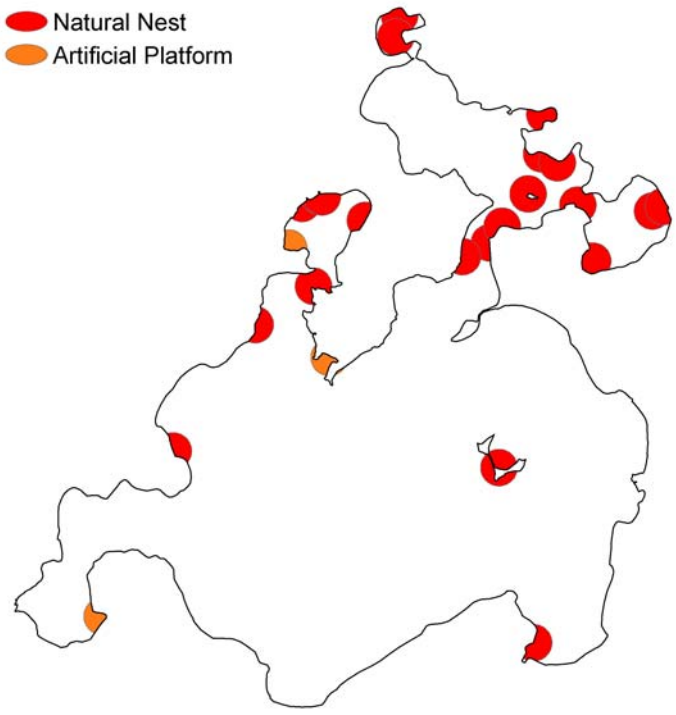
Using information from LoonWatcher reports and bird surveys, researchers mapped loon nesting locations in GIS. Mapped nests were buffered by 200 meters to account for locational uncertainty. Nests were identified as either natural or manmade.

Results

Between 1980 and 2007, volunteers identified 25 probable loon nesting sites. Of these nests, 22 were natural nests and three were manmade loon platforms (Figure 44). The majority of the documented nests (22/25) were located within bays. Five nests were

identified as active nests in 2007. These nests were located in Broadwater Bay and Lantern Bay.

Figure 44. Location of natural loon nests and manmade loon platforms recorded on Woman Lake between 1980 and 2007.



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

Summary

Aquatic frog surveys of Woman Lake were conducted between July 11 and July 17, 2006. Surveyors visited 121 stations located around the lakeshore. Mink frogs were heard calling at 25 of the stations, and green frogs were heard at 50 stations. Abundance of both species ranged from 0 to over 100 individuals. Gray tree frogs were also heard, for a total of 3 species documented. The vast majority of the green and mink frogs heard were located in bays.

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 frog surveys included mink frog (*Rana septentrionalis*) and green frog (*Rana clamitans*). These frogs 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.

Mink frogs (Figure 45) 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 45. Mink frog

Photo by: Jeff LeClere, www.herpnet.net

Green frogs (Figure 46) 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 51. Green frog

Photo by: Jeff LeClere, www.herpnet.net

Methods

The aquatic frog survey methodology followed the Minnesota Frog and Toad Calling Survey (MFTCS) protocol (see Minnesota's Sensitive Lakeshore Identification Manual for additional information on how this protocol was adjusted for water routes). Frog survey points were located around the entire lake, 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

Green frogs were the most common frog species found during the surveys, detected at 50 of the 121 sites. Estimates of abundance for green frogs ranged from 1 individual (at 3 sites) to over 100 individuals (at 11 sites; Figure 47). Index values ranged from 1 to 3 (individuals distinct to a full chorus of calls). Green frogs occurred mainly along the shorelines of Broadwater Bay and Lantern Bay, although frogs were also heard in Bungey Bay and Hunter's Bay (Figure 49). Surveyors heard mink frogs at 16 sites. They were also found primarily in Broadwater Bay and Lantern Bay; several calls were also heard in Bungey Bay (Figure 49). Abundance estimates varied from 1 individual (at 6 sites) to over 100 individuals (at 1 site; Figure 48), and index values ranged from 1 to 3. Both mink and green frog detections were closely associated with the presence of beds of emergent vegetation.

Other species

The only additional amphibian species heard during the surveys was the gray treefrog (*Hyla versicolor*), which was documented in Lantern Bay. Other frog or toad species that may be found near Woman Lake, such as wood frog (*Rana sylvatica*), spring peeper (*Pseudacris crucifer*), chorus frog (*Pseudacris triseriata*), leopard frog (*Rana pipiens*), and American toad (*Bufo americanus*), breed earlier in the year and are not strongly associated with larger lakes.

Figure 47. Abundance of green frogs heard during surveys, June 2006.

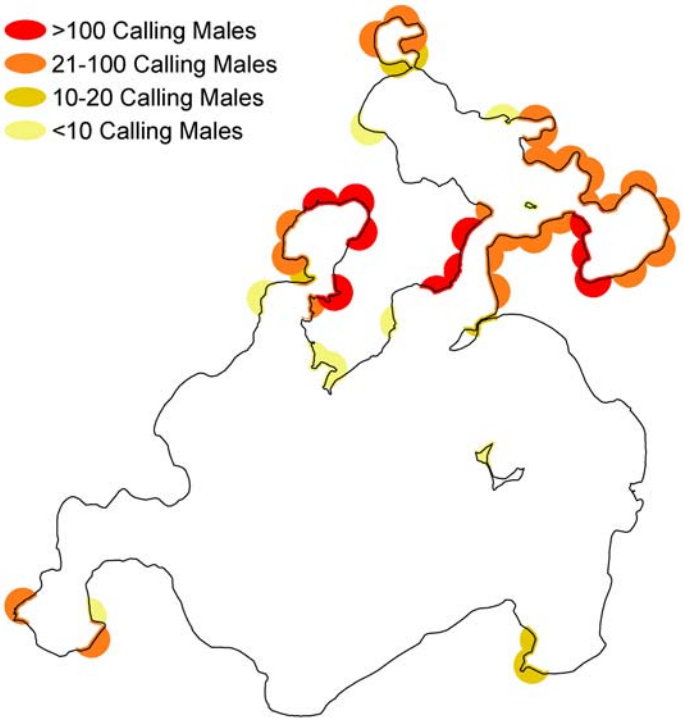


Figure 48. Abundance of mink frogs heard during surveys, June 2006.

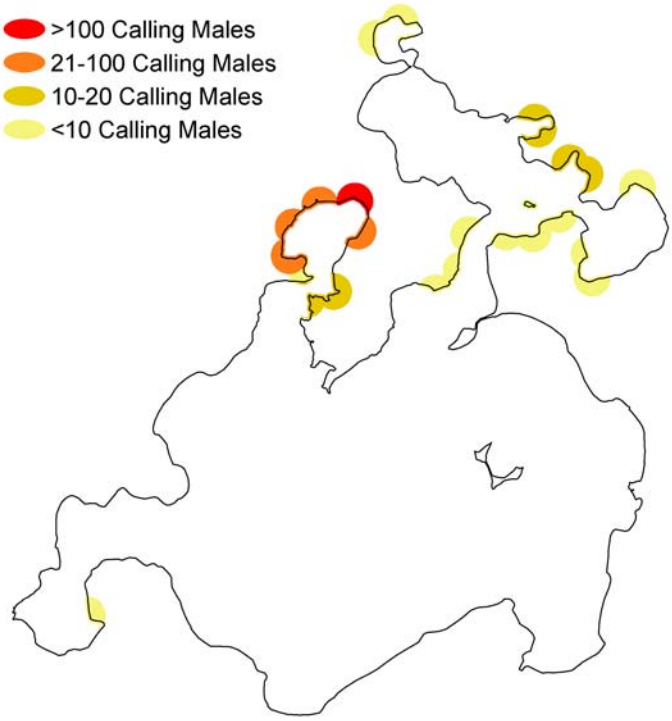
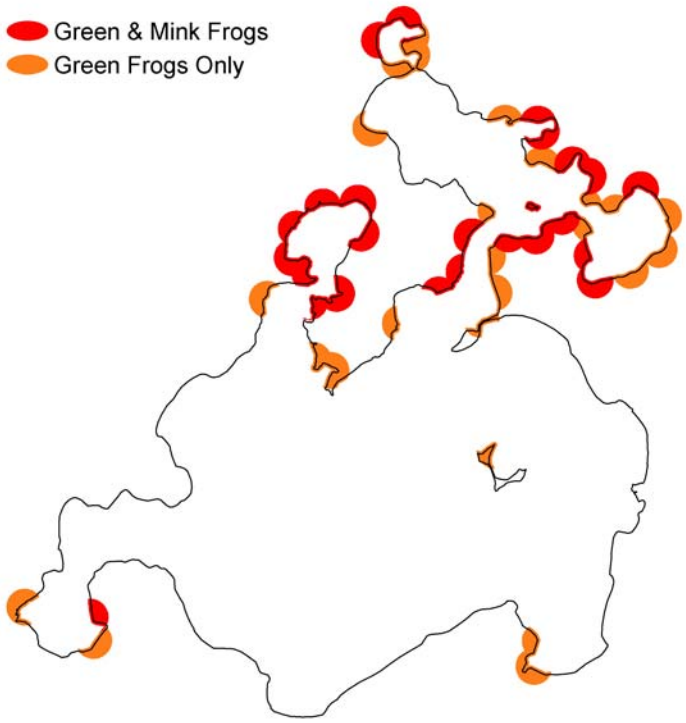


Figure 49. Distribution of mink and green frogs, June 2006.



Nongame Fish Surveys

Objectives

1. Record presence and abundance of fish species of greatest conservation need, including pugnose shiner (*Notropis anogenus*), least darter (*Etheostoma microperca*), and longear sunfish (*Lepomis megalotis*)
2. Record presence and abundance of proxy species, including blackchin shiner (*Notropis heterodon*), blacknose shiner (*Notropis heterolepis*), and banded killifish (*Fundulus diaphanus*).
3. Develop distribution maps for species of greatest conservation need and proxy species.
4. Identify habitat (substrate and aquatic vegetation biovolume) associated with presence and absence of species of greatest conservation need and proxy species.
5. Identify near-shore fish assemblages.

Summary

Nongame fish surveys of Woman Lake were conducted between August 28 and September 20, 2006. Surveyors visited 24 stations located around the lakeshore. Two of the three species of greatest conservation need (pugnose shiners and longear sunfish) were detected. All three proxy species were detected. Blacknose shiners were found most frequently; surveyors found 5 individuals at 4 different sites. A total of 30 fish species were identified during the surveys, including four species that had not been previously documented at Woman Lake.

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 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 (Figure 50) are small (38 – 56 mm), slender, silverish-yellow minnows. They possess a distinctively upturned mouth that gives them a "pugnose" appearance. They inhabit clear lakes and low-gradient streams and are intolerant of turbidity. Vegetation, particularly pondweed, coontail, and bulrush, is an important habitat component.

Figure 50. Pugnose shiner

Photo by: Konrad Schmidt

Least darters (Figure 51) 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. Removal of vegetation, riparian area modification, and poor water quality all pose threats to the least darter.

Figure 51. Least darter

Photo by: Konrad Schmidt

Longear sunfish (Figure 52) are a deep-bodied fish reaching a length of 71 – 94 mm. The belly 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 prefers clear, shallow, vegetated areas and is intolerant of turbidity.

Figure 52. Longear sunfish

Photo by: Konrad Schmidt

Proxy species

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

Blackchin shiners (Figure 53) 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.

Figure 53. Blackchin shiner

Photo by: Konrad Schmidt

Blacknose shiners (Figure 54) 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. Habitat includes clean, well-oxygenated lakes and streams with plentiful vegetation and low turbidity and pollution.

Figure 54. Blacknose shiner

Photo by: Konrad Schmidt

Banded killifish (Figure 55) 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 55. Banded killifish

Photo by: Konrad Schmidt

Methods

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

In addition to the fish data, habitat data were collected at each sampling station. Substrate data were recorded using standard near-shore classes. Aquatic vegetation

biovolume was also estimated at each station; this represented the volume of a sampling area that contained submerged aquatic vegetation.

Results

Rare fish and their proxies

Two of the three fish species of greatest conservation need were recorded at Woman Lake. Surveyors found three longear sunfish at one sampling site, and one pugnose shiner was identified during the survey. Least darters were not documented during the surveys. Sensitivity of these species of concern prohibits disclosure of exact locations; they are identified in the figure as "rare fish" (Figure 56). All three proxy species were documented during the surveys (Figure 57). Blacknose shiners were identified at four sampling stations, where surveyors counted five individuals. Three banded killifish were found at one sampling station, and only one blackchin shiner was found during the surveys.

As with the frogs, most of the target species were found within bays. Species of greatest conservation need were found in sites with varying substrate types. However, they were all found at sites with small-diameter substrate types, including sand, silt, and muck. Sites containing species of greatest conservation need also had more submerged aquatic vegetation than those without. Sites with SGCNs had an average biovolume of 42%, while sites without averaged 17%.

In total, 30 different species were identified at the 24 sampling stations (Table 3), bringing the Woman Lake observed community to 39 species. Four species not previously documented at Woman Lake were found during the surveys; they were blacknose shiner, pugnose shiner, spotfin shiner, and central mudminnow. Ten species previously documented at Woman Lake were not detected during the 2006 surveys. Yellow perch were the most abundant fish detected, with surveyors counting over 600 specimens at 22 sites. Bluegills, bluntnose minnows, spotfin shiners, mimic shiners, and rock bass were also present in numbers greater than 100. Species richness varied among the sites. Two sites contained 17 species, and an additional nine sites had 10 or more species.

Figure 56. Distribution of fish species of greatest conservation need (pugnose shiner and longear sunfish), August – September 2006.

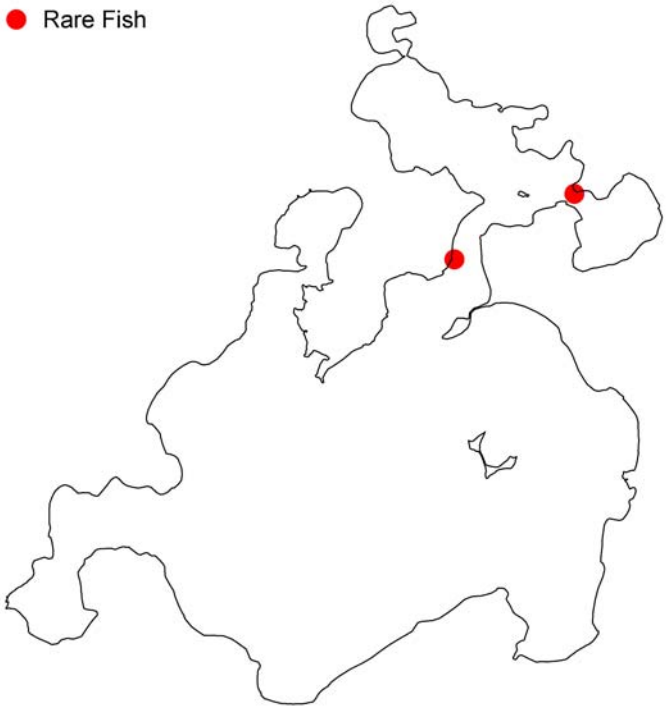


Figure 57. Distribution of proxy species, August – September 2006.

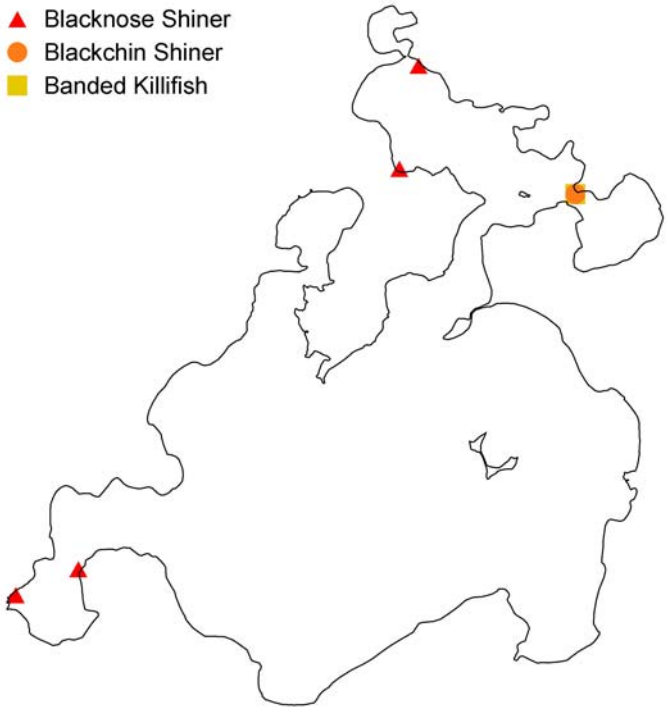


Table 3. Abundance and frequency of fish species identified during surveys, August – September 2006. * denotes species of greatest conservation need

[a] # – total number of individuals found

[b] % – percent of surveyed sample sites in which a species occurred

Family	Description	Common Name	Scientific Name	[a] #	[b] %
Amiidae	Bowfins	Bowfin	*Amia calva*	15	38
Catostomidae	Suckers	White sucker	*Catostomus*	2	4
Centrarchidae	Sunfishes	Black crappie	*Pomoxis*	18	21
		Bluegill	*Lepomis macrochirus*	467	92
		Largemouth bass	*Micropterus*	74	58
		Longear sunfish*	*Lepomis megalotis*	3	4
		Pumpkinseed	*Lepomis gibbosus*	81	75
		Rock bass	*Ambloplites rupestris*	131	88
		Smallmouth bass	*Micropterus*	24	33
Cyprinidae	Minnows/carps	Blackchin shiner	*Notropis heterodon*	1	4
		Blacknose shiner	*Notropis heterolepis*	5	17
		Bluntnose minnow	*Pimephales notatus*	366	63
		Emerald shiner	*Notropis atherinoides*	4	13
		Golden shiner	*Notemigonus*	1	4
		Mimic shiner	*Notropis volucellus*	173	33
		Pugnose shiner*	*Notropis anogenus*	1	4
		Spotfin shiner	*Cyprinella spiloptera*	180	4
		Spottail shiner	*Notropis hudsonius*	10	17
Esocidae	Pikes	Northern pike	*Esox lucius*	3	13
Fundulidae	Topminnows/killifishes	Banded killifish	*Fundulus diaphanus*	3	4
Ictaluridae	North American freshwater catfishes	Black bullhead	*Ameiurus melas*	1	4
		Brown bullhead	*Ameiurus nebulosus*	10	38
		Tadpole madtom	*Noturus gyrinus*	1	4
		Yellow bullhead	*Ameiurus natalis*	22	54
Lotidae	Hakes/burbots	Burbot	*Lota lota*	3	13
Percidae	Perches	Iowa darter	*Etheostoma exile*	18	21
		Johnny darter	*Etheostoma nigrum*	35	42
		Walleye	*Sander vitreus*	7	21
		Yellow perch	*Perca flavescens*	648	92
Umbridae	Mudminnows	Central mudminnow	*Umbra limi*	2	4

Aquatic Vertebrate Richness

Objectives

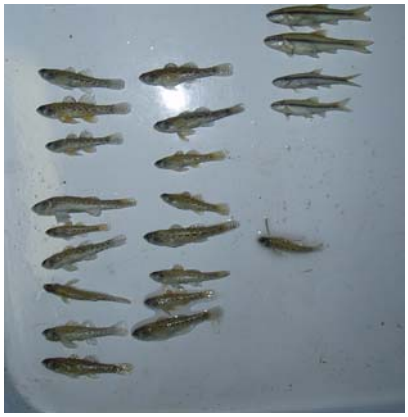
1. Calculate and map aquatic vertebrate richness around the shoreline of Woman Lake.

Summary

Species richness varied from two to 17 species at a single sampling station.

Introduction

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



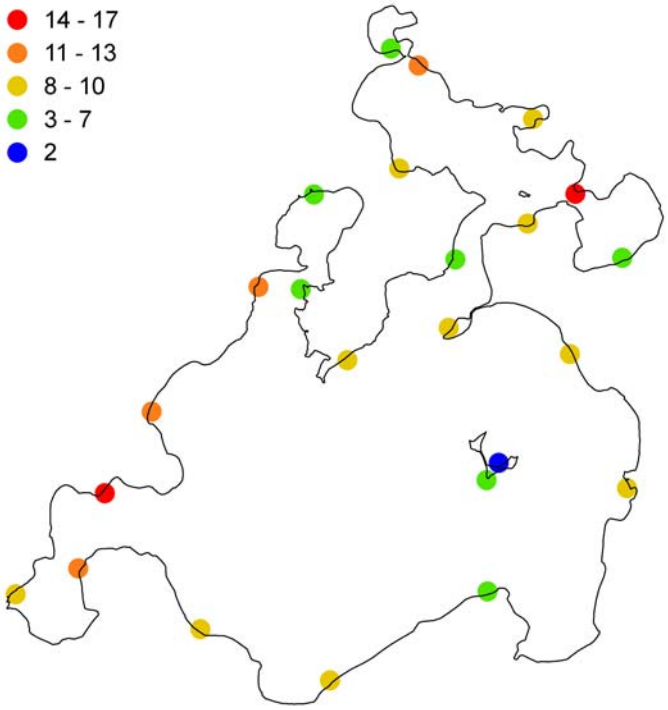
Methods

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

Results

Species richness varied among the sites. Maximum species richness at a sampling station was 17 species, and nine additional stations had 10 or more species. The majority of the documented species were fish, although mink frogs, painted turtles, and snapping were also identified. All of the aquatic vertebrate species identified during the surveys were native. Species richness was generally highest in the bays (Figure 58).

Figure 58. Aquatic vertebrate species richness (number of species per sample site) at sample sites, June 2006.



Rare Features

Objectives

1. Map rare features occurring within the state-defined shoreland area of Woman Lake

Summary

Seven Natural Heritage rare features have been documented near the shoreline of Woman Lake.

Introduction

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

Methods

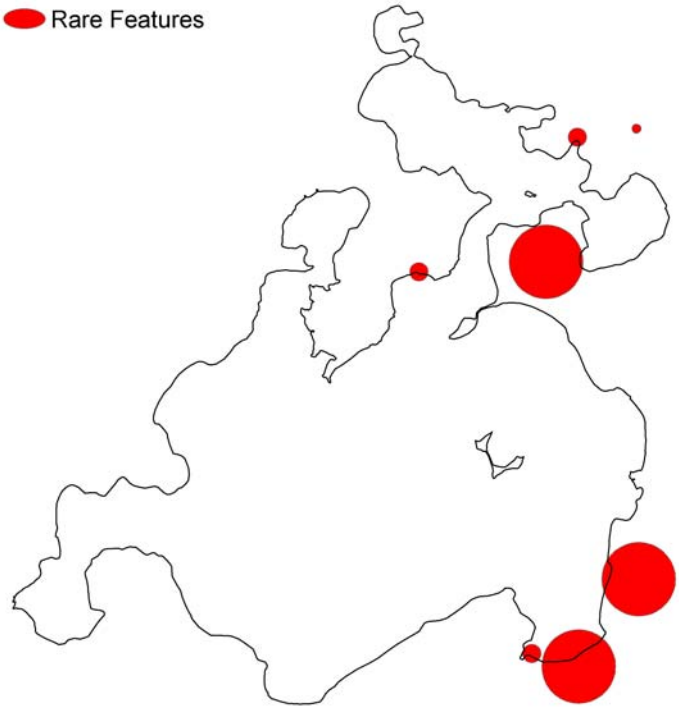
Researchers obtained locations of rare features from the Rare Features Database. Only "listed" animal species (Federal or State endangered, threatened, or special concern) were considered in this project; rare aquatic plant species were included in the "Unique Plant Species" section of this report. Rare features within 1320 feet of the shoreline were mapped using GIS. Varying buffer sizes around rare feature locations represent locational uncertainty.

Results

There were seven Natural Heritage rare features located near the shoreline of Woman Lake (Figure 59). These features included bald eagle nests, rare terrestrial plants, and a Blanding's turtle. The publication of exact locational information is prohibited in order to help protect these rare species.

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

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



Bay Delineation

Objectives

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

Summary

There were four isolated bays and five non-isolated bays in Woman Lake.

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

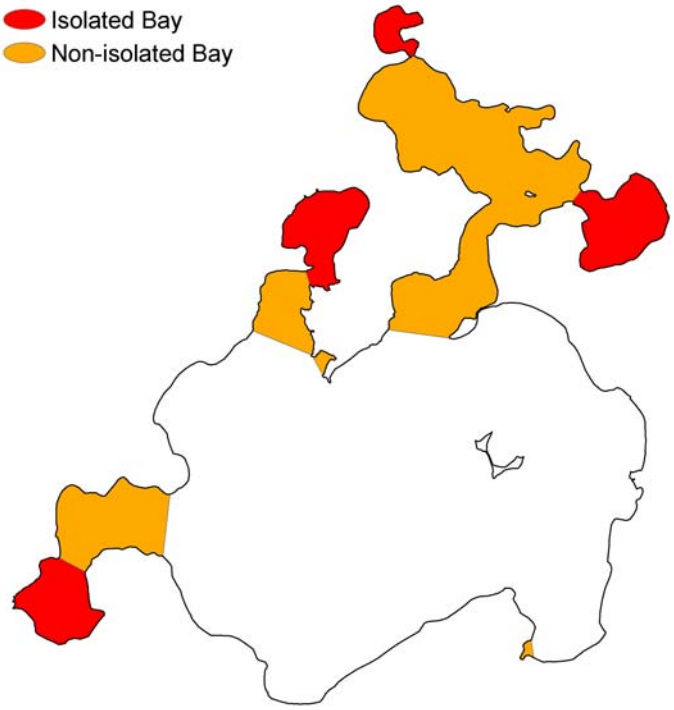
Bays were delineated using lake maps and aerial photos. Obvious bays (e.g., significant indentations of shoreline, bodies of water set off from main body or enclosed by land) were mapped based on inspection of lake maps. Additional bays were identified using aerial photos. Underwater shoals or reefs 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

Researchers identified four isolated bays and five non-isolated bays on Woman Lake (Figure 60). The northwester and southeastern corners of Broadwater Bay were defined as isolated bays, while the central portion and channel were described as a non-isolated bay. Lantern Bay was identified as an isolated bay, as was Bungey Bay. Non-isolated bays were located near Lantern Bay and Bungey Bay, and in Hunter's Bay.

Field surveys of aquatic plants, fish, frogs, and birds found that a large percentage of these species were located within bays. All of the 41 plant taxa were found within at least one bay. Over 95% of the mink and green frog detections were at sample stations within bays, and more than 95% of the loon nesting areas were in bays. All fish species of greatest conservation need found were within bays, and 75% of the bird SGCNs were within delineated bays.

Figure 60. Location of isolated and non-isolated bays.



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 4). 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 61). 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 62). 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 63).

Habitat Connectivity

In addition to the sensitive shorelands identified through the GIS model, surveyors considered adjacent river shorelines that provide habitat connectivity to and from the lake shorelands. Aquatic habitat connectivity allows for the movement of aquatic organisms within a watershed. These organisms can move between existing habitats, colonize new areas, or recolonize former habitat in the wake of local extinctions. In Woman Lake, several stream segments were identified as potential ecological connections. These included a segment between Bungey Bay and Child Lake, and between the southern end of Woman Lake and Blackwater Lake (Figure 63). These shorelands will also be forwarded to the local government for consideration in resource protection zoning.

Table 4. Criteria for assigning scores to analysis windows for each variable

Variable	Score	Criteria
Wetlands	3	> 25% of analysis window is in wetlands
	2	12.5 - 25% is in wetlands
	1	< 12.5% is in wetlands
	0	No wetlands present
Hydric Soils	3	> 25% of analysis window is hydric soils
	2	12.5 - 25% hydric soils
	1	< 12.5% hydric soils
	0	No hydric soils present
Near-shore Plant Occurrence	3	Frequency of occurrence is > 75% (> 75% of points within analysis window contained vegetation)
	2	Frequency of occurrence is 25-75%
	1	Frequency of occurrence < 25%
	0	No vegetation present
Aquatic Plant Richness	3	Total number of plant taxa per analysis window > 10
	2	Total number of plant taxa 5 - 10
	1	Total number of plant taxa 1 - 4
	0	No vegetation present
Presence of Emergent and Floating-leaf Plants Beds	3	Emergent and/or floating-leaf plant stands occupy > 25% of the aquatic portion of the analysis window
	2	Stands occupy 5 - 25%
	1	Stands present but occupy less than 5%
	0	No emergent or floating-leaf plant beds present
Unique Plant Species	3	Presence of 2 or more unique or rare plant species within analysis window
	2	Presence of 1 unique plant species
	0	No unique plant species present
Near-shore Substrate	3	Frequency of occurrence is > 50% soft substrate (i.e., > 50% of points within analysis window consisted of soft substrate)
	2	Frequency of occurrence is 25 – 50% soft substrate
	1	Frequency of occurrence < 25% soft substrate
	0	No soft substrate present
Birds	3	Presence of 3 or more SGCNs within analysis window
	2	Presence of 2 SGCNs
	1	Presence of 1 SGCN
	0	No SGCNs present

Bird Richness	3	Total number of bird species within analysis window > 18
	2	Total number of bird species 8 - 18
	1	Total number of bird species 1 - 7
	0	No bird species observed
Loon Nesting Areas	3	Presence of natural loon nest within analysis window
	2	Presence of loon nest on artificial platform
	0	No loon nesting observed
Frogs	3	Presence of both mink and green frogs within analysis window
	2	Presence of mink or green frogs
	0	Neither mink nor green frogs present
Fish	3	Presence of one or more SGCNs within analysis window
	2	Presence of one or more proxy species
	0	Neither SGCNs nor proxies present
Aquatic Vertebrate Richness	3	Total number of aquatic vertebrate species within analysis window > 10
	2	Total number of aquatic vertebrate species 5 - 10
	1	Total number of aquatic vertebrate species 1 - 4
	0	No aquatic vertebrate species observed
Rare Features	3	Presence of multiple Natural Heritage features within analysis window
	2	Presence of a Natural Heritage feature
	0	No Natural Heritage feature present
Bays	3	Protected or isolated bay within analysis window
	2	Non-protected or non-isolated bay
	0	Not a distinctive bay

Figure 61. Total score layer created by summing scores of all 15 variables. Highest total scores represent most sensitive areas of shoreline.

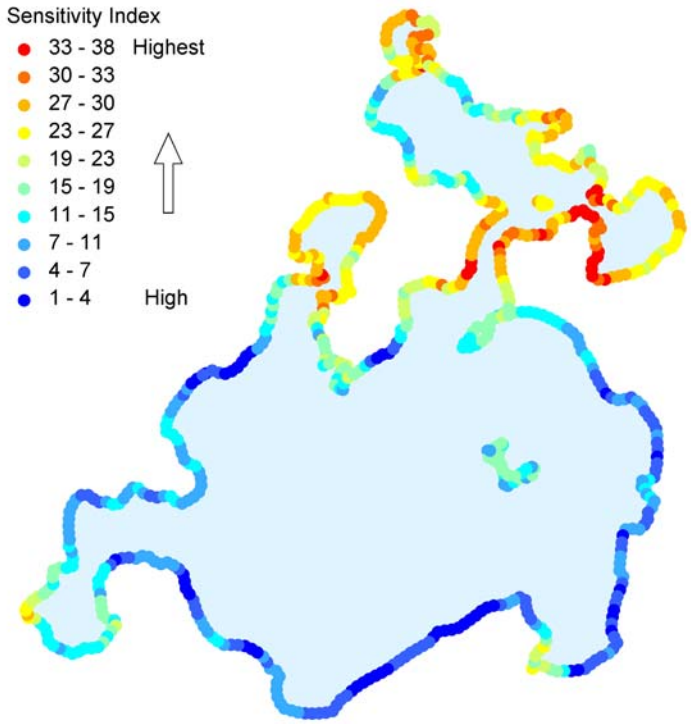


Figure 62. GIS-identified clusters of points with similar total scores. Red areas are those with high scores (i.e., areas of highly sensitive shoreland)

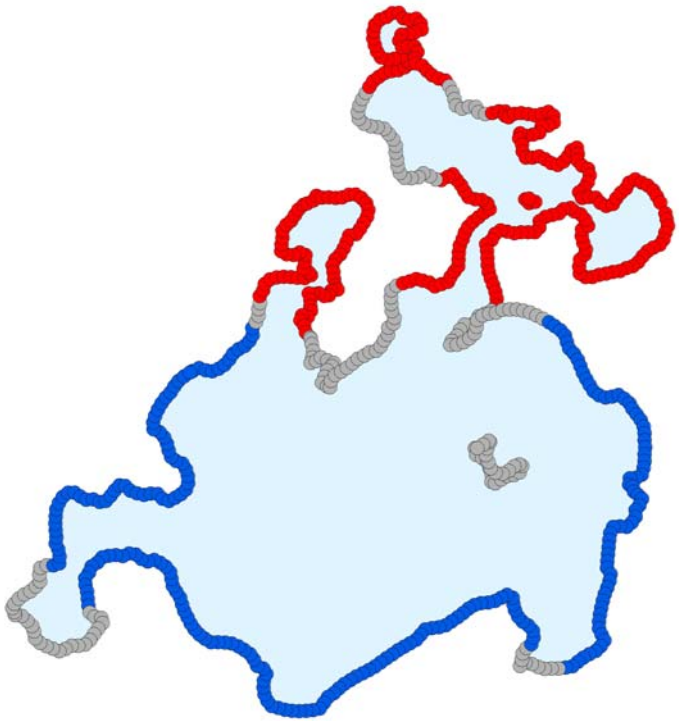
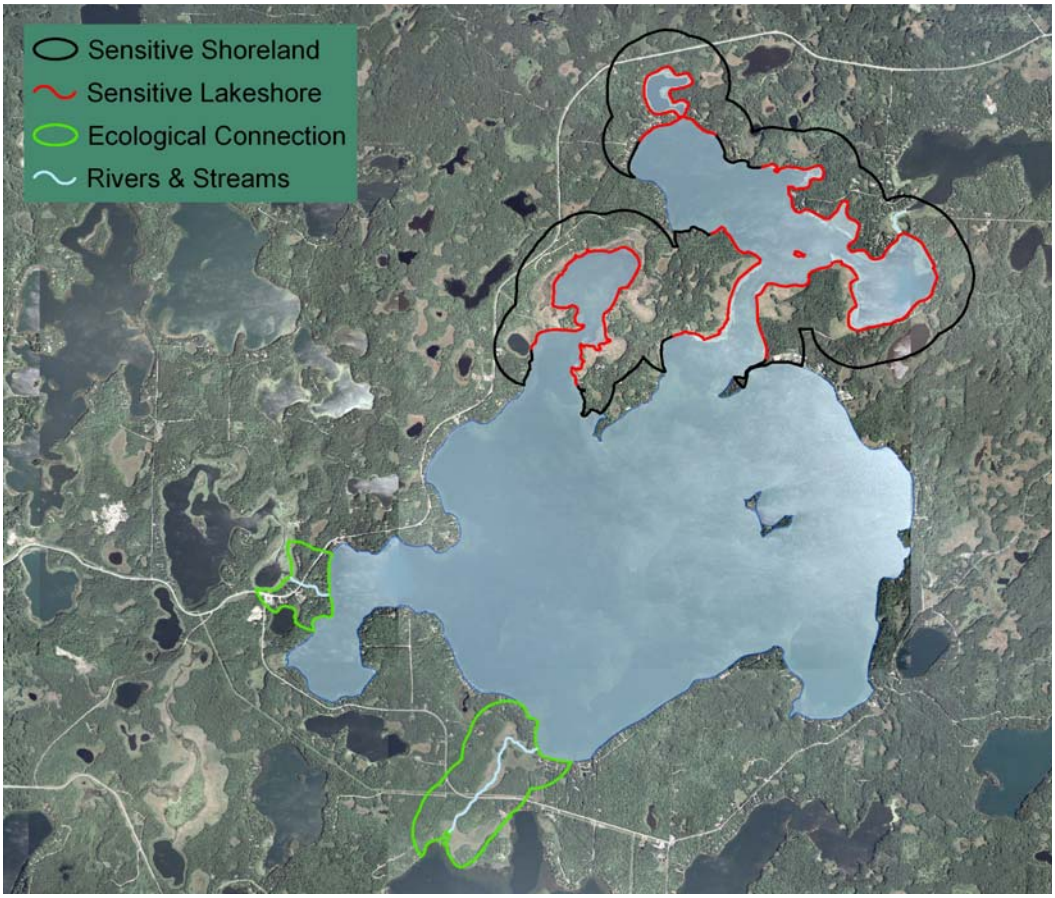


Figure 63. The primary sensitive lakeshore areas identified by the ecological model and ecological connections.



As the field surveys documented, the bays supported the greatest diversity of plant and wildlife species, including species of greatest conservation need. Critical habitat, such as wetland habitat, was also present in the highest quantities near the bays. The ecological model displays these areas both as sensitive shoreline and as high priority shorelands. Although the shoreline itself is important, development and land alteration nearby has significant negative effects on many species. The most probable highly sensitive lakeshore areas also contain one area of important ecological connectivity between critical areas. Habitat connectivity allows movement of animals from various populations, increasing diversity. It allows animals with different vegetation requirements during different life stages to access those habitats. Fragmented habitats often contain high numbers of invasive, non-native plants and animals that may outcompete native species. The larger a natural area is, the more likely it is to support populations of native plants and animals. Large natural areas that support a diversity of species and habitats help comprise a healthy ecosystem. Protection of both the shoreline itself and the habitat surrounding the shoreline will be the most effective way to preserve the plant and animal communities in and around Woman Lake, and the value of the lake itself.

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Appendix 1. Bird species list. Includes all species within Woman Lake and shoreland recorded during surveys and casual observation, June – July 2007.

Common Name	**Scientific Name**
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhynchos*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruffed Grouse	*Bonasa umbellus*
Common Loon	*Gavia immer*
Red-necked Grebe	*Podiceps grisegena*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Killdeer	*Charadrius vociferus*
Wilson's Snipe	*Gallinago delicata*
Ring-billed Gull	*Larus delawarensis*
Caspian Tern	*Sterna caspia*
Common Tern	*Sterna hirundo*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Veery	*Catharus fuscescens*
American Robin	*Turdus migratorius*

Appendix 1, cont.

Common Name	**Scientific Name**
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Pine Warbler	*Dendroica pinus*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapilla*
Common Yellowthroat	*Geothlypis trichas*
Scarlet Tanager	*Piranga olivacea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Red-winged Blackbird	*Agelaius phoeniceus*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Red Crossbill	*Loxia curvirostra*
American Goldfinch	*Carduelis tristis*