Sensitive Lakeshore Surveys

Final Report
State Wildlife Grants Program
T-10-R-1

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Introduction

Minnesota's lakes are one of its most valuable resources. They provide us with recreational opportunities and shorelands for living. 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, including species in greatest conservation need. However, increases in shoreland development are changing lake ecosystems. These changes affect multiple aspects of lake systems, from fish and wildlife habitat to water quality (Engel and Pederson 1998, Ramstack et al. 2004). Radomski and Goeman (2001) estimated that 20 to 28 percent of the near-shore emergent and floating-leaf coverage was lost at undeveloped compared to developed shorelines for a group of Minnesota lakes. The mean number of plant species and the percent of native species were lower at developed sites than along undeveloped Wisconsin lakeshores (Elias and Meyer 2003), and aquatic macrophyte abundance was significantly reduced in developed compared with undeveloped shorelines in an Iowa lake (Byran and Scarnecchia 1992). Christensen et al. (1996) found significantly less submerged woody habitat from fallen trees along developed shorelines in Wisconsin and Michigan, and predicted that recent losses in developed lakes will affect littoral communities for centuries. Changes in near-shore substrate composition in Wisconsin lakes have also been attributed to human activity (Jennings et al. 1996).

Shoreland development and shoreline alteration may have significant negative impacts on lake-dwelling fish and wildlife species. Alteration of native vegetation due to housing development reduced frog populations in northern Wisconsin (Meyer et al. 1997), and growth rates of several fish species were lower in heavily developed than in undeveloped Midwestern lakes (Schindler et al. 2000). Floating-leaf and emergent vegetation provides fish and wildlife with foraging areas and refuge from predators (Killgore et al. 1993; Casselman and Lewis 1996; Valley et al. 2004). Many fish depend on this habitat for a portion of their life cycle (Becker 1983). Emergent vegetation, such as hardstem bulrush, provides spawning habitat, cover, and colonization sites for aquatic invertebrates and protects shorelines from erosion by dampening wave energy. Numerous fish species use protected embayments and vegetative cover disproportionately to their availability (Wei et al. 2004). Human activities that change vegetative cover can alter ecological processes and energy flow within lakes, thereby reducing their ability to support diverse and healthy fish and wildlife populations (Schindler and Scheuerell 2002).

The effects of development on lake ecosystems are a concern in Minnesota, where lakeshore development is increasing at a rapid rate. More dwellings are being built per lake each year (Kelly and Stinchfield 1998), and the Minnesota State Demographic Center has projected growth in many of the lake-rich counties to exceed 35 percent in the next 25 years. Protection of critical fish and wildlife habitat, particularly for species in greatest conservation need, is crucial given the substantial near-shore habitat losses estimated to date and the losses projected with future shoreland development.

The Sensitive Lakeshore Area Surveys project began as a Cass County project named Intra-Lake Land Use Reclassification. In 2005, the county realized the need to examine land use impacts on area lakes. They recognized that lake shorelines often vary greatly with respect to their ecological characteristics and functions, but that the current state lake classification system

assigned one class to an entire lake basin without regard for these varied characteristics. The county led a technical team of federal, state, and local resource managers to develop criteria for determining sensitive areas. The criteria were then incorporated into a GIS (Geographic Information Systems) algorithm to identify sensitive lakeshores. The county proposed specific development standards, including larger lot sizes and greater structure setbacks for new lots, for these areas. The county held public hearings on this approach for protecting significant fish and wildlife habitat. Cass County acknowledged that insufficient resources existed for extensive field verification and validation of county designated sensitive areas, and they asked the DNR for assistance before proceeding with any proposed zoning or ordinance changes. This project was the result of this early Cass County/State collaboration.

Objectives

The current project is an amendment to the original proposal that began on July 1, 2006, which was developed to test survey protocols. This amended proposal extended the project end date and increased the number of lakes on which sensitive areas were identified. The objectives of this project were to:

1. *Develop, test, and evaluate field survey protocols to characterize near-shore habitat.*

2. *Use existing data and survey results on 20 lakes to develop a model to score the value of a segment of shore as to its habitat value to fish and wildlife and species of greatest conservation need on at least ten lakes in Cass County.*

3. *Provide technical advice to Cass County on potential sensitive area and bay reclassification for use within their shoreland ordinance and to others interested in this process.*

4. *Develop an amendment to the grant to continue work on identifying potential sensitive lakeshore areas.*

Methods

1. *Develop, test, and evaluate field survey protocols to characterize near-shore habitat.*

This task involved field surveys of the aquatic plant communities in the target lakes and how that aquatic plant habitat is being used by high priority animal species (both species in greatest conversation need (MN DNR 2006) and other animals whose distribution patterns represent a good proxy for species in greatest conservation need). Protocols are documented in a manual, Minnesota's Sensitive Lakeshore Identification Manual, 2009 (available at: http://www.dnr.state.mn.us/eco/sli/index.html).

Field surveys were conducted on twenty lakes[*] within Cass County (Figure 1, Table 1). These lakes include seventeen lakes identified by Cass County as high-priority lakes (large lakes with significant areas of undeveloped shoreline) as well as three connecting waterbodies.

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[*] A modified suite of field surveys was conducted on Leech Lake. Details follow throughout the report.

Figure 1. Locations of study lakes in Cass County.
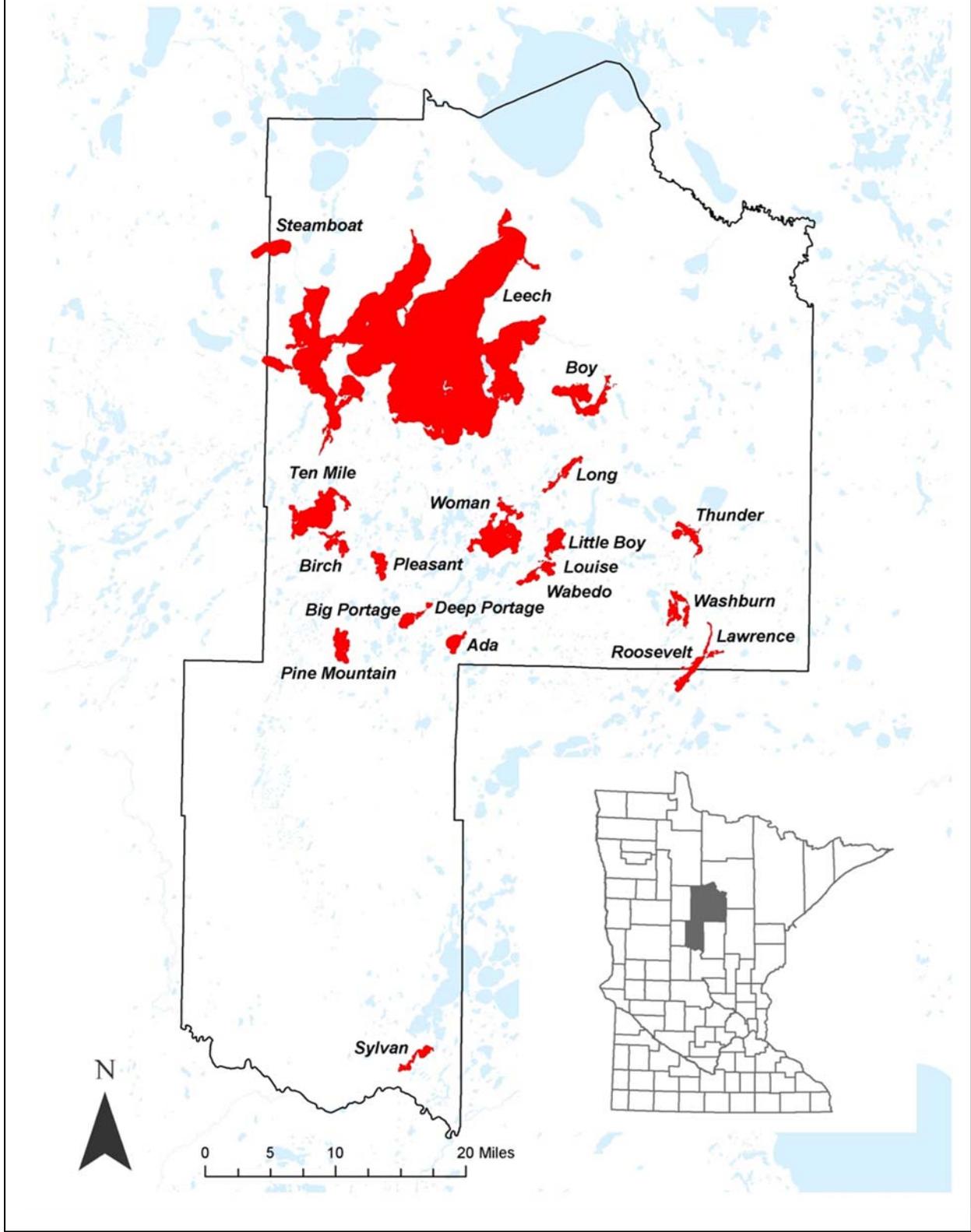
Aquatic Plant Surveys
Lake-wide vegetation survey
The lake-wide vegetation surveys attempted to quantitatively assess the major plant species within the lake basin. Objectives included:
- Record the aquatic plant species that occur in the lake
- Estimate frequencies of occurrence of individual species
- Estimate the percent of the lake occupied by rooted vegetation
- Develop GIS-based, lake-wide distribution maps for common species
- Estimate the maximum depth of rooted vegetation
- Describe the shoal water substrate types

Lake-wide aquatic plants were surveyed using grid point-intercept methodology. A GIS computer program was used to establish aquatic plant survey points throughout the littoral (i.e., vegetated) zone of each lake. Maximum depth of survey points was usually 20 – 25 feet. Number of sample points and point spacing were dependent on the size of the littoral zone and lake shape. The number of survey points sampled on Cass County project lakes ranged from 85 (Louise Lake) to 2,126 (Woman Lake). For Leech Lake, existing grid-point intercept data were used. Surveyors navigated to each site using a handheld Global Positioning System (GPS) unit. At each sample site, water depth was recorded and all vegetation within a one-meter squared sample area was sampled using a double-headed garden rake. Substrate type was described at sites where the water depth was about two meters or less. All aquatic plant species present within the sample lot were recorded and frequency of occurrence was calculated for each species. Any additional species found outside the sample plots were recorded as present in the lake. Voucher specimens were collected for most species and were submitted to The Herbarium of the University of Minnesota Bell Museum of Natural History, St. Paul, MN.

Emergent and floating-leaf plant bed delineation
Emergent and floating-leaf plant beds were mapped based on the procedures documented in the DNR draft Aquatic Vegetation Mapping Guidelines (MN DNR 2005). Procedures 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 shoreline from mats of perennial vegetation. Field mapping focused on bulrush beds, which were difficult to see on aerial photos. Bulrush beds were mapped by boating or walking around the edge of the stand. Handheld GPS units were used to collect information. Reconnaissance surveys were conducted of other plant beds to verify species composition and, if needed, modify boundary lines.

Near-shore vegetation surveys
Near-shore vegetation surveys were designed to characterize near-shore sites that contained unique habitat for native aquatic plant communities and high priority animal species. These sites were identified based on locations of fish species in greatest conservation need, locations of rare or unique aquatic plant species, or intact, high quality aquatic/wetland plant communities. Near-shore surveys were conducted on all of the study lakes except Leech, Louise, Lawrence, Sylvan and Big Portage. Near-shore plots measured 15 meters along the shoreline and 16 meters lakeward, and 30 (one-meter-squared) sites were sampled within each plot. Surveyors recorded plant species present, water depth, substrate, and presence of woody debris.

Searches for unique and rare plant species
Surveyors searched for unique and rare plant species during the grid point-intercept and near-shore surveys. Unique and rare plant species included:
- Rare (endangered, threatened, special concern) plant species
- Plant species that are not rare but are uncommon in the state or locally. These may include species proposed for rare listing.
- Plant species with high coefficient of conservatism values (C values). These values range from 0 to 10 and represent the "estimated probability that a plant is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition" (Nichols 1999, Bourdaghs et al. 2006). Plant species with assigned C values of 9 and 10 were included as unique species.

If unique or rare species were found, surveyors recorded the site location, the plant species found, associated plant species, approximate water depth, and substrate type. Any new sites of rare plant species were documented and entered into the MN DNR Natural Heritage Information System.

Plastic hoop (one-meter squared area) to delineate sample area.

Double-headed garden rake used for submerged plant sampling.

Establishing transect for conducting near-shore plant surveys.

Aquatic Frog Surveys

The aquatic frog survey methodology followed the Minnesota Frog and Toad Calling Survey (MFTCS) protocol. Surveys targeted mink frogs (*Rana septentrionalis*) and green frogs (*Rana clamitans*). These shoreline-dependent species are strongly associated with larger lakes, and are easily surveyed during their summer breeding season (late May – July). Objectives of the frog surveys included:

- Record index of abundance for all frogs and toads
- Estimate abundance of mink frogs and green frogs
- Develop distribution maps for mink frogs and green frogs

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

Survey crews heading out to begin night-time frog surveys.

Nongame Fish Surveys

Fish surveys identified critical areas for aquatic animals and mapped locations where sensitive indicator species were present. Target fish species included three species in greatest conservation need (pugnose shiner *Notropis anogenus*, least darter *Etheostoma microperca*, and longear sunfish *Lepomis megalotis*) and three proxy species (blackchin shiner *Notropis heterodon*, blacknose shiner *Notropis heterolepis*, and banded killifish *Fundulus diaphanus*). Proxy species are those whose life history characteristics and habitat needs are similar to species in greatest conservation need. Objectives of the nongame fish surveys were:

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

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Fish surveys were conducted at sample stations located 400 meters apart along the entire shoreline of each study lake. Fish were sampled during the summer using three different methods: shoreline seining, electrofishing, and trap netting. Seines were 15.2 meters long with 3.2 mm nylon mesh. The seine was set on the shoreline, perpendicular to shore, until the net was fully deployed or the maximum wadable depth was reached. The net was then pulled in an arc back toward shore. Electrofishing was conducted using a backpack electroshocker. Two shocking passes were conducted at each sampling station, one near the shoreline and one at a depth of approximately three feet. Electrofishing crews consisted of two people, one to carry and operate the backpack electroshocker and one to net fish. Trap nets were stationary nets set perpendicular to the shoreline. Trap nets were 1.1 meters deep with a 12.2 meter leader. Nets were set overnight and pulled the next morning. For each sampling gear, fish and other aquatic animal species were identified and counted.

Shoreline seining.

Backpack electrofishing.

Bird Surveys
Bird surveyors attempted to document all bird species utilizing the study lakes and lakeshore habitat. Objectives of the bird surveys included:
- Record presence of all bird species detected during point count surveys
- Record presence of marsh birds detected with call-playback surveys
- Document all non-survey observations of birds
- Develop distribution maps for species in greatest conservation need

Bird surveys were conducted during the nesting season (mid-May until early July), when species were most vocal. Surveyors used several techniques to collect information on bird species. Point counts were conducted at survey stations located 400 meters apart along the entire shoreline. These survey stations were the same stations used to collect data on frogs and nongame fish. Bird 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 with high-quality marsh/wetland habitat. These surveys targeted "secretive" marsh birds, such as least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), Virginia rail (*Rallus limicola*) and American bittern (*Botaurus lentiginosus*). At each station, surveyors played a tape that included the calls of six marsh birds and listened for a response. Call-playback surveys took place in the evening. Both survey techniques were

dependent on good listening conditions, and surveys were stopped if inclement conditions prevented the ability to hear bird vocalizations. Casual observations of birds seen or heard on the lake or lakeshore were also recorded.

Observing birds during bird surveys.

Recording data during bird surveys.

2. *Use existing data and survey results on 20 lakes to develop a model to score the value of a segment of shore as to its habitat value to fish and wildlife and species of greatest conservation need on at least ten lakes in Cass County.*

An ecological model based on fundamental conservation principles was used to assess lakeshore sensitivity. The model incorporated the results of the field surveys and analysis of additional data, so included information on plant and animal communities as well as hydrological conditions. A total of 15 attributes were used to identify sensitive lakeshores[†].

In order to develop a continuous sensitivity score along the shoreline, the ecological model used a GIS-based moving analysis window that included both shoreland and near-shore areas. Resource managers developed a system to score each of the 15 attributes. These scores were based on each attribute's presence or abundance in relation to the analysis window. Each analysis window was assigned a score, which was equal to the highest score present within the 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 attributes were summed, and the resulting total score represents an index of sensitivity. Higher total scores represent more highly sensitive areas, whereas lower total scores represent less highly sensitive areas.

Once the total score index was developed for the shoreline, clusters of points with similar values were identified using GIS. The clusters with high values (i.e., areas of most highly sensitive shoreline) were buffered by ¼ mile. These buffered areas were defined as most likely highly sensitive lakeshore areas.

[†] Leech Lake sensitive shoreline/lakeshore were identified using nine attributes. Unique plant species, near-shore substrate, birds, bird richness, fish, and aquatic vertebrate richness were not included in the Leech Lake analysis.

Criteria for assigning scores to analysis windows for each variable

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

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

3. ***Provide technical advice to Cass County on potential sensitive area and bay reclassification for use within their shoreland ordinance and to others interested in this process.***

Lake reports summarizing sensitive lakeshore assessments were completed for 20 lakes. These reports describe the results of the field surveys and other analyses as well as delineate potential resource protection districts. In addition, they highlight other ecologically important areas, such as shorelands of inlets and outlets that provide connectivity. These reports were distributed to Cass County as well as to interested lake associations, organizations, and individuals. They are also available to the public online at: http://www.dnr.state.mn.us/eco/sli/index.html
Public presentations explaining the sensitive area designation process and results were given to the Cass County Board of Commissioners, Cass County Planning Commission, Association of Cass County Lake Associations, U.S. Forest Service, multiple lake associations, and several other organizations.

4. *Develop an amendment to the grant to continue work on identifying potential sensitive lakeshore areas.*

An amendment to the project was developed, submitted to the USFWS and was approved. The amended proposal extended the project end date and increased the number of lakes on which sensitive areas were identified.

Results

1. *Develop, test, and evaluate field survey protocols to characterize near-shore habitat.*

Aquatic Plant Surveys

Aquatic plant surveys were effective in assessing the lake-wide and near-shore aquatic plant communities, delineating emergent and floating-leaf vegetation, and identifying unique and rare plant species.

Plant surveyors surveyed a total of 12,001 lake acres as part of the Sensitive Lakeshore Surveys project.[‡] Grid-point intercept surveys were conducted at 15,441 sample points (Table 2). Surveyors documented a total of 69 native aquatic plant taxa, including 42 submerged and free-floating, 7 floating-leaf, and 20 emergent taxa (Table 3). The macro-algae muskgrass (*Chara* sp.) was often the most frequently recorded submerged aquatic plant taxa. It occurred in all of the study lakes and was found at between 10 – 88% of the sample stations. Coontail (*Ceratophyllum demersum*) and Canada waterweed (*Elodea canadensis*) were also commonly occurring submerged plants. Both coontail and Canada waterweed were often found throughout all depth zones within the vegetated areas of the lake, but coontail tended to be more common in deeper water (>10 feet), whereas most Canada waterweed occurrences were in somewhat shallower water. Other common submerged plant taxa were bushy pondweed (*Najas flexilis*), northern watermilfoil (*Myriophyllum sibiricum*), and several pondweed species, including flat-stem pondweed (*Potamogeton zosteriformis*), Robbins' pondweed (*P. robbinsii*), white-stem pondweed (*P. praelongus*), and large-leaf pondweed (*P. amplifolius*).

Surveyors mapped over 2,000 acres of bulrush, and over 6,000 acres of other emergent and floating-leaf plant beds. The largest bulrush beds occurred in Leech Lake, where surveyors mapped over 1,300 acres. Little Boy, Pine Mountain, and Boy Lakes also had extensive bulrush stands; surveyors mapped over 150 acres of bulrush in each of these lakes. Bulrush beds were often associated with shallow water and sandy substrates. Wild rice (*Zizania palustris*) was scattered throughout the study lakes. The largest stands of this emergent occurred on Leech Lake, where surveyors mapped approximately 4,500 acres. The most commonly occurring floating-leaf plant species were white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*). Waterlilies were common in shallow protected bays, and were frequently associated with muck sediments. Waterlily beds often contained emergent plant species, such as bulrush, as well as submerged plants. Other emergent and floating-leaf species documented

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[‡] The Leech Lake grid point-intercept plant surveys were conducted as part of another project. Therefore, aquatic plant survey results (with the exception of emergent/floating-leaf plant results) do not include data from Leech Lake.

during the surveys included spikerush (*Eleocharis* spp.), arrowhead (*Sagittaria* spp.), cattail (*Typha* spp.) and burreed (*Sparganium* spp.).

Seventeen unique or rare plant species were documented during the grid point-intercept and near-shore vegetation surveys (Table 4). They included submerged, free-floating, floating-leaf, and emergent species.

Bushy pondweed.

White waterlily.
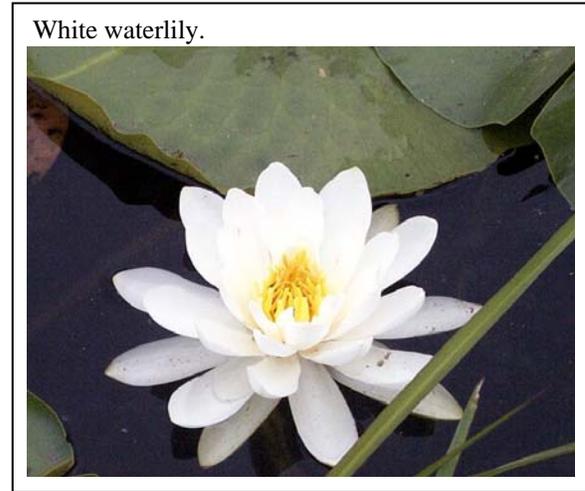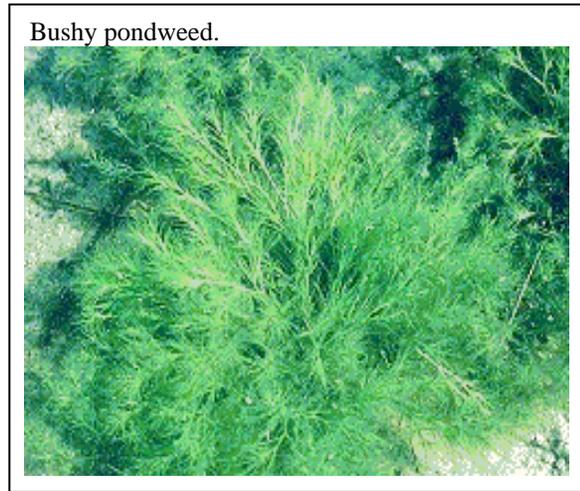
Aquatic Frog Surveys

Frog surveys were conducted at 1,799 survey stations on 19 lakes (frog surveys were not conducted at Louise Lake). Seven anuran species were recorded, including the target mink frogs and green frogs. Mink frogs were documented at 13 of 19 lakes, and green frogs were documented at 18 lakes (Table 5). At survey stations where target frog species were present, estimates of abundance ranged from one frog to over 100 frogs. Indices of abundance ranged from one (individual frogs could be counted, silence between calls) to three (full chorus; calls constant, continuous, and overlapping). The majority of the mink frog and green frog detections were within protected bays. Other frog and toad species documented were gray treefrogs (*Hyla versicolor*), American toads (*Bufo americanus*), northern leopard frogs (*Rana pipiens*), spring peepers (*Pseudacris crucifer*), and wood frogs (*Rana sylvatica*).

Green frog at Big Portage Lake, 2008.


Mink frog at Sylvan Lake, 2008.

Nongame Fish Surveys
Surveyors conducted fish surveys on 19 study lakes (fish surveys were not conducted on Leech Lake). In total, 773 stations were surveyed. Surveyors recorded four species in greatest conservation and three proxy species (Table 6). Pugnose shiners were the most widespread species in greatest conservation need, and were recorded on 10 study lakes. Longear sunfish and least darters were detected on four lakes each. One offshore-dwelling species in greatest conservation need, the greater redhorse (*Moxostoma valenciennesi*), was also documented in four lakes. The three proxy species were fairly widespread among the study lakes. Each of the proxy species was recorded in 17 lakes. Both species in greatest conservation need and proxy species tended to be located at survey sites with sandy or mucky substrate, and relatively high amounts of aquatic vegetation.

Overall, 39 fish species were recorded during the surveys (Table 7). Several hybrids were also observed, but are not included in the species tally. Mimic shiners (*Notropis volucellus*) and bluntnose minnows (*Pimephales notatus*) were documented in the highest numbers; surveyors often counted hundreds or even thousands of these fish at multiple sample stations. Bluegills (*Lepomis macrochirus*) were the most widespread species, found at 95% of the sample stations overall. Rock bass (*Ambloplites rupestris*), largemouth bass (*Micropterus salmoides*), and yellow perch (*Perca flavescens*) were also frequently recorded within the study lakes, and found at over 60% of the sample sites each.

Longear sunfish in Lawrence Lake trap net, 2008.

Fish specimens in the laboratory for identification verification, 2007.

Bird Surveys
Bird surveys were conducted at over 985 locations in 20 lakes. Surveyors documented 161 bird species, including 45 species in greatest conservation need (Tables 8, 9). Four of these SGCN are listed as Threatened in the state of Minnesota and seven species are of Special Concern status. Of the species in greatest conservation need recorded during the project, common loons (*Gavia immer*), ovenbirds (*Seiurus aurocapilla*) and the veery (*Catharus fuscescens*) were most widespread in their distribution; these species were each recorded at all 20 study lakes. Bald eagles (*Haliaeetus leucocephalus*), swamp sparrows (*Melospiza georgiana*) and rose-breasted grosbeaks (*Pheucticus ludovicianus*) were documented at 18 lakes. Thirteen species in greatest conservation need were recorded at only one lake each. The most commonly documented species overall were the song sparrow (*Melospiza melodia*), red-eyed vireo (*Vireo olivaceus*),

and red-winged blackbirds (*Agelaius phoeniceus*). Song sparrows and red-eyed vireos were each recorded at over 60% of the survey stations, and red-winged blackbirds were noted at approximately 50% of the sites.

Virginia rail at Boy Lake, 2009.

Photo by: Andrea Lambrecht

Bald eagles at Big Portage Lake, 2009.

Photo by: Andrea Lambrecht

2. *Use existing data and survey results to develop a model to score the value of a segment of shore as to its habitat value to fish and wildlife and species of greatest conservation need on at least eleven lakes in Cass County.*

Sensitive shoreline and sensitive shoreland (also referred to as potential resource protection districts) were delineated for 20 lakes in Cass County (Figure 2). A total of 190.2 miles of shoreline, representing 40% of the total shoreline miles, were identified as sensitive (Table 10). Nearly 28,000 acres of shoreland (47% of total shoreland acres) were designated as sensitive.

3. *Provide technical advice to Cass County on potential sensitive area and bay reclassification for use within their shoreland ordinance and to others interested in this process.*

In January 2010, Cass County amended their land use ordinance to include information on designation of resource protection districts. The ordinance reads as follows:

> **1202.2 Designation of Resource Protection Districts and Reclassification of Bays of Lakes**
> The [Planning Advisory Commission/Board of Adjustment] may assign RP district classification to the shoreland area adjacent to a bay of a lake, or to a clearly defined portion of the shoreline of a lake. The area considered for such classification must have a DNR Sensitive Lakeshore Survey Report based on the classification criteria and procedures set forth in the latest version of the Minnesota Department of Natural Resources document entitled "Minnesota's Sensitive Lakeshore Identification Manual: A Conservation Strategy for Minnesota's Lakeshores"…

The procedures to reclassify a section of shoreline or shoreland include:
1. A resolution of support from the Township(s) in which the proposed RP district(s) are to be located.

2. Verification from the Minnesota Department of Natural Resources that the area(s) proposed to be reclassified are consistent with the classification criteria
3. Public hearing
4. Final approval of the classification change by the Commissioner of the Minnesota Department of Natural Resources
5. Cass County Board will make changes in the official zoning map to reflect reclassification

In addition to Cass County, multiple other organizations have expressed interest in using the sensitive lakeshore identification information to help protect critical and vulnerable lakeshore areas. The Leech Lake Area Watershed Foundation (LLAWF) has mapped large, undeveloped parcels on each of the study lakes. These parcels, when overlaid with areas of sensitive shoreland, become priorities for conservation easements and acquisition. Several landowners on Wabedo Lake recently implemented conservation easements on four properties, protecting from development over 3500 feet of shoreline and nearly 70 acres of shoreland. Additional conservation easements that will protect another three to five miles of shoreline are currently in process.

4. *Develop an amendment to the grant to continue work on identifying potential sensitive lakeshore areas.*

Sensitive lakeshore identification work began in summer 2006 and continued through summer 2010. Field surveys and sensitive area analysis were conducted on seventeen high priority lakes as well as three connecting lakes.

Table 1. Sensitive Lakeshore project study lakes.

Lake name	DOW number	Lake area (acres)	Shoreland area (acres)	Shoreline length (mi)
Ada	11-0250-00	1044	1096	7.5
Big Portage	11-0308-00	956	1131	7.7
Birch	11-0412-00	1262	1825	15.7
Boy	11-0143-00	3404	3412	25.9
Deep Portage	11-0237-00	129	416	1.9
Lawrence	11-0053-00	224	729	4.8
Leech	11-0203-00	~109000	25942	229.3
Little Boy	11-0167-00	1396	1412	10.0
Long	11-0142-00	926	1827	15.6
Louise	11-0537-00	22	305	1.2
Pine Mountain	11-0411-00	1657	1374	9.5
Pleasant	11-0383-00	1038	1214	9.0
Roosevelt	11-0043-00	1561	2597	18.4
Steamboat	11-0504-00	1761	1401	8.2
Sylvan	11-0304-00	882	1553	11.1
Ten Mile	11-0413-00	4640	3120	25.2
Thunder	11-0062-00	1316	1966	15.9
Wabedo	11-0171-00	1272	1704	11.3
Washburn	11-0059-00	1768	2188	19.5
Woman	11-0201-00	5360	3980	30.7

Table 2. Summary of aquatic vegetation survey results, 2006 – 2010.

Lake Name	Total acres	Acres surveyed	Number of survey points	Total aquatic taxa[a]	Submerged/ free-floating taxa	Floating-leaf taxa	Emergent taxa	Bulrush acres mapped	Other acres mapped	Unique/ rare species
Ada	1044	424	479	42	28	4	10	10	41	7
Big Portage	956	901	833	28	22	4	2	14	378	3
Birch	1262	755	1046	41	27	6	8	50	50	7
Boy	3404	2007	919	34	24	3	7	170	608	2
Deep Portage	123	31	132	18	11	4	3	13	2	3
Lawrence	225	87	351	33	23	3	7	36	8	2
Leech[b]	109415	57994	NA	NA	NA	NA	NA	1315	4613	NA
Little Boy	1396	466	577	35	22	4	9	163	39	1
Long	926	356	1501	45	29	5	11	3	34	10
Louise	33	–	85	26	19	3	4	0	12	1
Pine Mountain	1657	737	829	39	22	5	12	153	150	2
Pleasant	1038	410	503	38	26	4	8	3	51	6
Roosevelt	1561	390	992	37	24	6	7	32	20	0
Steamboat	1761	532	632	30	20	3	7	90	27	1
Sylvan	882	367	420	35	25	4	6	6	125	4
Ten Mile	4640	1316	1465	47	28	6	13	NA[c]	NA	7
Thunder	1316	226	1160	33	21	4	8	36	9	1
Wabedo	1272	295	526	27	17	5	5	39	55	0
Washburn	1768	748	703	55	34	5	16	NA	NA	6
Woman	5360	1953	2126	41	28	4	9	NA	NA	6

[a] Total aquatic taxa, submerged/free-floating taxa, floating-leaf taxa, and emergent taxa numbers were obtained from grid point-intercept surveys and near-shore surveys. Wetland and terrestrial plant species recorded during near-shore surveys are not included in these results. Plant taxa documented by the Minnesota County Biological Survey are not included with these results. In addition, the totals include only native plant taxa.

[b] Results include only those collected during the Sensitive Lakeshore Survey project. Some Leech Lake results are not included, as the grid point-intercept plant surveys that took place on this lake were conducted as part of another project.

[c] NA - Minnesota Department of Natural Resources Area Fisheries crews conducted the emergent and floating-leaf plant bed mapping on Ten Mile, Washburn, and Woman Lakes.

Table 3. Unique and rare plant species documented during grid point-intercept and near-shore vegetation surveys, 2006 – 2008.

Common name	Scientific name	Ada	Big Portage	Birch	Boy	Deep Portage	Lawrence	Leech[a]	Little Boy	Long	Louise	Pine Mtn	Pleasant	Roosevelt	Steamboat	Sylvan	Ten Mile	Thunder	Wabedo	Washburn	Woman
Bog rosemary	*Andromeda glaucophylla*				x			–													
Water arum	*Calla palustris*	x		x	x			–				x	x				x				x
Wiregrass sedge	*Carex lasiocarpa*							–				x					x				x
Leatherleaf	*Chamaedaphne calyculata*			x				–													
Three-way sedge	*Dulichium arundinaceum*	x		x				–	x	x							x			x	x
Pipewort	*Eriocaulon aquaticum*							–		x	x										
Cottongrass	*Eriophorum* sp.					x		–													
Mare's tail	*Hippurus vulgaris*							–					x		x						
Leafless watermilfoil	*Myriophyllum tenellum*							–		x										x	
Vasey's pondweed	*Potamogeton vaseyi*							–		x											
Creeping spearwort	*Ranunculus flammula*	x						–		x										x	
Water bulrush	*Schoenoplectus subterminalis*	x						–		x			x			x	x			x	
Narrow-leaved burreed	*Sparganium angustifolium*							–		x										x	
Floating-leaved burreed	*Sparganium fluctuans*			x				–													
Humped bladderwort	*Utricularia gibba*	x	x	x				–		x			x			x	x				x
Flat-leaved bladderwort	*Utricularia intermedia*	x	x	x	x	x	x	–		x			x			x	x	x		x	x
Lesser bladderwort	*Utricularia minor*	x	x	x			x	–		x			x			x	x				x

[a] Results include only those collected during the Sensitive Lakeshore Survey project. Leech Lake results are not included, as the grid point-intercept plant surveys that took place on this lake were conducted as part of another project.

Table 4. Aquatic plant taxa list. Includes all native aquatic plant taxa documented during Sensitive Lakeshore surveys, 2006 – 2008.

Description	Common Name	Scientific Name
Submerged/free-floating	Watermoss	Not identified to genus
	Water marigold	*Bidens beckii*
	Coontail	*Ceratophyllum demersum*
	Muskgrass	*Chara* sp.
	Canada waterweed	*Elodea canadensis*
	Pipewort	*Eriocaulon aquaticum*
	Water stargrass	*Heteranthera dubia*
	Mare's tail	*Hippuris vulgaris*
	Quillwort	*Isoetes* sp.
	Lesser duckweed	*Lemna minor*
	Star duckweed	*Lemna trisulca*
	Northern watermilfoil	*Myriophyllum sibiricum*
	Leafless watermilfoil	*Myriophyllum tenellum*
	Whorled watermilfoil	*Myriophyllum verticillatum*
	Bushy pondweed	*Najas flexilis*
	Southern naiad	*Najas guadalupensis*
	Stonewort	*Nitella* sp.
	Large-leaf pondweed	*Potamogeton amplifolius*
	Ribbon pondweed	*Potamogeton epihydrus*
	Leafy pondweed	*Potamogeton foliosus*
	Fries' pondweed	*Potamogeton friesii*
	Variable pondweed	*Potamogeton gramineus*
	Illinois pondweed	*Potamogeton illinoensis*
	White-stem pondweed	*Potamogeton praelongus*
	Very small/small pondweed	*Potamogeton pusillus*
	Clasping-leaf pondweed	*Potamogeton richardsonii*
	Robbin's pondweed	*Potamogeton robbinsii*
	Snail-seed pondweed	*Potamogeton spirillus*
	Straight-leaved pondweed	*Potamogeton strictifolius*
	Vasey's pondweed	*Potamogeton vaseyi*
	Flat-stem pondweed	*Potamogeton zosteriformis*
	White water buttercup	*Ranunculus aquatilis*
	Creeping spearwort	*Ranunculus flammula*
	Water bulrush	*Schoenoplectus subterminalis*
	Greater duckweed	*Spirodela polyrhiza*
	Sago pondweed	*Stuckenia pectinata*
	Humped bladderwort	*Utricularia gibba*
	Flat-leaved bladderwort	*Utricularia intermedia*
	Lesser bladderwort	*Utricularia minor*
	Greater bladderwort	*Utricularia vulgaris*
	Wild celery	*Vallisneria americana*
	Watermeal	*Wolffia* sp.

Table 4, continued.

Description	Common Name	Scientific Name
Floating-leaf	Watershield	*Brasenia schreberi*
	Yellow waterlily	*Nuphar variegata*
	White waterlily	*Nymphaea odorata*
	Floating-leaf smartweed	*Persicaria amphibia (Polygonum amphibium)*
	Floating-leaf pondweed	*Potamogeton natans*
	Narrow-leaved burreed	*Sparganium angustifolium*
	Narrowleaf burreed	*Sparganium emersum*
Emergent	Water arum	*Calla palustris*
	Sedges	*Carex* spp.
	Three-way sedge	*Dulichium arundinaceum*
	Needlegrass	*Eleocharis acicularis*
	Spikerush	*Eleocharis erythropoda*
	Small spikerush	*Eleocharis palustris*
	Water horsetail	*Equisetum fluviatile*
	Soft rush	*Juncus effusus*
	Juncus	*Juncus* sp.
	Giant cane	*Phragmites australis*
	Arum-leaved arrowhead	*Sagittaria cuneata*
	Broad-leaved arrowhead	*Sagittaria latifolia*
	Sessile-fruited arrowhead	*Sagittaria rigida*
	Hard-stem bulrush	*Schoenoplectus acutus*
	Three-square bulrush	*Schoenoplectus pungens*
	Soft-stem bulrush	*Schoenoplectus tabernaemontani*
	Nuttall's burreed	*Sparganium americanum*
	Giant burreed	*Sparganium eurycarpum*
	Broad-leaf cattail	*Typha latifolia*
	Wild rice	*Zizania palustris*

Table 5. Frogs and toads recorded during frog surveys, 2007 – 2009. Incidental anuran detections during Sensitive Lakeshore fish, bird, and aquatic plant surveys are also included.

Common Name	Scientific Name	Ada	Big Portage	Birch	Boy	Deep Portage	Lawrence	Leech	Little Boy	Long	Louise	Pine Mtn	Pleasant	Roosevelt	Steamboat	Sylvan	Ten Mile	Thunder	Wabedo	Washburn	Woman
Green frog	*Rana clamitans*	x	x	x	x	x	x	x	x	x	–	x	x	x		x	x	x	x	x	x
Mink frog	*Rana septentrionalis*	x	x	x	x			x		x	–	x	x	x		x	x			x	x
American toad	*Bufo americanus*							x			–								x	x	
Gray treefrog	*Hyla versicolor*		x	x	x	x	x	x	x	x	–	x	x	x	x	x	x	x	x	x	x
Northern leopard frog	*Rana pipiens*							x		x	–	x						x			
Spring peeper	*Pseudacris crucifer*		x					x		x	–					x					
Wood frog	*Rana sylvatica*							x			–										

Table 6. Fish species of greatest conservation need and proxy species recorded during nongame fish surveys, 2006 – 2008.

Common Name	Scientific Name	Ada	Big Portage	Birch	Boy	Deep Portage	Lawrence	Leech	Little Boy	Long	Louise	Pine Mtn	Pleasant	Roosevelt	Steamboat	Sylvan	Ten Mile	Thunder	Wabedo	Washburn	Woman
Pugnose shiner	*Notropis anogenus*	x	x	x	x			–	x				x			x	x		x		x
Longear sunfish	*Lepomis megalotis*					x	x	–								x					x
Least darter	*Etheostoma microperca*						x	–						x			x	x			
Greater redhorse	*Moxostoma valenciennesi*				x			–	x					x						x	
Blackchin shiner	*Notropis heterodon*	x	x	x	x	x	x	–	x	x		x	x			x	x	x	x	x	x
Blacknose shiner	*Notropis heterolepis*	x	x	x	x	x		–	x	x	x	x	x	x		x	x	x		x	x
Banded killifish	*Fundulus diaphanus*	x	x	x	x	x	x	–	x	x		x		x		x	x	x	x	x	x

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Table 7. Fish species list. Includes all species documented during Sensitive Lakeshore surveys, 2006 – 2008.

Description	Common Name	Scientific Name
Bowfins	Bowfin	*Amia calva*
Minnows/carps	Spotfin shiner	*Cyprinella spiloptera*
	Common shiner	*Luxilus cornutus*
	Hornyhead chub	*Nocomis biguttatus*
	Golden shiner	*Notemigonus crysoleucas*
	Pugnose shiner	*Notropis anogenus*
	Emerald shiner	*Notropis atherinoides*
	Blackchin shiner	*Notropis heterodon*
	Blacknose shiner	*Notropis heterolepis*
	Spottail shiner	*Notropis hudsonius*
	Mimic shiner	*Notropis volucellus*
	Northern redbelly dace	*Phoxinus eos*
	Finescale dace	*Phoxinus neogaeus*
	Bluntnose minnow	*Pimephales notatus*
	Fathead minnow	*Pimephales promelas*
	Longnose dace	*Rhinichthys cataractae*
	Creek chub	*Semotilus atromaculatus*
Suckers	White sucker	*Catostomus commersonii*
	Shorthead redhorse	*Moxostoma macrolepidotum*
	Greater redhorse	*Moxostoma valenciennesi*
North American freshwater catfishes	Black bullhead	*Ameiurus melas*
	Yellow bullhead	*Ameiurus natalis*
	Brown bullhead	*Ameiurus nebulosus*
	Tadpole madtom	*Noturus gyrinus*
Pikes	Northern pike	*Esox lucius*
	Muskellunge	*Esox masquinongy*
Mudminnows	Central mudminnow	*Umbra limi*
Salmon	Cisco	*Coregonus artedi*
Burbots	Burbot	*Lota lota*
Killifishes	Banded killifish	*Fundulus diaphanus*
Sticklebacks	Brook stickleback	*Culaea inconstans*
Sculpins	Mottled sculpin	*Cottus bairdii*
Sunfishes	Rock bass	*Ambloplites rupestris*
	Green sunfish	*Lepomis cyanellus*
	Pumpkinseed	*Lepomis gibbosus*
	Bluegill	*Lepomis macrochirus*
	Longear sunfish	*Lepomis megalotis*
	Smallmouth bass	*Micropterus dolomieu*

Table 7, continued.

Description	Common Name	Scientific Name
Sunfishes	Largemouth bass	*Micropterus salmoides*
	Black crappie	*Pomoxis nigromaculatus*
Perches	Iowa darter	*Etheostoma exile*
	Least darter	*Etheostoma microperca*
	Johnny darter	*Etheostoma nigrum*
	Yellow perch	*Perca flavescens*
	Logperch	*Percina caprodes*
	Walleye	*Sander vitreus*

Table 8. Bird species of greatest conservation need recorded during bird surveys and casual observation, 2007 – 2010.

Common Name	Scientific Name	Ada	Big Portage	Birch	Boy	Deep Portage	Lawrence	Leech	Little Boy	Long	Louise	Pine Mtn	Pleasant	Roosevelt	Steamboat	Sylvan	Ten Mile	Thunder	Wabedo	Washburn	Woman
Trumpeter Swan	*Cygnus buccinator*		x		x			x													
American Black Duck	*Anas rubripes*																x				
Northern Pintail	*Anas acuta*							x													
Common Loon	*Gavia immer*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Horned Grebe	*Podiceps auritus*				x										x						
Red-necked Grebe	*Podiceps grisegena*	x						x				x									x
American White Pelican	*Pelecanus erythrorhynchos*		x		x			x				x	x		x	x	x		x		
American Bittern	*Botaurus lentiginosus*			x	x			x											x		
Least Bittern	*Ixobrychus exilis*							x													
Bald Eagle	*Haliaeetus leucocephalus*	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x
Northern Harrier	*Circus cyaneus*				x			x													
Red-shouldered Hawk	*Buteo lineatus*																x				
Yellow Rail	*Coturnicops noveboracensis*				x			x													
Virginia Rail	*Rallus limicola*				x			x					x				x				
Semipalmated Sandpiper	*Calidris pusilla*							x													
Dunlin	*Calidris alpina*							x													
Franklin's Gull	*Leucophaeus pipixcan*							x													
Black Tern	*Chlidonias niger*	x	x		x			x	x			x									
Common Tern	*Sterna hirundo*	x	x	x	x			x				x	x		x		x	x			x
Forster's Tern	*Sterna forsteri*							x													
Black-billed Cuckoo	*Coccyzus erythropthalmus*		x		x			x		x										x	
Common Nighthawk	*Chordeiles minor*		x	x	x			x	x	x	x	x	x				x		x	x	
Eastern Whip-poor-will	*Caprimulgus vociferus*					x															
Yellow-bellied Sapsucker	*Sphyrapicus varius*	x		x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x

Common Name	Scientific Name	Ada	Big Portage	Birch	Boy	Deep Portage	Lawrence	Leech	Little Boy	Long	Louise	Pine Mtn	Pleasant	Roosevelt	Steamboat	Sylvan	Ten Mile	Thunder	Wabedo	Washburn	Woman
Olive-sided Flycatcher	*Contopus cooperi*												x								
Eastern Wood-Pewee	*Contopus virens*	x	x	x	x	x		x	x	x		x	x	x	x	x		x		x	
Least Flycatcher	*Empidonax minimus*	x	x		x	x	x	x	x	x	x		x	x		x	x	x		x	x
N. Rough-winged Swallow	*Stelgidopteryx serripennis*		x		x			x	x								x				
Winter Wren	*Troglodytes hiemalis*								x			x			x				x		
Sedge Wren	*Cistothorus platensis*		x		x			x				x			x				x	x	
Marsh Wren	*Cistothorus palustris*				x			x				x				x					
Veery	*Catharus fuscescens*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Wood Thrush	*Hylocichla mustelina*								x							x			x	x	
Brown Thrasher	*Toxostoma rufum*							x													
Golden-winged Warbler	*Vermivora chrysoptera*	x	x	x			x	x	x	x				x	x	x	x		x	x	
Cape May Warbler	*Dendroica tigrina*				x			x										x		x	
Ovenbird	*Seiurus aurocapilla*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Connecticut Warbler	*Oporornis agilis*							x													
Canada Warbler	*Wilsonia canadensis*							x													
Le Conte's Sparrow	*Ammodramus leconteii*				x			x													
Nelson's Sparrow	*Ammodramus nelsoni*				x			x													
Swamp Sparrow	*Melospiza georgiana*		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
White-throated Sparrow	*Zonotrichia albicollis*			x	x		x	x		x		x	x		x		x	x	x	x	x
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x
Bobolink	*Dolichonyx oryzivorus*				x			x													

Table 9. Bird species list. Includes all species documented during Sensitive Lakeshore bird surveys and casual observation of lakes, 2007 – 2010.

Description	Common Name	Scientific Name
Waterfowl	Canada Goose	*Branta canadensis*
	Trumpeter Swan	*Cygnus buccinator*
	Wood Duck	*Aix sponsa*
	Gadwall	*Anas strepera*
	American Wigeon	*Anas americana*
	American Black Duck	*Anas rupripes*
	Mallard	*Anas platyrhynchos*
	Blue-winged Teal	*Anas discors*
	Northern Pintail	*Anas acuta*
	Green-winged Teal	*Anas crecca*
	Canvasback	*Aythya valisineria*
	Redhead	*Aythya americana*
	Ring-necked Duck	*Aythya collaris*
	Bufflehead	*Bucephala albeola*
	Common Goldeneye	*Bucephala clangula*
	Hooded Merganser	*Lophodytes cucullatus*
	Common Merganser	*Mergus merganser*
	Red-breasted Merganser	*Mergus serrator*
Grouse/turkeys	Ring-necked Pheasant	*Phasianus colchicus*
	Ruffed Grouse	*Bonasa umbellus*
Loons	Common Loon	*Gavia immer*
Grebes	Horned Grebe	*Podiceps auritus*
	Pied-billed Grebe	*Podilymbus podiceps*
	Red-necked Grebe	*Podiceps grisegena*
	Eared Grebe	*Podiceps nigricollis*
Cormorants	Double-crested Cormorant	*Phalacrocorax auritus*
Pelicans	American White Pelican	*Pelecanus erythrorhynchos*
Herons/bitterns	American Bittern	*Botaurus lentiginosus*
	Least Bittern	*Ixobrychus exilis*
	Great Blue Heron	*Ardea herodias*
	Green Heron	*Butorides virescens*
Vultures	Turkey Vulture	*Cathartes aura*
Hawks/eagles	Osprey	*Pandion haliaetus*
	Bald Eagle	*Haliaeetus leucocephalus*
	Northern Harrier	*Circus cyaneus*
	Sharp-shinned Hawk	*Accipiter striatus*
	Cooper's Hawk	*Accipiter cooperii*
	Red-shouldered Hawk	*Buteo lineatus*
	Broad-winged Hawk	*Buteo platypterus*
	Red-tailed Hawk	*Buteo jamaicensis*

Table 9, continued.

Description	Common Name	Scientific Name
Falcons	Merlin	*Falco columbarius*
Rails/coots	Yellow Rail	*Coturnicops noveboracensis*
	Virginia Rail	*Rallus limicola*
	Sora	*Porzana carolina*
	American Coot	*Fulica americana*
Cranes	Sandhill Crane	*Grus canadensis*
Plovers	Killdeer	*Charadrius vociferus*
Sandpipers/allies	Spotted Sandpiper	*Actitis macularius*
	Solitary Sandpiper	*Tringa solitaria*
	Lesser Yellowlegs	*Tringa flavipes*
	Semipalmated Sandpiper	*Calidris pusilla*
	Least Sandpiper	*Calidris minutilla*
	Dunlin	*Calidris alpina*
	Wilson's Snipe	*Gallinago delicata*
Gulls/terns	Bonaparte's Gull	*Chroicocephalus philadelphia*
	Franklin's Gull	*Leucophaeus pipixcan*
	Ring-billed Gull	*Larus delawarensis*
	Herring Gull	*Larus argentatus*
	Caspian Tern	*Hydroprogne caspia*
	Black Tern	*Chlidonias niger*
	Common Tern	*Sterna hirundo*
	Forster's Tern	*Sterna forsteri*
Doves	Mourning Dove	*Zenaida macroura*
Cuckoos	Black-billed Cuckoo	*Coccyzus erythropthalmus*
Owls	Great Horned Owl	*Bubo virginianus*
	Barred Owl	*Strix varia*
Goatsuckers	Common Nighthawk	*Chordeiles minor*
	Eastern Whip-poor-will	*Caprimulgus vociferus*
Swifts	Chimney Swift	*Chaetura pelagica*
Hummingbirds	Ruby-throated Hummingbird	*Archilochus colubris*
Kingfishers	Belted Kingfisher	*Megaceryle alcyon*
Woodpeckers	Red-bellied Woodpecker	*Melanerpes carolinus*
	Yellow-bellied Sapsucker	*Sphyrapicus varius*
	Downy Woodpecker	*Picoides pubescens*
	Hairy Woodpecker	*Picoides villosus*
	Northern Flicker	*Colaptes auratus*
	Pileated Woodpecker	*Dryocopus pileatus*

Table 9, continued.

Description	Common Name	Scientific Name
Flycatchers	Olive-sided Flycatcher	*Contopus cooperi*
	Eastern Wood-Pewee	*Contopus virens*
	Alder Flycatcher	*Empidonax alnorum*
	Least Flycatcher	*Empidonax minimus*
	Eastern Phoebe	*Sayornis phoebe*
	Great Crested Flycatcher	*Myiarchus crinitus*
	Eastern Kingbird	*Tyrannus tyrannus*
Vireos	Yellow-throated Vireo	*Vireo flavifrons*
	Warbling Vireo	*Vireo gilvus*
	Red-eyed Vireo	*Vireo olivaceus*
Jays/crows	Blue Jay	*Cyanocitta cristata*
	American Crow	*Corvus brachyrhynchos*
	Common Raven	*Corvus corax*
Swallows	Purple Martin	*Progne subis*
	Tree Swallow	*Tachycineta bicolor*
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
	Bank Swallow	*Riparia riparia*
	Cliff Swallow	*Petrochelidon pyrrhonota*
	Barn Swallow	*Hirundo rustica*
Chickadees	Black-capped Chickadee	*Poecile atricapilla*
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*
	White-breasted Nuthatch	*Sitta carolinensis*
Creepers	Brown Creeper	*Certhia americana*
Wrens	House Wren	*Troglodytes aedon*
	Winter Wren	*Troglodytes hiemalis*
	Sedge Wren	*Cistothorus platensis*
	Marsh Wren	*Cistothorus palustris*
Kinglets	Golden-crowned Kinglet	*Regulus satrapa*
	Ruby-crowned Kinglet	*Regulus calendula*
Thrushes	Eastern Bluebird	*Sialia sialis*
	Veery	*Catharus fuscescens*
	Swainson's Thrush	*Catharus ustulatus*
	Hermit Thrush	*Catharus guttatus*
	Wood Thrush	*Hylocichla mustelina*
	American Robin	*Turdus migratorius*
Mockingbirds	Gray Catbird	*Dumetella carolinensis*
	Brown Thrasher	*Toxostoma rufum*
Starlings	European Starling	*Sturnus vulgaris*
Waxwings	Bohemian Waxwing	*Bombycilla garrulus*
	Cedar Waxwing	*Bombycilla cedrorum*

Table 9, continued.

Description	Common Name	Scientific Name
Warblers	Golden-winged Warbler	*Vermivora chrysoptera*
	Nashville Warbler	*Vermivora ruficapilla*
	Northern Parula	*Parula americana*
	Yellow Warbler	*Dendroica petechia*
	Chestnut-sided Warbler	*Dendroica pensylvanica*
	Cape May Warbler	*Dendroica tigrina*
	Yellow-rumped Warbler	*Dendroica coronata*
	Black-throated Green Warbler	*Dendroica virens*
	Blackburnian Warbler	*Dendroica fusca*
	Pine Warbler	*Dendroica pinus*
	Palm Warbler	*Dendroica palmarum*
	Blackpoll Warbler	*Dendroica striata*
	Black-and-white Warbler	*Mniotilta varia*
	American Redstart	*Setophaga ruticilla*
	Ovenbird	*Seiurus aurocapilla*
	Northern Waterthrush	*Seiurus noveboracensis*
	Connecticut Warbler	*Oporornis agilis*
	Common Yellowthroat	*Geothlypis trichas*
	Wilson's Warbler	*Wilsonia pusilla*
	Canada Warbler	*Wilsonia canadensis*
Sparrows/allies	Chipping Sparrow	*Spizella passerina*
	Clay-colored Sparrow	*Spizella pallida*
	Savannah Sparrow	*Passerculus sandwichensis*
	Le Conte's Sparrow	*Ammodramus leconteii*
	Nelson's Sparrow	*Ammodramus nelsoni*
	Song Sparrow	*Melospiza melodia*
	Swamp Sparrow	*Melospiza georgiana*
	White-throated Sparrow	*Zonotrichia albicollis*
Cardinals/allies	Scarlet Tanager	*Piranga olivacea*
	Northern Cardinal	*Cardinalis cardinalis*
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
	Indigo Bunting	*Passerina cyanea*
Blackbirds	Bobolink	*Dolichonyx oryzivorus*
	Red-winged Blackbird	*Agelaius phoeniceus*
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
	Common Grackle	*Quiscalus quiscula*
	Brown-headed Cowbird	*Molothrus ater*
	Baltimore Oriole	*Icterus galbula*

Table 9, continued.

Description	Common Name	Scientific Name
Finches	Purple Finch	*Carpodacus purpureus*
	House Finch	*Carpodacus mexicanus*
	Red Crossbill	*Loxia curvirostra*
	Pine Siskin	*Spinus pinus*
	American Goldfinch	*Spinus tristis*
Old World Sparrows	House Sparrow	*Passer domesticus*

Table 10. Summary of sensitive lakeshore identified on Sensitive Lakeshore project study lakes, 2006 - 2010.

Lake name	Shoreline length (mi)	Sensitive shoreline (mi)	% Sensitive shoreline	Shoreland area (acres)	Sensitive shoreland (acres)	% Sensitive shoreland
Ada	7.5	3.6	48	1096	484	44
Big Portage	7.7	2.2	29	1131	310	27
Birch	15.7	5.1	32	1825	759	42
Boy	25.9	8.2	32	3412	1860	55
Deep Portage	1.9	0.2	11	416	114	27
Lawrence	4.8	0.7	14	729	204	28
Leech	229.3	107	47	25942	13693	53
Little Boy	10.0	4.1	40	1412	542	38
Long	15.6	3.6	23	1827	812	44
Louise	1.2	0.1	8	305	150	49
Pine	9.5	2.0	21	1374	422	31
Pleasant	9.0	3.3	37	1214	557	46
Roosevelt	18.4	5.5	30	2597	773	30
Steamboat	8.2	2.2	26	1401	594	42
Sylvan	11.1	4.3	39	1553	764	49
Ten Mile	25.2	11.6	46	3120	1825	58
Thunder	15.9	7.0	44	1966	802	41
Wabedo	11.3	2.9	26	1704	688	40
Washburn	19.5	4.7	24	2188	830	38
Woman	30.7	11.9	39	3980	1808	45

Figure 2. Example of sensitive lakeshore delineation (Ten Mile Lake).
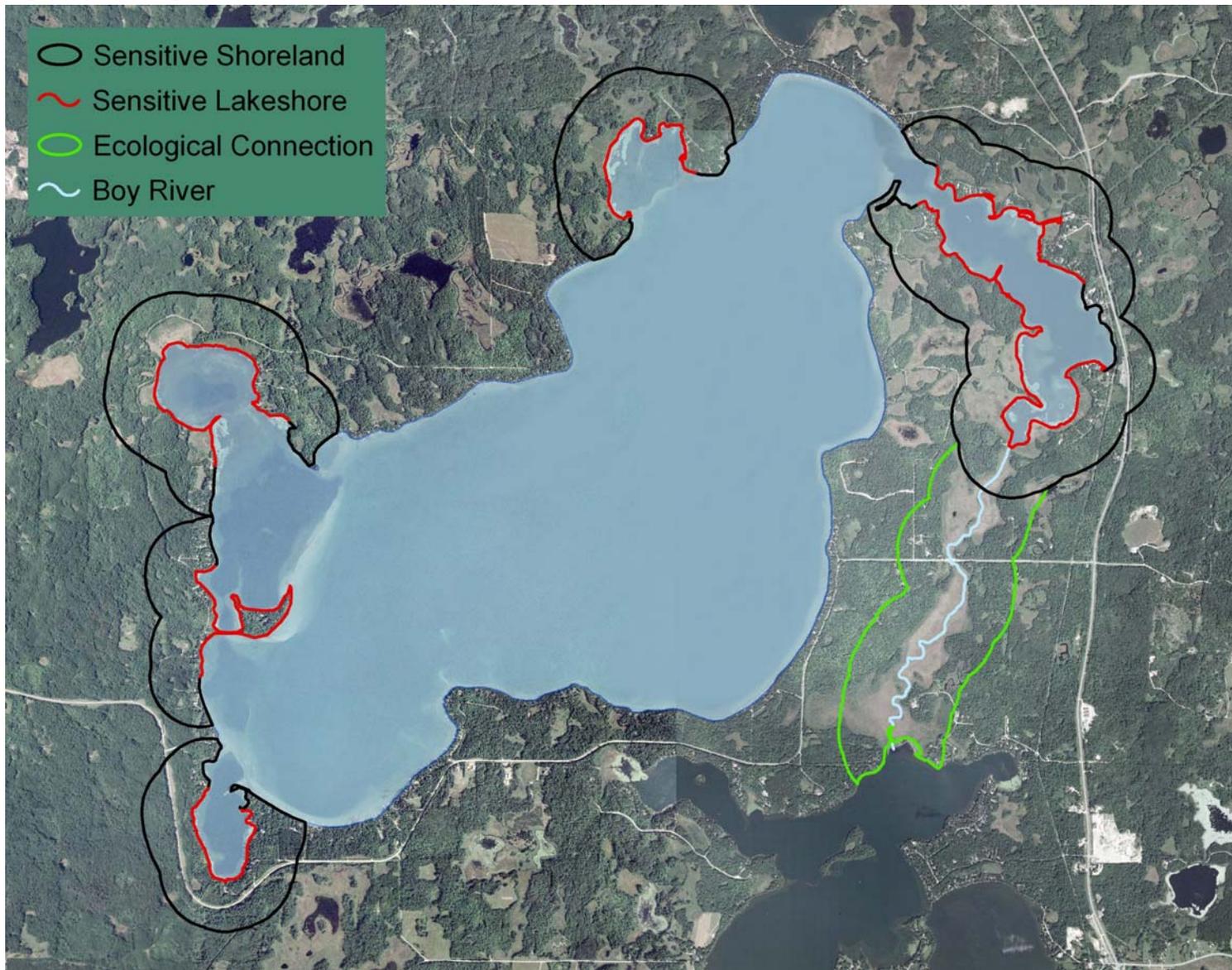
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