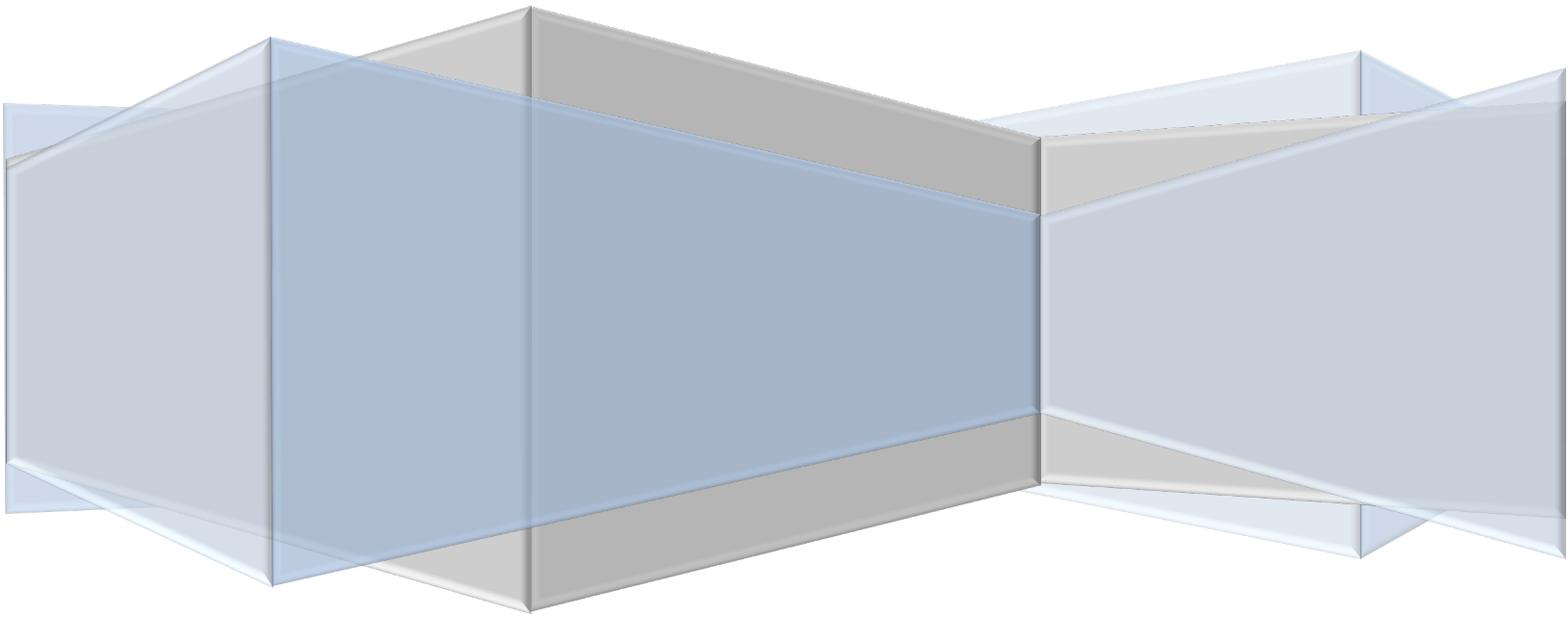
Leech Lake Ecosystem Management Plan

Leech Lake Association



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I. VISION FOR LEECH LAKE

Our vision for the future of Leech Lake and its shorelands, as stated in the first 2004 Management Plan volume, is that they retain the characteristics of a largely undisturbed ecosystem in spite of increasing pressures to provide more habitation, water access, recreation, and enjoyment for more people. This vision remains the same for this plan.

II. SUMMARY/RECOMMENDATIONS

The current state of Leech Lake suggests the following high priority actions for achieving the vision for the lake (main text support section in parenthesis):

- Assisting the MN Pollution Control Agency in organizing and conducting water quality monitoring activities on Leech Lake, including continuation of the Citizen Lake and Stream Monitoring Programs, and the Leech Lake River Intensive Watershed Monitoring effort starting in 2012; (Water Quality section)

- Encouraging Cass County to undertake a lake-wide individual wastewater treatment system inspection program to get a better idea of possible nutrient contributions to the lake from this source; (Water Quality)

- The 2002-2009 aquatic vegetation survey provides a good baseline of recent condition, location and abundance of the plants composing this important biotic community, and should be followed by future surveys to observe possible changes due to exotics, boat motors, climate change, anchoring, or other factors. (Vegetation)

- Continuing to monitor the status of the lake's rejuvenated walleye population, as well as other fish populations, through assistance or participation in various DNR projects and programs such as the Leech Lake (fisheries) Advisory Committee, annual DNR Roundtable discussions, field projects, and AIS prevention activities. It is imperative that steps be taken to insure that DNR work on Leech Lake is conducted out of the existing Fisheries Office in Walker and that it not be moved; (Fisheries)

- Taking steps to keep additional aquatic invasive species from invading Leech Lake by supporting DNR efforts to strengthen regulations preventing their transport to new waterbodies, assisting in obtaining equipment to clean watercraft, providing waste containers for left-over bait at public landings, distributing signs on state AIS laws and equipment, posting signs at public and private launch sites, and working with other lake organizations and the Cass County AIS Task Force to do as much as possible to keep AIS, and especially zebra mussels, out of Leech and other area lakes; (Aquatic Invasive Species)

- Assisting Cass County in establishing Resource Protection Districts by townships in Cass County; supporting county Environmental Services Division efforts to reduce storm water runoff by promoting the planting or protection of shoreline vegetative buffers and minimizing the construction of impervious surfaces in building projects on the shore;

assisting the City of Walker and Cass County efforts to prevent storm sewer effluents from directly entering Leech Lake; (Water Quality, Vegetation, Wildlife, Land Use and Zoning)

- Protecting the lake ecosystem and enhancing water quality by urging the state legislature to reauthorize the DNR to update the existing 1989 Shorelands Management Standards. The DNR has a refined draft set of standards, developed with extensive public consultation, that are streamlined, modernized, and reformed to provide better standards for development while reducing regulatory complexity; (Public Access and Harbors, Land Use and Zoning)

- Continuously monitoring county activities and decisions on shorelands as a consequence of application of (e.g. requests for variances and conditional use permits), or changes in, the county land use ordinance and state land use regulations; (Land Use and Zoning)

- Continuing support of efforts to preserve and protect sensitive shorelines through the acquisition of conservation easements. This is a particularly valuable and effective program for protecting certain critical lakeshore areas in perpetuity. Encouraging the development and support of shoreland and watershed Best Management Practices; (Land Use and Zoning, others)

- Sustainability of the present ecological state of Leech Lake will depend upon steps being taken as soon as possible to slow or arrest global climate change by reducing emissions of CO2 and other "greenhouse" gases. In addition to providing educational information and encouraging reduction of energy use by individuals, county or other area-wide energy conservation programs could be initiated, such as those facilitated by the U.S. EPA in Chicago and Kansas City, and counties in upstate New York. (Appendix 3)

III. PREFACE

The original Leech Lake Management Plan -- published in 2004 after a survey of all Leech Lake property owners -- identified key issues on the lake that needed immediate attention, and also established a long-term vision for the lake from the Association's perspective. Among the issues needing attention was the decline in walleye fishing success, which was negatively impacting local businesses. Also of concern was the explosion in the lake's cormorant population, along with burgeoning numbers of invasive rusty crayfish, both thought to be factors in the decline of the walleye fishery. The Plan encompassed other factors as well, most directed at the long term health of the lake, including the identification of sensitive shorelands with an eye to providing additional protections, the mapping of the lake's aquatic vegetation to establish a baseline for ongoing monitoring, studies to determine the effect of rusty crayfish on walleye reproduction, and collection of water samples as part of long term water quality studies.

These issues were addressed over the next seven years. Millions of walleye fry were stocked in the lake each year through a Department of Natural Resources (DNR) stocking program that will continue at least through 2014. An 18-26 inches protected slot and a four-fish possession limit was placed on Leech Lake walleyes in 2005 to protect spawning stock from excessive harvest.

Approximately 3000 cormorants were removed each year during this period by the Leech Lake Band of Ojibwe Division of Resource Management (LLB DRM), with the goal of maintaining the cormorant population at no more than 500 breeding pairs. In 2010, our Board of Directors participated on the Leech Lake Advisory Committee, a 17-member group charged with providing input to the DNR's 2011-2015 Five Year Plan. This Plan was completed in September of 2010 with a number of action items designed to protect Leech Lake lands and waters, control cormorants, and maintain recreational sport fishing.

This second edition of the Leech Lake Ecosystem Management Plan identifies new or continuing threats to Leech Lake lands and waters, establishes objectives and action items for dealing with these issues, and provides – with your help – the foundation for accomplishing our shared vision for Leech Lake. The word ecosystem has been added to the title to differentiate this edition from the DNR fisheries management plan (Schultz 2010) with the same title as the first Leech Lake Association management plan.

IV. GENERAL INTRODUCTION TO THE PLAN

What constitutes a good Lake Association? What is a Lake Management Plan and why do we need one? These are questions asked by the Leech Lake Association (LLA) Board and by many of our members.

What Constitutes a Good Lake Association?

Leech Lake Association believes that it can serve its members' interests best by acting as a guardian of the continued health and viability of Leech Lake by:

- Monitoring the intrinsic qualities of the lake, including the development of its shoreline and watershed.
- Educating members and the general public on good lake management practices.
- Representing all stakeholders on Leech Lake with a unified and informed voice to government units and agencies.

What is a Lake Management Plan?

A lake management plan results from the process of taking a hard, objective look at a lake. What is the state of the lake today and what contributes to it, good and bad? Where has it been in the past, and what is the future vision of the stakeholders for the lake? Most importantly, how can we get there?

Lake management planning is not a process to be taken on alone by a lake association. For successful implementation of a lake management plan, many people should be part of the planning process, including the local, state, and federal agencies available to assist a lake association.

Why Do We Need a Lake Management Plan Now?

Lake management plans can help establish a consensus for actions to protect natural resource systems, including the water quality of the lake, and native fish, vegetation, and wild life communities in and around the lake. While Leech Lake is fortunately in a high quality state, the Leech Lake Association believes a plan is desirable for the following reasons:

a. Population demographics and resultant development show that the Leech Lake area is one of the fastest developing areas in the state of Minnesota. According to state demographic projections, Cass, Crow Wing, and Aitkin counties – retirement magnets – could grow by 64 percent by 2030 as compared to 27 percent growth statewide.

b. Minnesota's lake management authority is spread across a number of county, state and federal agencies. This provides an opportunity for citizens, through lake and watershed associations, to play a role in promoting and coordinating management that will help protect lakes like Leech. Governments and most large organizations (lake and land management authorities in this case) respond more favorably to plans they can review and support rather than to everyday complaints. This is the rationale for this plan.

c. Funds and planning support are available through grants from state, federal, and private agencies, like the Initiative Foundation, for groups that develop comprehensive lake management plans and implement them.

d. While survey data indicate that Leech Lake presently has few serious discernible environmental or water quality problems, it must be remembered that large bodies of water are more tolerant of abuse but also harder to repair once a problem develops. The most effective time to establish a lake management plan is before serious problems occur.

The key is to write a lake management plan that gives our lake association the information and tools to preserve and improve our watershed area, including funding to implement the action items proposed in the plan.

V. ECOLOGICAL, HISTORICAL BACKGROUND

General Geology, Hydrology

Leech Lake is the third largest inland lake in Minnesota with 111,587 acres of water surface and approximately 200 miles of shoreline. Only the Red Lakes and Mille Lacs Lake are larger. At one time, Leech Lake was covered by glaciers as much as one mile thick. Over the past two million years, this area has been repeatedly crossed by glaciers coming from the north, northwest and northeast. The effects of the most recent glaciers can be identified throughout the Leech Lake region. The youngest deposits in the region are found mostly north of highway 2. These were deposited by the St. Louis sublobe of the Late Wisconsinan Age, between 13,500-11,600 years ago. Earlier glaciations include the Wadena lobe (St. Croix phase, 22,800-17,700 years ago) that produced the Itasca moraine, one of the most impressive moraines in the state, and the

Hewitt phase (27,300-23,600 years ago) that formed the extensive and well known Wadena drumlin field. These glaciers left a complex topography that is evident today. The geology can be characterized by thick (200-600ft) glacial deposits in outwash plains, lake plains, till plains, outwash channels, moraines, drumlin fields and debris flows. Additional information on the glacial history of the Leech Lake Watershed can be found in Melchior and Annexstad, 1996.

The Leech Lake we know today is considerably larger than the original due to the construction in 1884 of what is now called Federal Dam, which raised water levels an estimated 2.5 feet. Fourteen upstream lakes (including Leech Lake) are affected by the dam which has kept the water level of Leech Lake fairly stable for over 50 years. The lake has an irregular shape with many large and small bays. The deepest area of the lake is located in Walker Bay where depths reach around 150 feet. Approximately 80% of the lake is less than 35 feet. Average annual precipitation for the area is around 27 inches, and evaporation is approximately 31 inches. Average annual runoff is about 6 inches with one-in-ten-year high and low flows of 8 and 2 inches. The "Lakeshed Vitals" table and associated "Assessment" compiled by RMB Environmental Labs (2008b) provide additional ecological, geographical, demographic, and land use information for Leech Lake. This report can be read on the internet at Cass County, MN→Departments→Environmental Services→ Lake water quality information→Leech Lake.

Chippewa National Forest

An important ecological influence on Leech Lake and its development is the surrounding Chippewa National Forest, the first National Forest established east of the Mississippi River in 1908. Originally known as the Minnesota National Forest, the name was changed in 1928 to honor the original inhabitants of the area. According to Minnesota DNRs *Native Plant Community Classification* (Aaseng et al., 2003), the forest lies within the Northern Minnesota Drift and Lake Plains Section of the Laurentian Mixed Forest Province, where mesic forests of sugar maple, basswood, paper birch, aspen, and northern red oak are widespread. These occur mostly on moraines or till plains characterized by rough topography and fine textured parent material. Historically, forests and woodlands of jack pine and red pine were very common. The Forest boundaries enclose about 1.6 million acres including Leech, Winnibigoshish and Cass Lakes, three of the five largest in Minnesota. The Forest also includes over 1300 smaller lakes and ponds, 925 miles of rivers, 25 watersheds and 440,000 acres of wetlands that provide wildlife habitat for over 250 species. Over 180 pairs of nesting bald eagles are known to inhabit the forest, the highest breeding density in the continental United States. The 200 mile (approximately) shoreline of Leech Lake is primarily forested with minimum development. The only exception is at the city of Walker where a few miles of moderate shoreline development occurs.

Visitors to the Chippewa National Forest observe a working forest. Recreational development, wildlife habitat preservation projects and timber harvesting can all be observed in coexistence. About one percent of the forest is harvested for timber each year. Over 160 miles of hiking trails and 315 miles of snowmobile trails provide an opportunity to view the forest in all seasons. The winter season increasingly draws large numbers of nature lovers for cross country skiing, snowshoeing and ice fishing. White-tailed deer and ruffed grouse provide excellent hunting opportunities.

Much of the Chippewa National Forest and Leech Lake fall within the boundary of the Leech Lake Indian Reservation. Both the Chippewa National Forest and the Leech Lake Band of Ojibwe share responsibility for managing the cultural and natural resources within the Reservation.

Leech Lake Band of Ojibwe - Leech Lake Reservation History

When the first settlers arrived in this area, the Ojibwe people were living throughout northern Minnesota. The Pillager and Mississippi Bands of Ojibwe had homes, villages, and seasonal encampments on or near Cass Lake, Lake Winnibigoshish, and Leech Lake. The landscape was covered with a mixture of forests from majestic pines and mixed hardwoods-- including sugar maple--to wet lowland forests. Lakes, streams, and marshes were thick with wild rice, waterfowl, and abundant fisheries. These resources formed the basis of a healthy subsistence lifestyle as well as an active spiritual and religious life.

The Treaty of 1855 between several Ojibwe tribes of northern Minnesota and the US government was responsible for creating the Leech Lake Reservation (LLR) boundary similar to that of today. Over the next several years the land-base of the Leech Lake Reservation shrunk at alarming speed due to the passages of the Dawes and Nelson Acts, 1887 and 1889 respectively, which allowed settlement and ownership of Ojibwe land by non-tribal people. The complex checkerboard ownership that exists today within the LLR is a result of these defining land acts of the late 19th Century.

The towns of Walker and Cass Lake were established in 1896 and 1898, respectively. In an effort to protect mature pine stands from timber harvest on lands released by the Dawes and Nelson Acts, the federal government created the first congressionally mandated national forest in 1902. The boundaries of the newly created forest extended across the entire Leech Lake Reservation and into ceded territory. The establishment of the national forest did not, however, end cutting of mature pines. It is estimated that only five percent of the red and white pine present at the time the national forest was established still remain.

In 1971, the federal court ruled the Nelson Act did not, as the state previously argued, dissolve the Leech Lake Reservation and therefore tribal members retained hunting and fishing rights within its boundaries. In the first major hunting, fishing, and gathering case of its kind (in Minnesota), the right to control these activities on the reservation by the Tribe was confirmed. Enforcement on the reservation of fish and game is a joint responsibility of cross-deputized tribal officers and other civil authorities. The Leech Lake Band (LLB) membership was listed at 9,566 in February, 2010.

Fisheries, wildlife, and other resource management on Leech Lake is a multi-government, multi-agency responsibility. For example, the activity of non-tribal anglers on Leech Lake is governed by regulations issued by the Minnesota Department of Natural Resources (DNR). Fishing activity of LLB members is governed by the tribal *Conservation Code of the Leech Lake Reservation.* Unlike non-tribal individuals, tribal members are permitted under provision of the Conservation Code to take any number of game fish for personal/family use, rights retained

under the 1855 Treaty. Tribal fish harvest is not unlimited as Band members are not allowed to sell game fish and they must also have a permit to transport more than 25 lbs. of game fish off reservation. Leech Lake Band members may, however, commercially harvest non-game fish for sale. More broadly, recent actions such as the *Leech Lake Hunting and Fishing Agreement of 1973* and the *Supplemental Memorandum of Understanding* to that agreement in 1984 have codified responsibilities and lines of authority under the Leech Lake Division of Resource Management (LLDRM), the Minnesota DNR and other civil authorities. This is a complex arrangement, and while it is easy to imagine more streamlined governance for Leech Lake, it is probably not likely any time soon given the historical background.

Homestead and Tourism History

Leech Lake had a modest tourism industry even before the advent of automobile travel. By 1915 two hotels reigned over Leech Lake, with the Isabel Lodge and New Chase Hotel owned and operated by the Chase family. The 1929 *Minnesota Book* listed four hotels, eight resorts, and one tourist camp. By 1931 the number of resorts had grown to 19. The number continued to grow during the 1930's until 360 privately owned resorts were listed in 1941 in the Chippewa Forest region. However, due to increasing property values and shifting demographics the number of resorts began a rapid decline. By 1999 it was estimated that Leech Lake had 64 resorts. Currently it is estimated that only about 30 remain (Jerry Lerom, Association of Cass County Lakes, *personal communication*). A similar trend has been noted for Cass County with resorts declining from 240 in 1999 to about 110 in 2011(ibid.).

Resorts often occupy particularly desirable stretches of shoreline. A very substantial inflation of shoreline property valuations in recent years has resulted in the sale and conversion of existing resorts to individual private homesteads, condominiums and lakeshore associations of homes. A high percentage of these are occupied on only a seasonal basis. In 2010, the MN Dept. of Health identified 55 *Rental by Owner* properties in Cass County. In the short term, these property sales boost the local economy by creating demand for construction, furnishings, and other aspects of homestead establishment. Once completed, however, seasonal occupancy of homesteads directly injects less into the local economy than comparable use of the shorelines by the much larger numbers of visitors renting the cabins of resorts. On the other hand, 43% of county tax revenues were paid by seasonal recreational property owners in 2010 (Cass County Auditor's Office). Also, a 2007-2008 study (Davidson-Peterson Associates) estimated that among those traveling in Minnesota between June 2007 and May 2008, 37% of all expenditures were by tourists who stayed at the homes of family or friends ($4.12 billion), or were just passing through the state ($315.14 million).

Demographic changes are also a factor influencing the resource use picture in this area. For example, the population of Cass County grew by 25% from 1990 to 2000, and was projected to grow at a similar rate over the next decade. Many of those moving to Leech Lake on a more permanent basis were originally resort customers who decided to move North in retirement, or could afford to during the housing boom of the late 1900's and early 2000's. However, the severe economic down-turn, sometimes referred to as "the great recession" starting in 2007 and only slowly diminishing in 2012, reduced the increase to just 5% in 2000-2010. Where around 1,400 Cass County zoning permits were granted in 2005 to 2007, only about 800 to 1,000 were

obtained in 2008-2010. It remains to be seen whether the Cass County population growth rate will return to the previously projected high levels (64% by 2030, MN State Demographic Center, 2005) as state and national economies recover.

In 2011, 90 of the 165 new houses built in Cass County (54%) were on lakeshore lots (Cass County Planning and Zoning Office). Stretches that were once considered "undesirable" owing to shoreline vegetation, wetland proximity, offshore shallows, etc., are now being sought for development, often without adequate consideration of their intrinsic value to the lake. The conversion of older and smaller cabins into larger, more modern homes has also impacted shorelines. The net result is that shorelines which ought to be preserved or maintained for legitimate environmental or aesthetic reasons are now being reduced or eliminated with concurrent effects on water quality, or scenic beauty ('wildness'), or other irreplaceable attributes that make the lake such a highly valued natural resource. Two relatively new programs, the county Resource Protection Districts land use designation (*Cass County Land Use Ordinance, May, 2005*), and the creation of Conservation Easements, have been developed to protect critical and sensitive shoreland areas. These programs are discussed further in the Land Use and Zoning section of the Management Plan.

VI. THE STATE OF LEECH LAKE

Water Quality

Water quality is referred to in terms of its utility to support human recreational, domestic, and commercial uses; its suitability as habitat for fish and other wildlife; and the degree to which the water is different from other water bodies, or has changed since the advent of human influences. The kinds of measurements employed to judge water quality are usually determined by the kinds of human activity or land use in the surrounding area. In the case of Leech Lake, contaminants from industrial sources would likely not be present unless they were highly persistent and transported long distances. On the other hand, inputs from domestic uses or nearby commercial land use practices such as logging could have an influence on water quality. Fish or wildlife inhabitants can sometimes provide clues about the condition of the water or the nature of disturbances. The most common potentially solvable water quality problem for lakes in the sparsely populated recreational lakes area of North Central Minnesota is nutrient enrichment, or eutrophication, from leakage of individual wastewater elimination systems.

Storm water runoff from intensive lakeshore development and municipalities can also be a problem. The town of Walker has a number of storm sewers that empty into Leech Lake next to the urban housing and business area. With two exceptions that go to settling ponds, these effluent streams carry street and yard residues directly into the lake during periods of even moderate rainfall. The city Department of Public Works is concerned about this problem and would appreciate help from the Leech Lake Association and/or county in obtaining financial assistance to correct this problem. The LLA will work with the Cass County Environmental Services Department and City of Walker to try to find the means to remedy this pollution problem. The additional practice of managing run-off by directing precipitation off roofs and driveways into rain gardens, or otherwise into the ground where it falls, would also help. Lots of information on such practices is available from the Cass County Environmental Service Department in Walker.

Water quality data have been collected for Leech Lake off and on since 1972 (U.S. EPA STORET Legacy Database, http://www.epa.gov/storet.html.). Citizen volunteers from Leech Lake have participated in the Minnesota Pollution Control Agency's (MPCA) Citizen Lake Monitoring Program by recording Secchi depth, a measure of water transparency. Gerald Trimble, George Smith, Jerry Roehl, and Donald L. Bartsch have been the primary volunteers recording these data for Leech Lake. In addition, many agencies monitor water quality on the lake, including the MN Pollution Control Agency, MN Department of Natural Resources, Leech Lake Band of Ojibwe, and U.S. Army Corps of Engineers.

Since nutrient enrichment has been the most likely impairment candidate, three response-related measurements have been recorded most frequently to judge water quality: phosphorus, a highly nutritious (to algae) component of domestic wastes and fertilizer; chlorophyll *a,* which reflects the concentration of algae utilizing the phosphorus for photosynthesis; and Secchi disc depth or transparency, which is inversely related to the algae concentrations. These measurements are used together to calculate a trophic state index, or TSI (Carlson, 1977), which is indicative of the total weight of living biological material or biomass in a water body at a specific location and time.

Data sets for calculating TSIs using total phosphorus and chlorophyll *a* are very limited for all sites on Leech Lake (RMB Environmental Labs, 2008a). The results indicate that Walker Bay is weakly mesotrophic (relatively less productive), Agency and Kabekona Bays are more strongly mesotrophic (moderatly productive), and the Main Basin, Steamboat Bay and Shingobee Bay are the most mesotrophic (quite productive). Collecting more data would better explain the pattern and the relationship between phosphorus, chlorophyll *a* and transparency in Leech Lake. Continuation of the MPCA Citizen Lake and Stream Monitoring Program, and the MNPCA's Leech Lake River Intensive Watershed Monitoring effort starting in 2012, should help in this regard. Fourteen years of transparency data indicate that a statistically significant increase has occurred in Steamboat Bay. The reason for this is unclear, and there are insufficient data to detect trends for other variables or parts of the lake.

Minnesota is divided into seven ecoregions based on land use, vegetation, precipitation and geology. Leech Lake is in the Northern Lakes and Forests (NLF) Ecoregion. The MPCA has developed a method to determine an "average range" of water quality expected for lakes in each ecoregion. From 1985-1988, the MPCA evaluated the lake water quality for numerous reference lakes, which are not pristine but exhibit little human impact, and therefore are considered representative of lakes within the ecoregion. The average range refers to the 25th - 75th percentile range for the reference lake data within each ecoregion. The limited total phosphorus, chlorophyll *a* and transparency (Secchi depth) values for all the bays of Leech Lake are within the average range for this ecoregion (Table pg. 3, RMB Environmental Labs, 2008a).

There are no inlet or outlet water quality data for Leech Lake within the past decade. Some limited data exist from the US Geological Survey and US Fish and Wildlife Service from 1975 and 1993; however it mainly consists of field data such as dissolved oxygen, pH and temperature to characterize instantaneous conditions during sampling for other studies. Then in 1997 the Minnesota Chippewa Tribe Laboratory and the Leech Lake DRM completed a Leech Lake

Watershed Assessment that included monitoring the inlets and outlet of Leech Lake. They found the Boy River contributes the most phosphorus loading of all the inlets to Leech Lake while Whipholt Creek contributes the least. Loading takes into account both phosphorus concentration and stream volume. Based upon the data collected during the 1997 study, it appears that erosion and nutrient abatement practices in the Leech Lake watershed are effective management tools. They concluded that continued efforts to implement these resource conservation practices might reduce the direct watershed phosphorus load by 10%-15%, a substantial quantity for this relatively clean ecosystem.

The state has a Fish Contaminant Monitoring Program (FCMP; MNDNR 2012) that analyzes fish tissue samples from approximately 150 Minnesota lakes and rivers every year. This program provides data for science-based fish consumption advice; for mercury trend analysis and water quality standards development; and information on other and newer persistent contaminants. As a result, mercury has been found to exceed the MPCA/U.S. EPA total maximum daily load (TMDL) limit in the main body of Leech Lake and in several bays (Mark Briggs, *personal communication*, 2011). Mercury is toxic to both humans and aquatic organisms at very low concentrations. The greatest source of mercury in Minnesota is in the emissions from coal-fired power plants. Mercury's persistence and propensity to accumulate in muscle tissues of some higher-food-chain fish, coupled with its human toxicity, have led the MN Department of Health to publish fish consumption advisories for cisco, walleye and northern pike in Leech Lake (Appendix 1). According to FCMP data, average mercury concentrations in walleye and northern pike trended downward over a 25-year period until the mid-1990s but have since shown an unexpected upward trend (Monson, 2009). The reason is unknown, but could be related to increasing industrialization and combustion of fossil fuels globally, or even due to warmer water and faster environmental cycling (see Appendix 3). The Leech Lake Association urges all persons eating fish from the lake to follow the state fish consumption advisories in Appendix 1.

In summary, it appears from the limited water sampling data that Leech Lake water quality is basically in pretty good shape and supports a wide array of healthy endemic communities and human activities. However, there are insufficient data on the condition of the large number of onsite waste water treatment systems (called subsurface septic treatment systems or SSTS) around the lake. Cass County conducted inspections on over 700 SSTS on riparian properties in the southwest area of Leech Lake in 2006-8. The observations are still being analyzed and tabulated due to technical problems but are expected to be available in the spring of 2012. This is a good start but, regardless of the results, further analyses are warranted on what SSTS elsewhere around the lake are contributing in the way of nutrients. Such a study would add significantly to knowledge about the existing condition of the lake, about human effects on lake water quality, and might help explain some of the differences in trophic state in various sections of the lake. Mercury tissue residues are a problem but most of the sources are outside the local area, impeding our ability to do much about them directly. However, it's important to continue to bring our concerns to the attention of industries and state or federal agencies that are in a position to reduce atmospheric mercury emissions and to prevent it being transported long distances. The limited water sampling information for Leech Lake indicates that other persistent contaminants such as some pesticides, PCBs, dioxins, perfluorocarbons, heavy metals, and residues in sewage treatment plant effluents have not been found here or are not considered significant water quality problems at this time.

Vegetation

Wetlands and natural areas support a great diversity of native plants and animals which provide a wide variety of "biological services" that benefit people directly and indirectly. Services like flood attenuation, erosion control, nutrient cycling, and community resilience to natural catastrophic events. In general, these "services" work best when the natural suite of native plants and animals is present and appropriately abundant. Non-native invasive species (NNIS) reduce the presence and abundance of native communities, and therefore interfere with the "services" an ecosystem is able to provide.

In addition to the concerns mentioned above, the subsequent growth of invasive populations is affected by a broad suite of biotic and environmental conditions. Although property owners may not have direct control over individual introductions of NNIS or other aquatic invasive species (AIS), they can still play an important role in reducing the chances of NNIS or AIS from getting established and taking-over, and can even improve the overall health of Leech Lake in the process. A set of lake-friendly land use practices can help:

- R**educe shoreline disturbance of the lake bottom** (substrate or benthic zone)**.** Disturbance can release excess nutrients into the water potentially creating algal blooms, affecting water quality, and/or fueling the growth of invasive organisms.
- **Avoid clearing shoreline vegetation.** Native shoreline plants provide important "biological services" with wide-ranging benefits.
    - Most of the plants growing along the shoreline are probably not "weeds" or NNIS but rather the key components of a healthy lake. Native plants provide the critical habitat essential for fish, micro-organisms, invertebrates, amphibians, birds, and waterfowl to reproduce and develop.
    - They also function as nutrient pumps, pulling nutrients out of the water column and into plant structures, thereby capturing nutrients and reducing the "fuels" for undesirable invasive species.
- **Increase natural near-shore vegetation.** Preserve or restore the *native* shrubs, trees, shoreline plants that naturally occur around lakes. Collectively they reduce nutrient run-off entering lakes to 10% and increase infiltration of rainfall by 55%. Conversely, the standard lawn creates a hard surface which increases run-off to 55% and reduces infiltration to 15%.
- **Work with your neighbors**. Shoreline management can have cumulative impacts that affect overall watershed health. Work together to improve the function of the shoreline zone by incorporating some of the ideas above.
- **Consider the watershed impacts of all land use practices**. Stop and consider the potential impacts of fertilizing, using herbicides, dumping yard "waste" near shore, or maintaining your lakeshore or beach area as "weed-free".
- **Stay positive.** After years of doing things the "same old way" it is difficult to change engrained habitats or ideas but stay positive; you are making a difference that will be experienced and appreciated by your grandchildren.

In August 2010 The DNR published a 109 page study titled *Aquatic Vegetation of Leech Lake, Cass County, 2002-2009* (Perleberg and Loso 2010. The goal for these surveys was to describe

the current aquatic plant community and to generate data that could be used as a baseline for setting up specific monitoring projects to track changes in plant community composition and distribution.

About 30 percent of Leech Lake supports plant growth, and aquatic plants were found to a depth of 24 feet. Vegetation occurred in only 39 percent of the survey sites and was influenced by water depth and turbulence. Plant growth was concentrated in protected, shallow bays and the shallow, windswept, main basin was mostly un-vegetated.

Forty-nine native plant taxa were identified including 15 emergent, three free-floating, four floating and 27 submerged taxa. The greatest number of plant taxa occurred in depths of six feet and less. About one-third (5,800 acres) of these shallows were occupied by wild rice (*Zizania palustris*), bulrush (*Schoenoplectus* spp.) or other emergent and floating-leaf plants.

The submerged plant muskgrass (*Chara* sp.) was the most frequently recorded taxon and was found in 26 percent of all sample sites. Other important submerged taxa included bushy pondweed *(Najas flexilis*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), a variety of broad-leaf pondweeds (*Potamogeton spp.),* greater bladderwort (*Utricularia vulgaris*), wild celery (*Vallisneria americana*), Canada waterweed (*Elodea canadensis*) and coontail (*Ceratophyllum demersum*).

Potential threats to the native plant communities include competition with non-native plants, predation by rusty crayfish, water level manipulation, changes in water clarity or quality, and direct destruction of plant beds. Follow up assessments of the condition of the aquatic plant communities of Leech Lake might consist of smaller more intensive surveys of particularly important or sensitive plant communities in order to establish better baselines or detect changes. No time lines have been established yet for such studies (Donna Perleberg, MNDNR, *personal communication,* 2012).

Fisheries

Fifty years ago Leech Lake represented quite an attraction to vacationing and resident anglers alike. With a few hours invested in sport fishing, a vacationing family could reasonably expect to provide itself with enough fish for most of its meals if desired. Walleye was the preferred species to catch and they tended to be abundant as any angler from that period can readily demonstrate with photographs of heavily laden stringers. Northern pike, perch and crappies also were caught but typically returned to the lake unless of "keeper" size.

When our initial *Leech Lake Management Plan* was published in 2004, the sport fishery – particularly for walleye – was in decline and adversely affecting the Leech Lake resort and business community. Resorts sat empty. Walleye fishermen were no longer coming to spend their money on lodging or in area businesses. The causes of the decline were unclear, but a number of factors were suspected, including poor year classes in the early 2000's, the population explosion in cormorants which were suspected of eating large quantities of young perch and walleye, over harvest of brood stock, and the explosion of invasive rusty crayfish which were thought to be preying heavily on walleye eggs and destroying weed beds.

The situation demanded action and actions were taken. A DNR *2005-2010 Leech Lake* [fisheries] *Management Plan* was developed as a result of intense interest by the local community (the LLA and LLBO included); legislative decree resulting from pressure by the Leech Lake Fishing Task Force regarding stocking levels; and the DNR's desire to reach an informed community consensus on what to do. The plan laid out a number of steps to improve the walleye fishery, including:

- Protecting mature female walleye with an 18 to 26-inch protected slot and reducing the walleye limit to four.
- Supporting efforts by the Leech Lake Band's DRM to reduce the number of double-crested cormorants on the lake. (Their population level had risen to about 10,000 in 2004.)
- Stocking 7.5 million marked walleye fry during years 2005-2007, which, when compared with captured unmarked young walleye, could be used to estimate walleye hatch rates (there were concerns about possible reproductive problems with Leech lake walleyes).
- Continuing to protect water quality and shorelands sensitive to human disturbance.

Actual stocking rates during years 2005-2010 ranged from 7.5 to 22.5 million marked walleye fry annually.

These efforts, whether singly or in combination, are delivering positive results. The summer creel census of walleye fisherman has shown walleye catch rates to rival those of the state's other large walleye lakes. Today, Leech Lake boasts one of the best multi-species fisheries in Minnesota. Estimates of walleye hatch rates are similar to those observed for other large Minnesota walleye lakes, and suggest no chronic issues exist with egg or fry survival. DNR test netting indicates a significant percentage of the walleye population is now within the protected slot limit and reproductively mature. Rusty crayfish observations from lakes in both Wisconsin and Minnesota suggest that predation on walleye eggs is minimal and probably has no significant direct effect on walleye population levels (see further discussion in the AIS section). The current state of cormorant control efforts and consequences are discussed in the Wildlife section of this plan. Yellow perch abundance and harvest have increased significantly from 2004-2005 estimates. Catch and harvest rates of other species have remained within their historical range.

To assist them in efforts to maintain good fishing in years to come, the DNR established a 17-member Leech Lake Advisory Committee to provide input to a 2011-2015 management plan. The LLA has two seats on this committee. The *Leech Lake Management Plan 2011-2015* (Schultz 2011) has now been approved and published and is available at the Walker Fisheries Office or on their website. The DNR uses a number of methods to gauge the status of the fishery: (1) an annual "population assessment" obtained by counting and analyzing fish captured at different times of the year in seines, trawls, electro-fishing, and gill nets; (2) periodic surveys to estimate fishing pressure, harvest, and catch statistics; and (3) information gathered by independent studies by various parties. The DNR netting data extend back to the early 1980's and form the basis for determining long term trends of fish abundance. The Leech Lake Advisory Committee will continue to meet annually to review the Five Year Plan against established benchmarks. While primarily directed at the walleye fishery, the plan also includes sections on protecting habitat, preventing the spread of invasive species, protecting known muskie spawning

beds, and monitoring aquatic vegetation. Walleye fry stocking will continue at least through 2014.

Non-native Invasive Species (NNIS) / Aquatic Invasive Species (AIS)-Plants

Non-Native Invasive Species of Leech Lake

Non-native Invasive Species (NNIS) quickly establish themselves, displacing native plants and animals and often causing significant ecological and economic impacts. Impacts include impairment of recreation or navigation or flood control, degradation of water quality, erosion, loss of fish and wildlife habitat, aesthetics, and decrease in property values. Depending upon the species, non-native invasive species can change water quality or water chemistry, which may trigger a cascade of trophic level affects, ultimately changing how aquatic ecosystems function.

Problematic NNIS are extraordinarily successful for a number of reasons. Typically NNIS exhibit rapid growth and prolific reproduction of propagules, seeds, or offspring. Since these species originate in other areas of the world, they are often relocated without the predators, diseases, or pathogens that keep their populations in check. A species introduction without natural predators or pathogens is one reason why classical biological control has been included as a management tool.

Plant Invasive Species Currently Present
Eurasian water milfoil, purple loosestrife, and curly-leaf pondweed are three NNIS that currently occur within Leech Lake:

Eurasian water milfoil (*Myriophyllum spicatum*)
Eurasian milfoil was introduced to the United States in the 1940's and has since spread to nearly every state. This submersed aquatic plant can be identified by its feather-like leaves arranged in whorls of four around a long stem. Stems produce several branches forming dense floating mats on the water's surface. Vegetative reproduction by small stem fragments increase this plants ability to root and form new colonies. Mats of this plant have been shown to reduce native plant diversity as well as the quality of fish spawning habitat and to interfere with recreational activities such as boating and swimming. It is important to note that Eurasian milfoil is strongly associated with total water column phosphorous and loss of native plant cover.

Purple Loosestrife (*Lythrum salicaria*)
Purple loosestrife is a tall purple-flowered perennial wetland plant imported from Europe in the early 1800's without its natural predators, giving it an advantage over our native wetland plants. Once it's established, purple loosestrife forms dense stands crowding out native plants, thus degrading food, shelter, and nesting sites for wildlife. There are several known sites on Leech Lake including Shingobee and Kabekona Bays, Brevik public access, Minnesota Island, Oak Point Community shoreline, and a floating bog east of Welshes Bay. Current management of purple loosestrife on Leech Lake by the Leech Lake Division of Resource Management includes the combined use of *Galerucella* beetles as agents of biological control, crown digging, and deadheading. Despite yearly efforts to control the size and numbers on these sites, infestations continue to be found in new locations. There may be several factors influencing continued

spread, including snowmobile traffic though infested marshes and shorelines which carry seed to new locations.

Curly-leaf Pondweed *(Potamogeton crispus)*
Curly-leaf pondweed is a non-native submerged aquatic plant. It typically grows in shallow water 3-10 feet in depth. Curly leaf pondweed readily invades disturbed areas and tolerates low water clarity. It begins growth early in spring and can even be seen growing under the ice. Early development allows this plant to capture nutrients, grow rapidly ahead of native plants, and die back by mid-summer. Rafts of dying pondweed can cause an increase in available phosphorous (normally a growth-limiting nutrient) resulting in undesirable algal blooms. Transfer and spread of curly-leaf occurs when turions (hardened stem tips) are carried on other vegetation attached to boat trailers, watercraft, etc.

Animal Invasive Species Currently Present

Rusty Crayfish *(Orconectes rusticus)*

It is suspected that rusty crayfish were introduced into Leech Lake in 1990 by anglers using them as fishing bait. They are now found throughout the lake and are most abundant in shallow rocky areas. Rusty crayfish are native to streams in the Ohio River Valley region of Ohio, Indiana, and Kentucky and have now spread widely to eastern and mid-western streams and lakes, including many in the recently glaciated regions of Minnesota and Wisconsin. Incidental counts by DNR fisheries personnel of rusty crayfish clinging to fish survey nets indicate that the population is currently about at its 10-year average in Leech Lake (Doug Schultz, MNDNR 2012 *personal communication*).

With their large size, aggressive nature and high metabolic rate, rusty crayfish tend to reduce or displace native crayfish species. Studies in Wisconsin found that the native crayfish *Orconectes virilis*, which is the most common native species in Leech Lake, was eliminated in 75% of the lakes invaded by rusty crayfish (Olden et al. 2011). Rusty crayfish generally devour more aquatic vegetation than native crayfish and can reduce species diversity as well (Wilson et al. 2004). High numbers are often accompanied by a reduction in the abundance of a wide variety of other bottom dwelling invertebrate organisms that serve as fish food items (larval life stages of insects such as damsel flies and mayflies, snails, etc.). Data from several published studies (e.g. Roth et al. 2006) indicate that invertebrates are a much higher energy source than plants and are selected first as a food source, and that plants are primarily eaten by rusty crayfish when the invertebrates become scarce.

Rusty crayfish are known to eat the eggs of some fish like bluegill that build nests and spawn at higher temperatures (e.g. 70 degrees) than walleyes (Dorn and Mittelbach 2004, Wilson ibid, Roth et al. 2007). Being native to more southerly latitudes, rusty crayfish have a growth range between 59 and 84 degrees (Mundahl and Benton 1990, Roth et al. 2006). Walleye, on the other hand, spawn at 38 to 50 degrees and their eggs hatch at 47 to 55 degrees (Becker 1983), so rusty crayfish are largely inactive when the scattered walleye eggs would be susceptible to crayfish predation. Three rusty crayfish-infested lakes in the Tower, MN area have relatively stable, naturally produced walleye populations. However one of these lakes, Eagle's Nest Three (last stocked in 1985), has experienced a sharp decline in bluegill abundance and in some aquatic plant species (MNDNR 2012 *personal communication*). Walleye and perch are known to eat the

young of rusty crayfish, which may or may not lead to reductions in crayfish populations. The ecosystem response of Leech Lake to invasion by rusty crayfish is not entirely clear at this point in time, and is possibly still evolving. Further observations and studies of both the plant and animal communities discussed throughout this document should help shed light on this issue.

The results of many studies indicate that the response to invasion by rusty crayfish is variable and unpredictable between water bodies, and that profound ecological changes are possible. Therefore, every effort should be made to prevent their spread to other area lakes. Crayfish from one lake should never be used as bait in any other lake. The possibility of transport and distribution by commercial bait dealers should continue to be carefully monitored and controlled through the state's AIS prevention program.

Animal Potential Invader Species

Zebra mussels (*Dreissena polymorpha)*

Zebra mussels are small, brownish, clam-like animals that are somewhat triangular in shape and have a series of darker or black stripes across their shells. They are 1-1 ½ inches long as adults and usually grow in groups or clusters which are strongly attached to solid surfaces in water 6-30 feet deep. They were transported to the U.S. in the late 1980s by ships entering the Great Lakes from Eurasia. Along with their deeper water-inhabiting but otherwise similar relative quagga mussels (*D. rostriformis bugensis*) , they have become established in all of the Great Lakes and the Mississippi River and its tributaries, and have been spreading from there to many points around this country and Canada. Since the early 19th century they have also been spreading across Europe from their original native range in Russia, causing the same problems there as in the U.S. (Karatayev et al. 1997). Each adult produces millions of eggs that hatch into near-microscopic, free-swimming larvae called veligers. The veligers become dispersed in the water column and are the form considered most likely to be transported to uninfested water in bait buckets, bilges, and live wells that are not emptied and dried. The attached adult forms can 'clam up' and live for several days out of the water, which also presents a transport and invasion hazard.

Zebra and quagga mussels are particularly noxious AIS both physically and biologically. Physically, they attach to rocks, pilings, docks, boats, motors, intake pipes, locks and dams, etc., causing many billions of dollars in damage and severe inconvenience to individuals and industries. They propagate into enormous densities and accumulate in windrows of sharp shells on beaches when they die. It is estimated that over 700 trillion quagga mussels currently inhabit Lake Michigan and that they filter all the water in the lake every 10 days or so. Biologically they can consume most of the randomly distributed phytoplankton and zooplankton that are the foundation of all freshwater food chains, leaving only remnants to higher trophic levels such as young fish and larger fish food organisms (e.g. insect larvae, amphipods, snails) that also depend on this vital food chain component. They reduce or eliminate populations of native bivalves (clams) and other hard shelled organisms (crayfish) that they outcompete or attach to. Their own waste products, representing the end product of most of the energy captured by the system, plus any toxic materials they extract from plankton become concentrated at the bottom (a process termed benthification). The net result can be a significantly changed system having different energy cycling processes, reduced populations of desirable free-ranging plankton species, and increased populations of organisms with an affinity for the bottom (e.g. bullheads, suckers,

worms, amphipods). Toxic residues can be concentrated to lethal levels for some aquatic organisms or diving birds. It should be mentioned that Leech Lake has a water chemistry profile with high calcium that is very similar to Lake Michigan, which is heavily infested with both zebra and quagga mussels. Additional information on their life cycles and effects can be found on many internet sites, including the MNDNR website, under AIS.

Needless to say, it is very important that every possible attempt be made to keep zebra mussels out of Leech Lake. Minnesota currently lists about 60 lakes and 15 streams or rivers that are infested with zebra mussels, plus some additional unnamed wetlands and ponds. The state is rapidly strengthening its AIS program to deal with several immediate threats, the two most important at the moment being the invasion of more lakes and streams by zebra mussels, and the invasion of the upper Mississippi River and tributaries by Asian carp. Cass County currently (2011) has 7 lakes listed as being infested with zebra mussels, reflecting the state-wide pattern for invasions to move from infested waters in the south or east to 'clean' waters in the north. The infested waters closest to Leech are only about 50 miles to the south. The DNR considers Leech Lake to be a key waterbody in the zebra mussel defense battle because:

a) Large numbers of people come from areas of infested waters in other parts of Minnesota or other states to launch watercraft of many kinds on Leech Lake, thereby increasing the chances for it to become infested. Other equipment like docks and lifts can also bring attached zebra mussels to Leech.
b) If Leech does become infested, or if it is already infested, the possibility of zebra mussels being transported from Leech to other uninfested waterbodies would be high because of its intensive use by locals as well as out-of-area visitors, unless protection measures such as cleaning and drying watercraft and equipment are mandated and enforced. It has been speculated that some resident users such as very active local fishermen and guides might be less diligent in cleaning and drying their equipment between uses on different waterbodies than most visitors, with obvious adverse consequences.

For these reasons, the Leech Lake Association supports a variety of measures intended to keep zebra mussels at bay, including:

- Requiring all boats, other watercraft, and associated equipment be adequately cleaned so as to remove all AIS before they enter the water, including all fishing tournament boats;
- Increasing enforcement of all existing laws and regulations aimed at preventing transport of AIS to and their introduction into Leech and other area lakes through either recreational and commercial activities;
- Extending the same level of protection against introductions to all watercraft accesses on Leech Lake, whether public or private;
- Working with the DNR and other agencies or organizations to increase knowledge about AIS, their effects on uninfested waters and native species, and measures to prevent their spread;
- Locating watercraft cleaning stations and equipment at convenient locations around Leech Lake;
- Providing containers for disposal of unused bait at public accesses around the lake;

- Assisting the MNDNR in posting signs at accesses that remind users about laws and regulations to prevent transporting AIS between waterbodies;
- Working with other lake associations and organizations to promote legislation and acquire resources required to implement effective AIS prevention measures and programs.

Appendix 2 displays a locally-produced DNR information sheet containing a summary of the latest (2012) regulations and watercraft cleaning recommendations aimed at preventing the transport of AIS, particularly zebra mussels, from one water body to another. For more information visit: http://www.dnr.state.mn.us/invasives/index_aquatic.html.

Spiny water flea (*Bythotrephes longimanus)*

Spiny water fleas are zooplankton about 3/8 inches long that were transported to the Great Lakes from Europe prior to the mid-1980s. They have since spread to all the Great Lakes and to many inland waters in the U.S. and Minnesota, including Mille Lacs Lake and Lake of the Woods. They are found at all depths and accumulate as gelatinous globs on trolled fishing lines and down rigger cables. They eat smaller zooplankton that are an important food source for many other inhabitants, causing the decline or elimination of native species. Their name comes from a long spiny 'tail' that causes fish to reject spiny water fleas as food. Their proximity to Leech, and presence in lakes visited frequently by boaters also using Leech, means that they could easily be transported here unless preventative steps are taken. The same measures employed to prevent the spread of zebra mussels should also work for spiny water fleas, *and should be carried out even though zebra mussels are not also present.*

Faucet snail (*Bithynia tentaculata)*

Faucet snails are another species imported from Europe that has caused problems in nearby waters. They have become established in Lake Winnibigoshish and, as the intermediate host of for three intestinal trematodes, have cause mortality in ducks and geese. They are believed to have been responsible for about 9,000 scaup and coot deaths on Winnie in 2007-2008. The trematodes are not thought to be a threat to humans. They can be spread by attaching to aquatic plants, boats, anchors, decoy anchors, and other recreational gear and equipment placed in water (MNDNR AIS website). Some movement by waterbirds may also spread this invasive to new waters. In addition to the same cleaning procedures described for the above invasive species, some additional care and common sense should be employed to prevent the spread of this species from Winnie to Leech. For example, *waterfowl hunters as well as fishermen* should take appropriate steps to avoid carrying them elsewhere.

Other potential invaders:

There are a number of other non-native invasive species that could cause serious ecological disruptions if they became established in Leech Lake, but for which there is a somewhat lower risk of getting transported here. These include several species that have been carried by both domestic and foreign ships to the Duluth Harbor on Lake Superior: white perch, round goby, Eurasian ruffe, and New Zealand mud snail. The same procedures for preventing other more prevalent AIS from reaching Leech should also work for these species. The Asian carp established in the lower Mississippi are a very serious concern, but with any luck and the necessary resources, the hope is they can be stopped before advancing this far north. Infection of Leech Lake fish populations by the disease Viral Hemorrhagic Septicemia (VHS), also found in

Lake Superior, could be calamitous, although some degree of natural resistance might exist here. Here again, the DNR is trying to control its spread by monitoring and regulating the movement of fish and water between lakes and streams. More information on VHS and the other potential invaders is provided on the MNDNR AIS website.

Wildlife

Minnesota's lakes are home to many species of wildlife. From our famous loons and bald eagles to muskrats, otters, frogs and fish, wildlife is an important part of our relationship with lakes. In fact, Minnesota's abundant wildlife can be attributed largely to our wealth of surface water. From small marshes to large lakes, these waters are essential to the survival of wildlife.

The most important wildlife habitat begins at the shoreline. The more natural the shoreline, which would include trees, shrubs and herbaceous vegetation, the more likely that wildlife will be there. Just as important is the shallow water zone close to shore. Cattail, bulrush, and wild rice along the shoreline provide both feeding and nesting areas for wildlife. Loons, black terns and red-necked grebes are important Minnesota birds that are particularly affected by destruction of this vegetation. Underwater vegetation is also important to wildlife for many portions of their life cycle, including breeding and rearing of their young.

The MNDNR report *Sensitive Lakeshore Survey Leech Lake (11-0203.00) Cass County, MN* (2010) lists the following wildlife species for Leech Lake.

Bird Surveys:

- 130 bird species have been identified and recorded at Leech Lake.
- 38 species in greatest conservation need.
- 2 species listed as threatened in MN: common tern and trumpeter swan.
- 5 special concern species: American white pelican, bald eagle, Forster's tern, Franklin's gull, and yellow rail.
- 18 Loon nesting areas.

Fish Surveys:

- 42 species have been identified and recorded in Leech Lake.
- Species in greatest conservation need: pugnose shiner and least darter.

Frog Surveys:

- 797 survey stations were conducted along the shoreline of Leech Lake.
- Mink and green frogs were the most common identified and recorded.
- Other frogs and toads identified and recorded include gray tree frogs, American toads, northern leopard frogs, western chorus frogs and wood frogs.

The Water Quality and Vegetation sections of the plan have already dealt with the importance of maintaining or improving environmental conditions in the lake or in shorelands that are the essential habitats for wildlife. Often the degree of the presence or absence of these animals is indicative of the health of these ecosystems. Their presence is important not only to the health of the lake, but also to the resident human community and visitors who depend on the observation of wildlife, or knowledge that it's there, as their reason for living on or coming to Leech Lake. The wildlife contribute to the functional, aesthetic, spiritual, and economic components of the surrounding area. Therefore the Leech Lake Association supports measures aimed at protecting the water and shoreland habitats of indigenous wildlife species, and at maintaining wildlife

population levels indicative of healthy, well balanced ecosystems (more on this in the Land Use and Zoning section).

One native species that is of concern to many fishermen is the **Double-crested Cormorant (*Phalacrocorax auritus*)**. This bird has been noted as a resident of Leech Lake as far back as written records are available (Mortensen and Ringle, 2007). They are one of 30 species of cormorants in the world and one of six in North America. They can live up to 17 years in the wild with an average life expectancy of 6.1 years. Cormorants have long been persecuted by humans and were decimated after WWII by the use of chemicals such as DDT. Cormorants were officially protected under the *Migratory Bird Treaty Act* and in 1972 it became a federal offence to kill cormorants or destroy their nests and eggs. Since being protected from killing and with a decline in the use of DDT, the bird numbers started to recover, but have not reached historic numbers. The establishment of catfish farms in the wintering range of cormorants has also been implicated in their rapid increase as the birds now have an abundant source of high quality food when compared to the Gulf of Mexico where they normally winter. It is estimated that breeding and non-breeding cormorants total upwards of 2 million in North America, with the bulk of them nesting in the Great Lakes region and Canadian provinces. The cormorant population also increased rapidly on Leech Lake, where the Leech Lake Band of Ojibwe Division of Resource Management (DRM) counts found 1,144 nests in 2003, increasing to 2,524 nests in 2004.

With each adult bird consuming about one pound of small fish per day there were concerns that they might be affecting fish populations in the lake. Cormorants are protected under federal and tribal law, but the development in 2003 of the US FWS *Public Resources Depredation Order* does allow for control where cormorant numbers are causing damage to public resources such as fish and rare habitats or species. The colony on Leech Lake nests on tribal lands and therefore their management is under the control of the LLBand's Division of Resource Management. In order to initiate a control program, a joint federal, tribal and state Environmental Assessment (EA) was prepared that would cover Leech Lake as well as other sites in Minnesota where there were legitimate impact issues.

Large numbers of cormorants nest on Gull and Little Pelican Island where the DRM was able to demonstrate that they were competing with ring-billed gulls for nesting space and were having a negative effect on common terns, a threatened species. Due to the concerns over common tern populations, the DRM was able to initiate cormorant control efforts in 2005, and by 2011 a total of 19,636 adult and sub-adult cormorants were removed from the lake. Although there was inconclusive evidence that cormorants were affecting game fish populations on Leech Lake, there was some circumstantial evidence that they might be having a negative effect on young walleyes. As a condition of conducting cormorant control, the DRM also had to initiate a diet study to determine what cormorants were actually eating on the lake. This study has found that cormorants consume mainly small yellow perch and lesser amounts of a variety of other species. Walleye consumption was found to range from 1.5 to 6.5% of their diet, by mass, among years. Conversely, the perch diet ranged from 45.1 to 76.2% by mass (Schultz, *in preparation*, 2012).

Due to a number of changes that occurred at the same time the diet study was initiated, including walleye fry stocking, an angler bag limit reduction and slot (size) limit, it is difficult to determine the effects of cormorant predation. Preliminary findings of the diet study and modeling indicate

that cormorant predation on walleye fingerlings is probably not a significant factor as it is replacing natural mortality which is very high. If mortality on yearlings is high however, this may result in lower walleye populations in future years. This is all due to the compensatory versus additive mortality in fish populations. The vast majority of all small fish in a lake die each year due to being eaten by other fish or other natural causes. This is compensatory mortality and in the grand scheme of things it makes little difference how these fish die, they just pass through the food web in a different way. Additive mortality is that which is over and above what would naturally occur, and should this be too high it can result in changes to a fish population. Human harvest, for example, is highly additive because we take fish that otherwise would have survived most natural mortality. Modeling of Leech Lake's fish population and this complex interaction continue in an effort to better understand the effect of cormorant predation.

Cormorant control is very expensive, costing up to $50,000 per year on Leech Lake, and is becoming increasingly difficult as the birds adapt to control measures. The DRM is working to come up with alternatives to lethal measures to keep cormorant numbers controlled on the lake due to the high cost and controversy over lethal control of a native species. The DRM plans to continue control efforts at current levels unless compelling evidence indicates they should do otherwise, and if funding is available. The Leech Lake Association actively supports these studies and the resulting actions developed to deal with cormorants on Leech Lake.

Lake Water Level

The water level of Leech Lake is controlled via US Army Corps of Engineers operation of the dam on the Leech Lake River located at Federal Dam, MN. The Corps is responsible for managing the outflows of 6 lakes in the region comprising the Mississippi River Headwater Reservoir System.

The guidelines, regulations and the general plan for operating the Mississippi River Headwaters Reservoirs are contained in six *Water Control Manuals*, dated January 2003, and the *Reservoir Operating Plan Evaluation (ROPE) Study Report* completed in September 2009 and officially approved January 19, 2010.

General regulations governing the operation of the Mississippi Headwaters dams were first established by the War Department in 1889 and were formally modified in 1931, 1935, 1936, 1944 and 1988. The area surrounding the Headwaters lakes was largely undeveloped when the dams were first constructed in the late 1800's and early 1900's. Consequently, there were no serious objections to widely fluctuating lake levels. During this period it was not uncommon to store the entire spring runoff, which often resulted in very high lake levels. The water would then be released over the summer to augment flows downstream for navigation, mill power, and other uses, which in turn often resulted in low lake levels.

Lake level records dating from 1885 show that the Corps has become increasingly sophisticated and successful at managing summer fluctuations, thus dramatic deviations that were recorded in the late 19th and early 20th centuries have all but disappeared in recent decades. Although this may seem like a good thing, the plants and animals in the lake evolved to a system that periodically experienced fluctuations in water level. Changes in the lake ecosystem will occur when these fluctuations are eliminated or reduced. Examples include loss of shoreline vegetation and erosion, and siltation of fish spawning areas.

During and after the first third of the 1900's, as recreation and the number of homes on the reservoirs increased and agricultural and urban development downstream began to occur, local landowner interests became more important in governing reservoir water levels. For example, in 1929 and 1930 the headwaters reservoirs were lowered in an effort to test their capabilities to increase flows below St. Paul, MN. Following drawdown, subsequent dry weather resulted in persistently low water levels. Resort owners and local residents organized and demanded the establishment of minimum operating levels to provide greater stability. As a result, on 11 February 1931, following a request from the Minnesota Lake Levels Association, the Secretary of War issued an order establishing high and low reservoir operating limits, minimum outflows, minimum summer flows at St Paul, and other rules. Additional regulations were issued in later years as needed.

Normal Summer Range/Band. The Corps attempts to manage the outflow of Leech Lake so that the summer water level fluctuates within a "band" of 1294.5 to 1294.9 feet above the 1929 National Geodetic Vertical Datum (NGVD). This summer band was determined to be most beneficial to a majority of the users during the summer months based on public consultation.

Ordinary Operating Limits. These ordinary operating limits (1293.20 to 1295.70) were also adopted through public consultation. In general, the limits range from the normal winter drawdown level to the elevation where high water begins to accelerate shore erosion in a particular reservoir. They are meant to be a range of elevations residents might expect to experience in an "ordinary" annual cycle. In actual practice, the lower elevations are reached in most years as part of the winter drawdown. The, upper limits are reached less frequently. At Leech Lake, a normal drawdown elevation of 1293.80 feet has been found to be adequate.

Total Operating Range. These limits (1292.70 to 1297.94) represent the absolute upper and lower limits within which the Corps is allowed to operate the reservoirs but Flowage Rights were acquired to approximately 1301.94, 1929 NGVD. Leech Lake Dam and Reservoir controls runoff from 1,163 square miles of the Leech Lake River drainage basin. At normal pool, the backwater effect from the dam effects eight lakes which are connected to the reservoir. When the maximum operating limit is exceeded, a total of fourteen lakes are affected.

Reservoir Operating Plan Evaluation **(ROPE Study), finalized January 19, 2010.** A plan was developed and proposed for implementation to provide a good balance between benefits and negative effects to all resources and user groups that depend on the reservoirs and rivers in the Headwaters. However public support for environmental benefits of a more natural hydrologic regime was limited. Because of the opposition, the final plan does not better simulate a more natural hydrologic regime for the Headwaters reservoirs. The ROPE made some specific changes for Leech Lake including: Minimum releases will be 120 cfs and will fall to 60 cfs under very low water levels. The operating limits, normal summer elevations, Congressional notification levels, and other operational aspects of Leech Lake were not changed by the ROPE. Stated a different way, the Water Control Manual, dated January 2003, still governs the regulation of the Leech Lake project, with the slight changes from the ROPE as noted.

Flood Damage Reduction. Whereas the northern reservoirs once functioned primarily as a water source for downstream navigation and milling, today they are managed not only to provide stable water levels on the reservoirs, but also to assist with downstream flood control. All six reservoirs can be regulated, if necessary, for this purpose. Winnibigoshish, Leech Lake, and Pokegama reservoirs are regulated for flood control at Aitkin. Winnibigoshish and Leech also

store water to assist Pokegama in accomplishing its final winter drawdown. To alleviate flooding problems upstream of Pokegama, the combined outflow of Leech Lake and Winnibigoshish cannot exceed 2200 cfs. A minimum outflow is required – even during drought periods – to maintain viability of the Leech Lake River downstream from the dam

Drought/Low Flow. In addition to the low flow amounts (120cfs/60cfs) spelled out in the ROPE Final Report, the Water Control Manual of January 2003 refers to a Drought Contingency Plan, dated September 1992. This plan was never approved and exists only in draft form. It will be consulted, along with other documents, in the event of a severe drought situation. Congressional notification is required 14 days prior to Leech Lake going below elevation 1193.20, which would likely create hardships for lakeshore owners and recreational users of the reservoir. The following documents will primarily be used during a drought condition: Water *Control Manual for Leech Lake (January 2003), Drought Contingency Plan Appendix DCP* (dated September 1992), *Mississippi River Headwaters Lakes in Minnesota Low Flow Review* (dated October 1990), *Water Available from Upstream Locations Section 22 Report* (dated September 1994). In addition, related documents maybe found in the *Water Control Manual*, paragraph 1-03.

Public Access and Harbors

Research has shown that Minnesotans rely heavily on public access sites to get on to the state's lakes and rivers. A 1988 boater survey conducted by the University of Minnesota showed that three quarters of the state's boat owners launch a boat at a public water access site at least once a year. In addition, over 80 percent of boat owners report using public water access sites for recreation activities other than boating (viewing the lake, bird watching, exercise, etc.).

The primary agency responsible for pubic water accesses in Minnesota is the Department of Natural Resources, Division of Ecological and Water Resources. They are responsible for the acquisition, development and management of public water access sites. The DNR either manages them as individual units or enters into cooperative agreements with county, state, and federal agencies, as well as local units of government such as townships and municipalities. The DNR's efforts to establish and manage public water access sites are guided by Minnesota Statutes and established written DNR policy. The goal of the public water access program is free and adequate public access to all of Minnesota's lake and river resources, consistent with recreational demand and resource capabilities to provide recreation opportunities.

According to Minnesota Department of Natural Resources Regional Headquarters in Bemidji there are ten public accesses on Leech Lake:

Ownership	Type	Description
DNR	Concrete	Battle Point
DNR	Concrete	Sucker Bay, new 2010
DNR	Asphalt	Shingobee Bay
City of Walker	Concrete	City Park
DNR	Concrete	Erickson Landing
DNR	Earthen	Brevik

DNR	Concrete	Whipholt
Corps of Engineers	Concrete	Federal Dam
US Forest Service	Earthen	Oak Point, unimproved lane
US Forest Service	Concrete	Stony Point

The Division of Ecological and Water Resources has state authority to oversee construction of private or public boat ramps. No state permit is required if all the conditions listed on their website can be met. These conditions generally apply where a modest amount of lakeshore modification is required; otherwise a permit from the DNR is needed. The *Cass County Land Use Ordinance (May 27, 2005)* states that no private residential watercraft access ramps are permitted on lakes with one or more public accesses, which would include Leech Lake, but many do exist as legally non-conforming structures that were built before the 1996 revision of the ordinance. There is no current lake-wide planning to establish future accesses according to current or anticipated public wishes.

The number and kinds of accesses on Leech Lake has attracted greater attention lately because of the threat of exotic species, especially zebra mussels, being introduced into the lake at these points. The fewer the accesses, the easier it is to examine or clean watercraft entering or leaving the lake. Most of these prevention measures are being considered or designed for the public accesses and for private accesses at resorts. In addition to these accesses, the private residential launch sites around the lake are potential AIS entry points. The Cass County AIS Task Force, of which the Leech Lake Association is a member, is attempting to deal with this problem through educating all users about the dangers of infestations, and the need for and ways to inspect and clean watercraft. It would be very useful, however to know exactly how many trailered watercraft accesses of all types, public and private, there are on Leech Lake, and where they are located. The County does not have the boating equipment that would be needed to conduct such an inventory so it would probably have to be done by the DNR or a citizen task group like the LLA. It would still miss accesses by things such as canoes or kayaks that can be carried by hand to the water's edge and launched.

As resorts are acquired by developers, the harbors that were part of the resort operation are usually retained and often improved as a highly prized attribute of the property. The convenience and safety of boating from a harbor usually costs new owners a considerable premium for harbor rights.

There are numerous examples of long term erosion or disruption of adjacent lakeshores or lakebeds (littoral areas) that have been caused by changes in currents or wave action resulting from harbor and/or breakwater construction. Current DNR "guidelines" for breakwater construction (*MN Statutes 326.02*) require that they be designed by a state certified professional engineer and be based on U.S. Army Corps of Engineers shore protection requirements. Their design must consider possible effects on adjacent littoral and shoreline areas, and they should be oriented *parallel* to shore. They should be a distance from the shore of at least two times their length.

DNR regulations pertaining to harbor construction are contained in 2008 *Minnesota Administrative Rule 6115.0200* titled *Excavation of Public Waters* (3 pp.). Goals are to:

A. Preserve the natural character of public waters and their shorelines, in order to minimize encroachment, change, or damage to the environment, particularly the ecosystem of the waters;

B. Regulate the nature, degree, and purpose of excavations so that they will be compatible with the capability of the waters to assimilate the excavation, and

C. Control the deposition of materials excavated from public waters and protect and preserve the waters and adjacent lands from sedimentation and other adverse physical and biological effects.

The Rule states that this includes any activity resulting in displacement or removal of bottom materials or the widening, deepening, straightening, realigning, or extending of public waters, and may include proposals for excavations landward or waterward from the ordinary high water level. The Rule also prohibits excavation where it is intended to gain access to navigable water depths when such access can be reasonably attained by alternative means which would result in less environmental impact. This would seem to apply to Leech Lake with its numerous free, well-constructed and widely distributed public accesses, plus the many resort accesses on the lake.

Cass County is generally opposed to the construction of any new private harbors or breakwaters on Leech Lake, but the county does support maintenance and limited improvement of existing harbors. This requires a *Shoreline Alteration Permit* that explains what's to be done and where dredged sediment or other material removed in the process will be placed or disposed of. Here again, care should be taken to avoid changes that would cause disruption of adjacent littoral areas or shorelines.

Land Use and Zoning

The water quality of a lake or river is often a reflection of the land uses within its watershed. While the specific impacts on a lake from various land uses vary as a function of local soils, topography, vegetation, precipitation, and other factors, citizens can exercise control over potentially negative land use effects through prudent zoning.

Shore zoning regulations are based upon the *Shoreland Management Act* adopted by the Minnesota legislature in1969 and revised in 1989, and the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to each lake for ease of reference (11-0203-00 for Leech Lake). Counties in turn have used these classifications as a tool to establish lot setback and size criteria that are intended to protect and preserve the character and uses reflected in the classification. These criteria for Cass County are shown in the tables below:

SINGLE FAMILY RESIDENTIAL WITH GUEST QUARTERS

Lake Classification	Min. Lot Area (ft^2)	Min. Lot Width	Min. Buildable Area (ft^2)	Min. Lot Area (ft^2)	Min. Lot Width	Min. Buildable Area (ft^2)
General Development - Riparian	30,000	100'	12,000	60,000	180'	27,000

General Development - Non-Riparian	40,000	150'	20,000	80,000	265’	40,000
Recreational Development-Riparian	40,000	150’	16,000	80,000	225’	40,000
Recreational Development-Non-Riparian	40,000	150’	20,000	80,000	265’	40,000
Natural Environment-Riparian	80,000	200’	40,000	120,000	300’	60,000
Natural Environment- Non-Riparian	80,000	200’	40,000	160,000	400’	80,000

SETBACKS FRON THE ORDINARY HIGH WATER LEVEL (IN FEET)

Lake Class	Structure setback	SSTS Setback
General Development	75	50
Recreational Development	100	75
Natural Development	150	150
Resource Protection Districts	150	150

Most lakes have numerous “legally non-conforming” properties that came into existence prior to development of the regulations in the current *Cass County Land Use Ordinance* dated May 27, 2005. In general, these pre-existing conditions are allowed to remain unless they are identified as a threat to human health or environment, or are destroyed by natural, accidental causes, or in association with significant renovation. Developers often establish covenants for properties within a specified tract which then become legally binding on owners, but such covenants are not stipulated by law. The cities of Walker and Federal Dam have jurisdiction over the shore lands in their municipalities.

Leech Lake is classified as a General Development (GD) lake under the DNR system. This category is described in the *Cass County Land Use Ordinance* as generally large, deep lakes, or lakes of varying sizes and depths, with high levels and mixes of existing development. These lakes often are extensively used for recreation and, except for the very large lakes, are heavily developed around the shore. Second and third tiers of development are fairly common. The larger examples of lakes in this class can accommodate additional development and use. The Shoreland section of the Cass County Ordinance notes that “the GD management district is established to provide minimum regulations in areas presently developed as high density, multiple use areas; and to provide guidance for future growth of commercial and industrial establishments which require locations on protected waters.” Shorelands are defined as those lands within 1,000 feet of the ordinary high water (OHW) level of a lake and within 300 feet of a river or stream.

Leech Lake, owing to its very long shoreline (~200 miles) and large variety of shoreline features, is not particularly well served by this system. Mixes of large tracts of developed and undeveloped shorelines, and the existence of sensitive natural areas critical to maintaining the character and health of the ecosystem, are not accommodated well by a single set of standards. Development and land alterations in lakeshore areas may have disproportionately greater negative impacts on native plants and animals because of the large number of species inhabiting

or frequenting these areas, including many species of greatest conservation need. The existence of water or proximity to it is the key feature here. One mechanism to provide greater flexibility to deal with these issues is the recent addition to the Cass County Ordinance of a regulation permitting "Designation of Resource Protection Districts and Reclassification of Bays". Such a designation for a section of shoreline or a bay requires a "resolution of support" from the township(s) involved. This designation also changes the lake classification from General Development to Natural Environment for that section of shoreline (see tables pg. 26-27), which indicates an intention to accommodate less intensive development and greater natural resource protection. The land must also have been designated a "sensitive lakeshore" as a result of the DNRs intensive ecological study and report titled *Final Report, Sensitive Lakeshore Survey, Leech Lake, Cass County, Minnesota* by K.Thompson and. D. Perleberg, 2010, MNDNR, one of 19 such studies on lakes in North Central Minnesota. Sensitive lakeshores, as defined in the survey, are comprised of shorelands and near-shore areas with natural and biological features that provide unique or critical habitat for the health and well-being of fish, wildlife, and native plants. Sensitive lakeshores also include: vulnerable shoreland due to soil conditions, areas vulnerable to development (wetlands, shallow bays, etc.), nutrient susceptible areas, areas with high species richness and/or essential fish and wildlife habitat, important habitat for endangered species, and areas that provide habitat connectivity.

Since Resource Protection Districts are a new opportunity to provide greater protection for deserving areas, none have been proposed yet by townships around the lake. The Leech Lake Association could assist the county in implementing this program by helping to identify a pilot lakeshore area, and by encouraging the townships to participate. Alternatively, the Association could encourage the DNR to consider reclassification of clearly defined portions of Leech Lake shoreline to provide higher standards for new development. Some lakes, such as Leech, contain unique biological communities and have ecological conditions that make them highly sensitive to disturbances in their watershed. The DNR may reclassify any public water or modify or expand the existing shoreland classification system to provide specialized shoreland management standards based on unique protection characteristics and capabilities. It may be desirable to consider such higher shoreline standards for some basins or areas of Leech Lake.

The Leech Lake Association is presently working closely with the Leech Lake Area Watershed Foundation (LLAWF) to protect shorelands and adjoining waters identified as particularly environmentally sensitive. These may include wetland areas or offshore spawning beds that would be seriously damaged by development. During the past five years some of these areas have been protected through acquisition, such as lakeshore along Five-Mile Point and Miller Bay which was purchased by the LLAWF and the DNR to protect offshore muskie spawning beds. Other sensitive areas can be protected through donation of Conservation Easements, which allow landowners to maintain all rights of ownership while agreeing to limit future development in return for certain tax benefits. Through state grants provided to Cass County and the Leech Lake Area Watershed Foundation, landowners who treasure their properties now have additional financial incentive to maintain their holdings in a pristine state for future generations. Landowner grants funded from the Minnesota Environment and Natural Resources Trust Fund (lottery proceeds) or the Outdoor Heritage Fund (dedicated sales tax) help defray the out-of-pocket costs of establishing a conservation easement by covering such upfront costs as appraisals, land surveys, legal review, and so on. The 2010 *Sensitive Lakeshore Survey, Leech*

Lake by Thompson and Perleberg should prove especially valuable in targeting areas for special protection or procurement of conservation easements. It can be accessed through the MNDNR website at: http://www.dnr.mn.us/eco/sli/index.html.

Safety and Managing Use Conflicts

The dimensions of Leech Lake and its many connecting bays and channels support a multitude of boating and other water resource uses. However, this diversity of commercial and recreational uses creates a wide array of potential or actual safety problems and use conflicts.

Because of the danger of underwater hazards and increasing travel at night, the Leech Lake Association took the lead in purchasing both lighted and unlighted buoys for key locations around the lake. The buoys are placed and retrieved each year by the Sheriff's office. Funding comes from Association memberships, grants, resorts, businesses, and personal donations. The Leech Lake Association has also been instrumental in maintaining boat travel through the Roosevelt Canal by dredging when necessary, and providing buoys to mark the entrances. Dredging is required every seven to nine years because of drifting sand on both sides of the Canal. The Leech Lake Tribe, working in partnership with the Leech Lake Association, transports the dredged sand from the Agency Bay side of the Canal to a suitable location on Tribal property. Sand dredged from the Traders Bay side of the canal is put on Tribal property adjacent to the canal. Without this help, dredging of the canal would be difficult if not impossible. Funding for dredging also comes from membership dues, grants, and area businesses. The Association has assisted in the promotion of lake safety generally through presentations to civic groups on current state watercraft regulations and boating hazards. It has distributed packets of educational materials and applications for certification of youth watercraft operators.

The primary agency responsible for managing surface water use conflicts is the Minnesota Department of Natural Resources, Bureau of Information and Education. The Boat and Water Safety Section within the Bureau oversees surface water use and is in charge of administering the Water Surface Use Management (WSUM) program. The goal of this program is to enhance the recreational use, safety and enjoyment of the water resources in Minnesota and to preserve these water resources in a way that reflects the state's concern for their protection.

Within this context, any governmental unit may formulate, amend or remove controls for water surface use by adopting a suitable ordinance, but which must have the following characteristics:

- Where practical and feasible the ordinance must accommodate all compatible recreational uses;
- Minimize adverse impacts on natural resources,
- Minimize conflicts between users in a way that provides for maximum use, safety and enjoyment, and
- Conform to the standards set in WSUM Rules.

The Leech Lake Association is working with local municipal and Tribal law enforcement agencies to develop use restrictions that can be effectively enforced. It is working with the local and Tribal communities in attempts to develop other 'softer', non-legal measures to deal with use

conflicts. A complementary approach might entail annual distribution of information on state standards for hours of operation, operational setbacks from shorelands, locations of loon nests or other sensitive areas, locations of swimming areas, etc., to help create "peer pressure" to minimize the types of behavior that tend to lead to conflicts.

VII. VISION FOR LEECH LAKE

Our vision for the future of Leech Lake and its shore lands is that they retain the characteristics of a largely undisturbed body of natural water as they evolve in response to increasing pressures to provide more habitation, water access, recreation, and enjoyment for more people.[*]

VIII. SUMMARY/RECOMMENDATIONS

The current state of Leech Lake suggests the following high priority actions for achieving the vision for the lake (main text section support in parenthesis):

- Assisting the MN Pollution Control Agency in organizing and conducting water quality monitoring activities on Leech Lake, including continuation of the Citizen Lake and Stream Monitoring Programs, and the Leech Lake River Intensive Watershed Monitoring effort starting in 2012; (Water Quality section)

- Encouraging Cass County to undertake a lake-wide individual wastewater treatment system inspection program to get a better idea of possible nutrient contributions to the lake from this source; (Water Quality)

- The 2002-2009 aquatic vegetation survey provides a good baseline of recent condition, location and abundance of the plants composing this important biotic community, and should be followed by future surveys to observe possible changes due to exotics, boat motors, climate change, or other factors. (Vegetation)

- Continuing to monitor the status of the lake's rejuvenated walleye population, as well as other fish populations, through assistance or participation in various DNR projects and programs such as the Leech Lake (fisheries) Advisory Committee, annual DNR Roundtable discussions, field projects, and AIS prevention activities. It is imperative that steps be taken to insure that DNR work on Leech Lake be conducted out of the existing Fisheries Office in Walker and not be moved; (Fisheries)

- Taking steps to keep additional aquatic invasive species from invading Leech Lake by supporting DNR efforts to strengthen regulations preventing their transport to new waterbodies, assisting in obtaining equipment to clean watercraft, providing waste containers for left-over bait at public landings, distributing signs on state AIS laws and equipment cleaning for posting at public and private launch sites, and working with other

[*] To some extent, all development will compromise the natural characteristics of the lake. Planning determines which compromises we are willing to accept and under what conditions.

lake organizations and the Cass County AIS Task Force to do as much as possible to keep AIS, and especially zebra mussels, out of Leech and other area lakes; (Aquatic Invasive Species)

- Assisting Cass County in establishing Resource Protection Districts by townships in Cass County. Support the county Environmental Services Division efforts to reduce storm water runoff by promoting the planting or protection of shoreline vegetative buffers, and by minimizing the construction of impervious surfaces in building projects on the shore; assisting City of Walker and Cass County efforts to prevent storm sewer effluents from directly entering Leech Lake; (Water Quality, Vegetation, Wildlife, Land Use and Zoning)

- Protecting the lake ecosystem and enhancing water quality by urging the state legislature to reauthorize the DNR to update the existing 1989 Shorelands Management Standards. The DNR has a refined draft set of standards, developed with extensive public consultation, that are streamlined, modernized, and reformed to provide better standards for development, while reducing regulatory complexity. (Public Access and Harbors, Land Use and Zoning)

- Continuously monitoring county activities and decisions on shorelands as a consequence of application of (e.g. requests for variances and conditional use permits), or changes in, the county land use ordinance and state land use regulations; (Land Use and Zoning)

- Continuing support of efforts to preserve and protect sensitive shorelines through the acquisition of conservation easements. This is a particularly valuable and effective program for protecting certain critical lakeshore areas in perpetuity. Encouraging the development and support of shoreland and watershed Best Management Practices; (Land Use and Zoning, others)

- Sustainability of the present ecological state of Leech Lake will depend upon steps being taken as soon as possible to slow or arrest global climate change by reducing emissions of CO2 and other "greenhouse" gases. In addition to providing educational information and encouraging reduction of energy use by individuals, county or other area-wide energy conservation programs could be initiated, such as those facilitated by the U.S. EPA in Chicago and Kansas City, and counties in upstate New York. (Appendix 3)

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Appendices:

APPENDIX 1
Minnesota Department of Health fish consumption advisories

APPENDIX 2
DNR hand-out showing watercraft transport laws and cleaning procedures

APPENDIX 3
Sustainability and Climate Change

While there are a couple of dictionary definitions of sustainability, the one referred to here is that of "harvesting or using a resource so that the resource is not depleted or permanently damaged" (Merriam-Webster 2011). This definition underlies the purpose and objectives of the whole management plan. Threats or challenges to sustainability can have widely variable time dimensions: present or pending, of long or short duration, likely to reoccur or not, and the many time characteristics in between these extremes. The ease with which different threats can be reduced or eliminated also varies widely, and some of the most destructive are also the most difficult to deal with. The threat posed by the changing climate phenomenon commonly referred to as global warming, which is actually only one aspect of climate change, is one of the 'toughies'.

The eventual environmental impacts of climate change, beyond those already being observed (record high global air temperatures, melting glaciers, sea level rise, less stable weather), are largely derived from complex, physics based models that estimate the effects of "greenhouse" gases (GHGs) such as carbon dioxide (CO2) and methane on climate variables (e.g. air temperature, precipitation) and on temperature-responsive environmental conditions (e.g. water temperature, dissolved oxygen concentrations). It is widely accepted among scientists studying this issue that CO2 is the most important climate-changing agent and GHG, and that human activities related to the combustion of fossil fuels are the largest source of increased CO2 in the planet's atmosphere (US National Academy of Science, 2011; United Nations Intergovernmental Panel on Climate Change, 2007; American Meteorological Society; Geological Society of America; National Oceanographic and Atmospheric Administration; highly respected scientists and research programs around the world). Carbon dioxide also has the longest half-life, about 10 years, among the most abundant GAGs. Atmospheric concentrations of CO2 have risen from a relatively constant or 'baseline' level of 280 PPM before the industrial revolution to about 390 PPM today, and the rate of increase is still rising (i.e. more tons of CO2 emissions each year than in the previous year, 5.2% in 2010, the highest increase yet recorded). In 2010 the US ranked second (at 16%) in the world to China (at 24%) in CO2 production. A doubling of baseline levels of atmospheric CO2 in the next 50 to 100 years is considered likely, accompanied by dramatic climatic and environmental effects on land and water. Global warming is occurring faster at higher latitudes, as in the northern US and Canada, than it is closer to the equator. Even with reduced CO2 emissions, the need for it to come back into equilibrium with the huge reservoir of elevated ocean concentrations would delay the time required to reduce atmospheric concentrations. The point is that CO2 emissions from human activity must be drastically reduced soon to achieve any degree of environmental sustainability on planet Earth.

Two questions come to mind when considering Leech Lake in this context: 1) what specific physical and biological effects will it have, and 2) what can we do to prevent it, reduce it, or adapt to it? The main body of Leech Lake is relatively shallow (5-35 ft.), moderately productive (meso- tending toward oligotrophic), cool water (supports walleye, northern pike, black crappie, etc.), and nearly completely mixed (monomictic) in the summer (MNDNR). The western basin of Leech Lake has several deep areas of 50-150 feet that serve as refuges for small populations of cold water species (cisco and whitefish) during warm water periods in the summer (dimictic

or temperature-stratified areas) (ibid). Later ice formation and earlier ice out are being observed on lakes at this latitude for which reliable long term records exist. In Minnesota, ice has gone out earlier by two days per decade since 1950, and 7.5 days earlier per decade since 1996 (ibid). Ice cover will be reduced by up to three months in lakes at this latitude with a doubling of atmospheric CO2 concentrations (Stefan et al., 2001). These conditions will promote greater algal growth (eutrophication) and probably also the abundance of organisms associated with aquatic plants. Modeling of lake temperature and dissolved oxygen concentrations under climate conditions predicted to occur with CO2 doubling indicate that most cool water fish species in lakes like Leech will not suffer a drastic loss of suitable habitat (Eaton et al., 1995; Stefan et al., 2004; Abraham, 2008), but they will be faced with increased competition as warm water species like largemouth bass and bluegill become more numerous. Cold water fish (trout, whitefish, cisco) in many streams and lakes in this area are very likely to experience water temperatures high enough or dissolved oxygen concentrations low enough to eliminate populations of these species (Eaton and Scheller, 1996; Mohseni et al., 2003; Abraham, ibid; Stefan et al., 2004). The impacts of many other changed climate variables or ecosystem responses such as in the amounts and the form of precipitation, cloud cover, storm frequency, ground water supplies, and runoff are harder to model or predict. As in all very large scale perturbations like this one there will be surprises, effects that weren't predicted ahead of time. And with continued warming being extremely likely, adaptation to many environmental changes will be necessary. Habitat protection and wise land and water resource planning will be vital components of any adaptation strategies.

The answer to the second question, what can we do about it, is simple: reduce emissions of GHGs, particularly CO2, as rapidly as possible. How to do this is not so simple. Perhaps a method will be developed some time in the future to remove large quantities of CO2 from the atmosphere, but no such silver bullet currently exists. The US EPA, MNDNR, US Dept. of Energy, National Oceanographic and Atmospheric Administration and others provide an abundance of information and assistance to individuals and local communities through the internet, libraries, schools, municipalities, utilities, etc. on saving energy to reduce emissions. In nearly all cases this can be accomplished with little or no inconvenience while saving money at the same time. For example, everyone can help by adopting measures to reduce fossil fuel and electricity use, many of which are recommended or even provided by local public utilities, and by supporting local conservation and renewable energy projects or programs. Many large and small communities around the US, or groups of them, have developed Climate Change Response Plans to audit energy use, increase efficiency of services, reduce emissions, save money, and plan for expected climate and environmental changes. Cass County might be an organizational unit suitable for developing such a plan. Talk about climate change with your friends. Make the effort to become knowledgeable about climate change, and to play a role you think is appropriate in reducing GHG emissions.

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