Executive Summary

View of Thunder Bay, Ontario, from Sleeping Giant Provincial Park.
Photo Credit: John Marsden, Environment Canada.

Lake Superior Lakewide Management Plan
2006

Executive Summary

BACKGROUND

One of the most significant environmental agreements in the history of the Great Lakes was put in place with the signing of the Great Lakes Water Quality Agreement of 1978 (GLWQA), between the United States and Canada. This historic Agreement commits the U.S. and Canada (the Parties) to address the water quality issues of the Great Lakes in a coordinated, joint fashion. The purpose of the Agreement is to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem" (IJC 1993). The 1987 amendment to the GLWQA requires the development of Lakewide Management Plans (LaMPs) which "shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses...they are to serve as an important step toward virtual elimination of persistent toxic substances...". This document represents the current LaMP for Lake Superior.

The Great Lakes Water Quality Agreement specifies that the LaMPs are to be completed in four stages. However, under a streamlined LaMP review and approval process, the LaMPs now treat problem identification, selection of remedial and regulatory measures, and implementation as a concurrent, integrated process rather than a sequential or staged one. In the Lake Superior LaMP, Stages 1 and 2 for critical chemicals were completed before the decision was made to integrate. Stage 3 was merged into LaMP 2000 as the critical chemicals chapter. To date, no other LaMP has a load reduction schedule for critical pollutants as required by the Agreement.

The LaMPs go beyond the GLWQA requirement to address critical pollutants by using an ecosystem approach to integrate habitat, terrestrial wildlife and aquatic ecosystem components. This integration allows for the development of both environmental protection and natural resource management strategies.

The Lake Superior LaMP is unique because of an additional agreement between the federal governments, states and province surrounding Lake Superior. Announced in 1991, the agreement, called the "Binational Program to Restore and Protect the Lake Superior Basin," established a Zero Discharge Demonstration Program for critical pollutants and a broader ecosystem approach.

LaMP progress is now reported on every two years. Adaptive management is used to allow the process to change as needed by building upon successes, accepting new information and drawing from public involvement and input. The LaMP therefore, can be adjusted over time to respond to the most pertinent issues facing the lake ecosystem. Additional details on the process can be found in Chapter 1.

The LaMP/Lake Superior Binational Program contains funded and proposed (non-funded) actions for restoration and protection to bring about improvement in the ecosystem. Actions include commitments by the government partners as well as suggested voluntary actions that could be taken by non-governmental partners. LaMP 2000 identified these actions in six

ecosystem themes: critical pollutants, aquatic communities, terrestrial wildlife communities, habitat, human health and developing sustainability. The 2002 LaMP update reported on the success of those actions, and identified challenges remaining to achieve established goals and ecosystem objectives. LaMP 2004 reported accomplishments from 2002-2004, challenges to achieving goals and objectives, and next steps.

LaMP 2006

LaMP 2006 builds on the previous LaMP documents. Many of the original LaMP 2000 chapters have been revised, replaced and updated, although the Human Health and Critical Pollutants chapters remain the same as in the LaMP 2000. The Critical Pollutants chapter will be replaced in LaMP 2008 by a "Chemical Milestones" report scheduled for release in Summer 2006. The LaMP 2006 chapters contain a 2004-2006 progress report, presenting an accomplishment summary of the 1) actions completed or underway to improve the lake, 2) challenges, and 3) next steps or changes to ongoing management actions.

Highlights of LaMP 2006 include: an integrated and consolidated ecosystem chapter combining terrestrial wildlife, habitat and aquatic communities activities (Chapter 6); an expanded description of ecosystem goals, objectives and indicators (Chapter 3); community sustainability projects (Chapter 7); public outreach and education brochures and newspaper inserts (Chapter 2); and actions and projects targeted at critical pollutants reduction (Chapter 4). A chapter on coordination with other Great Lakes programs (Chapter 8), including the Great Lakes Regional Collaboration, is also presented. Updates on progress to restore Areas of Concern are contained in Appendix A, and a description of a successful Lake Superior Legacy Act Project (Hog Island) is highlighted in Chapter 1. A holistic, comprehensive look at the "state of lake superior" (the highlights report from the 2004 State of the Lakes Ecosystem Conference) can be found in Addendum A of the Executive Summary. LaMP 2006 also identifies data gaps and next steps for LaMP 2008.

LaMP 2006 is available on a CD-ROM, and is designed to be printed in a loose-leaf format that can be inserted into a three-ringed binder. This format allows for easy updates, additions of new material and removal of outdated information. A description of how to update the LaMP 2004 binder with the 2006 material is presented in the Preface. The LaMP 2006 will also be available on the web at www.epa.gov/glnpo.

This Lakewide Management Plan Report 2006 is not intended to be circulated extensively to the public; the agencies plan to produce a separate document to inform the public on Binational Program activities. Citizens of the basin, as partners and stakeholders in the Binational Program, are strongly encouraged to become actively involved. The Lake Superior Binational Forum can be reached at 1-888-301-LAKE (1-888-301-5253).

ACCOMPLISHMENT AND NEXT STEPS: HIGHLIGHTS 2004 TO 2006

The Lake Superior Binational Forum

The Lake Superior Binational Forum, the citizen's group associated with the government agencies responsible for carrying out the Binational Program, has been key to establishing an effective multi-stakeholder process. The Forum has held many workshops over the years for the purpose of acquiring necessary background information to help develop recommendations and proposals for sustainable development, human health and reducing the Lake Superior nine critical pollutants. They have also held very successful public input sessions and published many documents on key issues relating to the LaMP.

Accomplishments include:

- Initiating and conducting an annual Lake Superior Environmental Stewardship Awards Program;
- Developing, expanding, and promoting an annual Lake Superior Day celebration held on the third Sunday in July around the basin;
- Publishing, producing, and distributing an educational four-page color newspaper supplement that highlights Lake Superior "good news" stories around the basin;
- Holding public input sessions on a variety of topics including watershed planning and management, mining trends and issues, and impacts of aquatic nuisance species.

Next Steps include:

- Establishing a mercury-mentoring program to work with the shipping industry, other targeted industries, and municipalities to identify and reduce mercury sources;
- Participating with the Work Group in an effort to identify the monitoring efforts of private, corporate, municipal, non-profit, and tribal entities so that a more complete Lake Superior monitoring inventory can be obtained.
- Seeking to involve more youth in Lake Superior leadership activities, with a focus on university and college students.

The Lake Superior Binational Program Partners

The activities below represent accomplishments by the various partners represented on committees of the Lake Superior Binational Program. Additional details can be found in the relevant chapters of LaMP 2006.

Critical Pollutants

Accomplishments include:

- Mercury pollution prevention and awareness (e.g., progress in dental sector, school mercury removal, collection of thermostats, fluorescent tubes, auto switches, and thermometers);
- PCB phase-out from utility transformers;
- Hazardous and electronic waste collections and pesticide clean sweeps programs;

- Residential garbage burning awareness campaigns;
- Progress on contaminated sediment assessment and cleanup;

Next Steps include:

- Continued implementation of LaMP 2000 priority activities;
- Continued effort to update chemical inventories;
- Completion of a Chemical Milestones Report in Summer 2006; report will review current milestones and update reduction strategies;
- Continuation of sediment remediation in both countries; and
- Continuation of Stormwater Management to prevent pollutant loadings.

Ecosystem (Habitat, Aquatic, Terrestrial Wildlife)

Accomplishments include:

- Initiation of a landscape-scale invasive free zone;
- Restoration and enhancement of wildlife habitat;
- Initiation of a basinwide herptile monitoring program;
- Completion of a peregrine falcon survey;
- Continuation of National Lynx Detection surveys;
- Establishment of a National Marine Conservation Area;
- Establishment of a Watercourse Stewardship Project;
- Progress on watershed habitat rehabilitation;
- Continued development of a hydroacoustic-based pelagic prey fish monitoring program;
- Mapping and quantification of critical fish habitat;
- Initiation of a lower trophic level monitoring effort;
- Removal of structures that limit fish passage and fragment aquatic habitat; and
- Consolidation of various ecosystem components of LaMP 2000 into a single chapter.

Next Steps include:

- Map and describe additional areas of critical fish habitat;
- Continue management and research to prevent introductions and limit the spread of aquatic nuisance species;
- Continue basinwide herptile monitoring program;
- Finalize and implement the hydroacoustic-based prey fish monitoring program;
- Continue development of a Lake Superior Decisions Support System;
- Continue lower trophic monitoring efforts;
- Evaluate and initiate monitoring techniques for medium-sized carnivores;
- Update information in the public kiosk network;
- Continue to rehabilitate coaster brook trout, walleye, and sturgeon populations and manage a sustainable lake trout fishery;
- Complete a report on lake herring status; and
- Continue invasive free zone planned treatment and monitoring.

Human Health

Accomplishments include:

- Formation of the Canadian Great Lakes Public Health Network;
- Participation in the U.S. Great Lakes Human Health Network;
- Enhanced beach monitoring and outreach efforts; and
- Improved education and outreach on fish consumption advisories.

Next Steps include:

- Integration of the U.S. and Canadian Great Lakes Human Health networks;
- Expansion of membership to the Network;
- Improve integration with children's health issues and programs;
- Increase integration with the LaMP groups to jointly set human health priorities and action steps; and
- Additional and continued outreach on human health concerns and risks to Great Lakes human health officials.

Sustainability

Accomplishments include:

- Completion of Phase I of the Community Awareness Review and Development (CARD) project;
- Completion of a riparian buffer demonstration project; and
- Coordination on local sustainability projects with Lake Superior communities.

Next Steps include:

- Possible continuation of the CARD project;
- Recruitment of additional Sustainability Committee members;
- Integration with other ongoing sustainability efforts around the Basin;
- Promoting water conservation, marketing waste reduction and energy efficiency, understanding sprawl; and
- Promoting sustainability workshops.

CHALLENGES OF THE BINATIONAL PROGRAM

In general, the next steps for the Binational Program are to:

- continue to implement projects and priorities identified in the LaMP;
- advocate the benefits to decision makers and the public to ensure continued support for toxic chemical reduction activities;
- continue communication and outreach activities that will achieve measurable progress toward the Binational Program goals;
- continue with priority ecosystem monitoring, mapping, research and restoration efforts;
- prepare various internal and public reports, including the biennial LaMP updates;
- build capacity in the Binational Program by recruiting additional partners; and

- seek additional funding for LaMP implementation from a wide variety of sources.

Future accomplishments will be dependent upon commitments by governments, NGOs, and individuals to support the science, resource management, and legislative activities that will protect and restore the basin.

Ecosystem challenges include:

- protecting critical lake and tributary habitats;
- continuing rehabilitation plans for sturgeon, walleye, lake and brook trout;
- preventing invasion and transport of non-native species within the basin;
- ensuring the maintenance of healthy aquatic communities on rivers with hydropower;
- establishing long-term monitoring programs of biological communities;
- establishing monitoring programs for invasive species and fish community changes and status;
- ongoing support and maintenance of the geographic database and projects associated with the Lake Superior Decision Support System;
- closing information gaps on the status and trends of habitat conditions;
- developing land use change models; and
- educating the public on important habitat and ecological resources in the Lake Superior basin by expanding the use of interactive information kiosks.

Even though the idea of sustainability has long provided a foundation for the Lake Superior Binational Program, it is challenging to facilitate sustainable practices “on the ground”. To promote practices that provide for sustainable outcomes requires consideration of a variety of issues that go beyond the prevention of pollution. To produce a truly sustainable society, we must grapple with issues that are more general in scope than those associated with other aspects of the LaMP. Though progress has been made, we are still a long way from promoting a full range of social and economic initiatives that will make for a sustainable future.

ADDENDUM A

STATE OF THE GREAT LAKES 2005

Lake Superior

Assessment: The status of the Lake Superior ecosystem is *mixed*.

Bald eagles, gray wolf and cormorants have recovered and forest cover has increased. Fisheries recovery indicators are also good. Some trends in contaminant loadings are showing declines while others remain constant. Invasive species continue to be a problem and remain a threat to the recovering fish population. Stresses on the system include shoreline development, habitat loss, land use change and invasive species.

Summary of the State of Lake Superior

Lake Superior is the largest freshwater lake in the world by area and third largest by volume; it averages 147 metres in depth, with a maximum depth of 406 metres. The total watershed area is 228,000 km^2 including Lake Nipigon and two major diversions. Water transparency can reach a depth of 23 metres. Lake Superior has the lowest summer surface temperature (13 degrees Celsius) and mean annual water temperature (3.6 degrees Celsius) of the Great Lakes. The watershed contains many globally rare vegetation types, including arctic alpine communities, sand dunes, and pine barrens. The three principal industries are forestry, mining and tourism. The retention time for Lake Superior is 173 years; what goes into the lake affects it for several generations. Lake Superior has eight Areas of Concern (AOCs) as shown on the map (Figure 1).

CHEMICAL CONTAMINANTS

Over the last 30 years, concentrations of nearly all measured contaminants in fish and the water column, with the exception of toxaphene, have declined in Lake Superior. Because of its remote location, limited industrial activity and large surface to

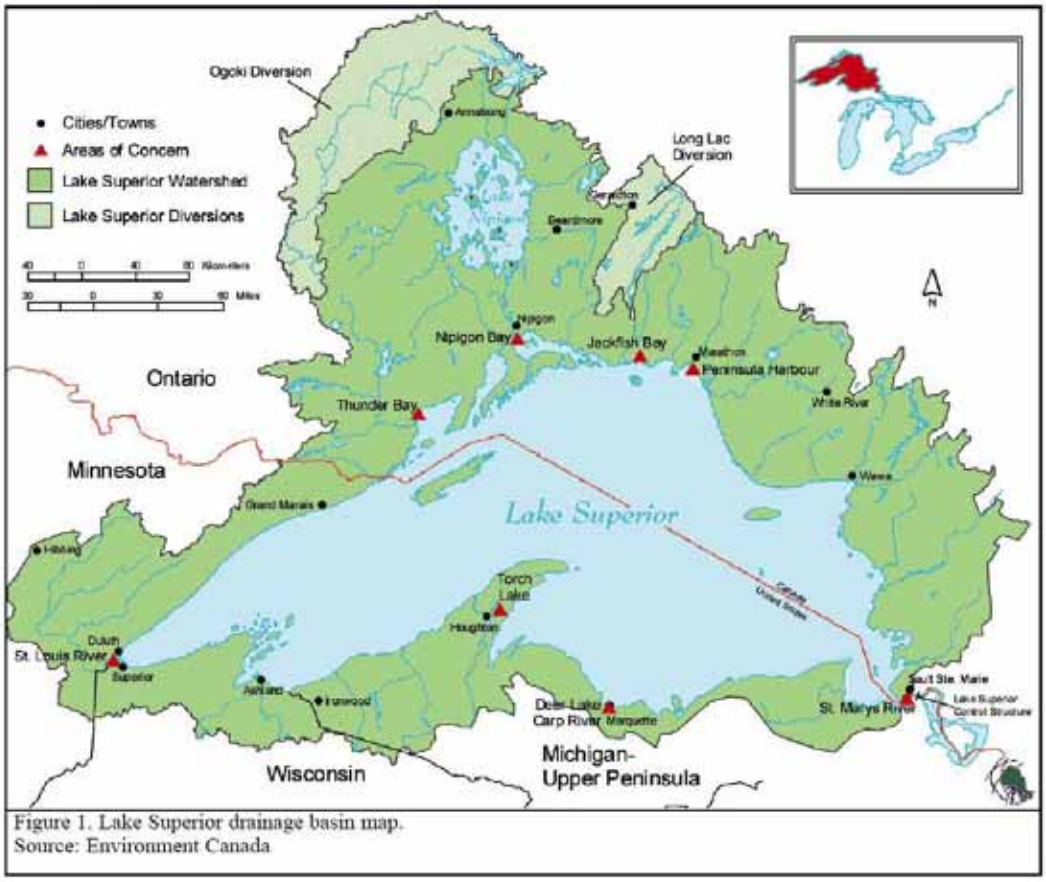

Figure 1. Lake Superior drainage basin map.
Source: Environment Canada

watershed ratio, Lake Superior receives the majority of its loading via atmospheric deposition, especially with regard to PCBs, mercury and toxaphene.

Figure 2 shows the mercury emission decreases that have occurred between 1990 and 2000. While significant reductions have occurred in products and mining, emissions from fuel combustion are virtually unchanged.

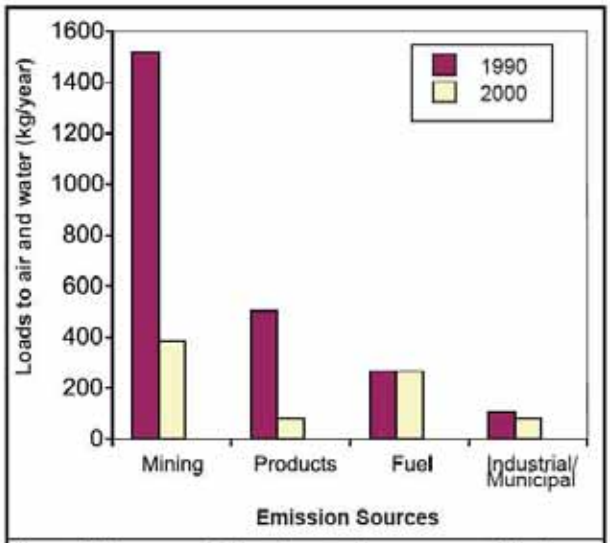

Figure 2. Mercury emissions from various sources within the Lake Superior basin.
Source: Lake Superior LaMP Chemical Committee, 2003

Water Column

Concentrations of a suite of toxic organic contaminants in water including the Lake Superior critical and lakewide remediation pollutants declined more than 50% between 1986 and 1997. Nevertheless, of the nine critical pollutants, dieldrin, mercury, PCBs and toxaphene concentrations in Lake Superior continue to exceed the most stringent water quality standards.

Gull Eggs

Herring Gull eggs have been collected and analyzed annually from the same two Lake Superior sites, Granite Island and Agawa Rocks, since 1974 for selected contaminants. Overall contaminant levels have declined. For the period 1974 to 2002, 64% of Lake Superior contaminant–colony comparisons declined as fast as or faster than they did earlier in the study, while 29% declined more slowly in recent years.

Data from 1974 to 2002 illustrates the decline in dieldrin in herring gull eggs at the Agawa rocks monitoring site. For most compounds, this site, which is in eastern Lake Superior, ranked low compared to other locations. The Granite Island site in western Lake Superior, however, ranked 3rd overall in the Great Lakes. For dieldrin and heptachlor epoxide, the two Lake Superior sites ranked the 4th and 3rd most contaminated of 15 sites studied, respectively, on the Great Lakes. For more information on contaminants in herring gull eggs, refer to the Great Lakes indicator report #115, Contaminants in Colonial Nesting Waterbirds, found later in this report.

Fish Contaminants

DDT data for lake trout collected by the U.S. Environmental Protection Agency–Great Lakes National Program Office (GLNPO) and Canada Department of Fisheries and Ocean (DFO) display a general fluctuation in concentrations from year–to–year with a recent increase in concentration. It is likely that this increase is due to a change in the sampling location rather than to an actual increase in contaminant concentration.

Concentrations of toxaphene have declined dramatically in lake trout across all Great Lakes except for Lake Superior. Lower productivity, colder temperatures and large surface area are likely responsible for higher Superior levels. Seventy–80% of Ontario's sport fish consumption advisories are due to toxaphene.

GLNPO lake trout collections show PCBs are fluctuating, although levels have dropped since 1980. The DFO lake trout data show very little recent change in mean PCB concentrations. Lake trout concentrations remain above the GLWQA criteria.

DFO smelt data continue to show a steady decline in mercury concentrations through 2002. While mercury levels are below GLWQA criteria, the trend data show continuing improvement in mercury levels for smelt. At every site monitored, mercury levels in lamprey were significantly greater than those detected in their primary prey. These data also demonstrate the significantly elevated mercury levels in lamprey from the Lake Superior system compared to other Great Lakes.

Figure 3 shows the trends for four of the Lake Superior critical chemicals. Dieldrin and chlordane appear to be leveling off. DDT appears to be increasing slightly and PCBs are fluctuating, as noted above. The number and geographic extent of sport fish consumption advisories in Lake Superior is expected to decrease as contaminant concentrations decline. However, the ecosystem requires decades to purify itself, and agencies will likely continue to issue sport fish advisories for some time.

Atmospheric Deposition

Data from the Great Lakes Integrated Atmospheric Deposition

STATE OF THE GREAT LAKES 2005

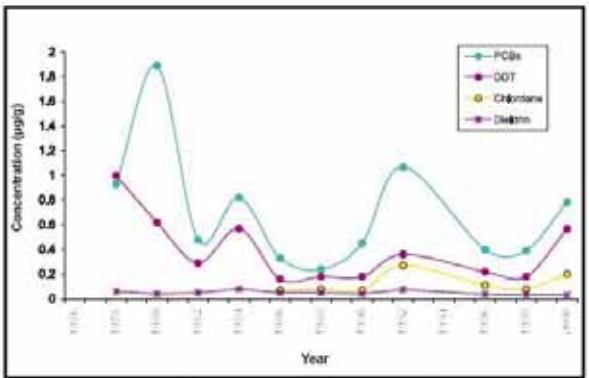

Figure 3. Apostle Island lake trout contamination trends, 1978-2000.
Source: Murphy, 2004

Network (IADN) indicate that levels of PCBs and banned organochlorine pesticides are declining at all master stations. For Lake Superior, the Duluth/Superior area appears to have some influence on PAHs and possibly HCB deposition to the lake. There is no apparent effect of this urban area on PCB deposition.

IADN data also suggest that the Canadian Prairie Provinces and the southern U.S. are sources of lindane to Lake Superior. PCB behavior in Lake Superior is unique with little storage in the sediments. Also there is little organic matter in the ecosystem to affect PCB levels. PCBs deposited into the lake are recycled into the food web via the plankton and also volatilized back into the atmosphere. Only 2–5% accumulates in bottom sediments.

Over many years, net volatilization of PCBs has released 26,000 kilograms to the atmosphere. Lake Superior was considered a PCB source but is now is at equilibrium with the atmosphere.

WILDLIFE AND HABITAT

Shoreline Development and Hardening

Shoreline development is one of the most pressing issues facing the Lake Superior basin today. The Keweenaw Peninsula on Michigan's Upper Peninsula has seen unprecedented housing growth in the past 20 years, mainly in recreational homes; over 50% of the homes in Keweenaw County are now classified as second homes. Population growth is greatest in the Duluth/Superior areas, Grand Marais and the Bayfield Peninsula. In Ontario, this population trend is greatest along the shorelines east and west of Thunder Bay and north of Sault Ste. Marie.

Shoreline hardening, which consists of sheet piling, riprap or other anthropogenic changes, is an increasing problem for Lake Superior. Although Lake Superior has the lowest percentage of shoreline hardening, the trend is increasing due to rapid growth of population in the areas previously mentioned (Figure 4).

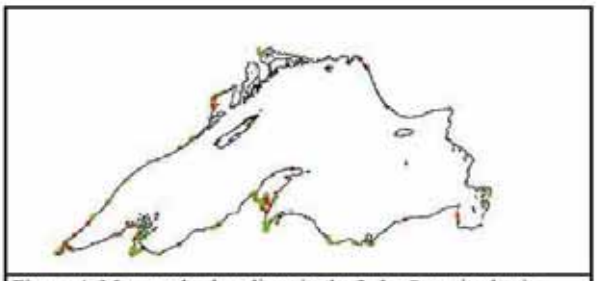

Figure 4. Man-made shorelines in the Lake Superior basin. Red circles represent riprap, sheet piling and other anthropogenic changes to the shoreline.
Source: U.S. Environmental Protection Agency, 1994 and Environment Canada, 1993

Forest

Forest fragmentation and changes in forest composition are two of the seminal changes to the Lake Superior basin since settlement times. Beginning in the 1880s, U.S. forests were almost entirely clear–cut. Aspen, birch, fir and poplar have increased since logging began while spruce and pines have been severely reduced. Forest cover is anticipated to remain the same or slightly increase in the future. Forest fragmentation of hardwoods will continue to increase due to development and including road construction. The Great Lakes Forestry Alliance reported in 1995 that timber growth in Michigan, Minnesota, and Wisconsin exceeded harvest by 90% and timber volume increased from about 700 million m^3 (25 billion ft^3) in 1952 to more than 14 billion m^3 (50 billion ft^2) in 1992.

Wetlands

About 15% of the U.S. Lake Superior basin and 6–25% of the Canadian basin are wetlands (Figure 5). The greatest threats to Lake Superior's wetlands are wetland draining and filling, toxic contamination, water level regulation and site–specific stresses such as shoreline development. Other threats include invasive species and diminished water quality. Although there have been many wetland restoration success stories, it is not possible to determine if there has been a net loss or gain of wetlands because of limitations on, and lack of coordination among, current monitoring efforts. Monitoring, use of Best Management Practices and remedial actions are necessary to completely address the wetland issue.

Loss of wetland habitat has been small in some counties but most of the St. Louis River estuary wetlands at Duluth have been lost since the early 1900s. The wetlands of the Apostle Islands, Bad River and Kakagon Slough are largely intact.

There are no comprehensive estimates of coastal wetland losses for Lake Superior. Wetland loss in Ontario is low (0–25%) for most of the basin, but locally, wetland losses have been reported in the Thunder Bay and St. Marys River AOCs due to shoreline modification and urban encroachment. Wetland area around Thunder Bay has declined by over 30% since European settlement.

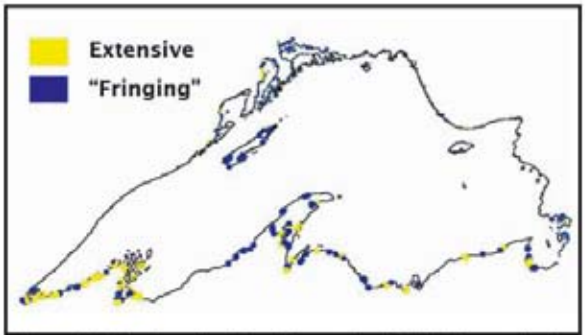

Figure 5. Lake Superior shoreline wetlands. Fringing wetlands are marsh communities, characteristically found in shallow water coves protected from wind and waves. They closely border the shore to form a narrow belt of aquatic vegetation. Extensive wetlands are larger (up to 1 to 2 km long) and occupy shallow coves with stream outlets.
Source: U.S. Environmental Protection Agency, 1994 and Environment Canada, 1993

Lake Superior shoreline wetlands are a particular concern in Ontario, given their scarcity and proximity to developed areas. The potential for further development at Cloud Bay, Sturgeon Bay and Pine Bay threatens wetlands.

Wildlife

Habitat changes on the landscape, as well as harvest and management of select species, have created some dramatic changes in wildlife communities over the past 150 years. Ungulates, wolves and furbearers were hunted to near extinction but are now rebounding.

Successful reintroduction of peregrine falcons is also underway within the basin. Cormorants and herring gulls are recovering after being decimated by toxic contaminants in the 1970s.

Caribou in Canada and Canada lynx in the U.S. are still scarce although recovery planning is underway for these and a number of other species at risk in the basin, i.e. piping plover and wood turtle.

Eighteen animal species found in the Lake Superior watershed, including mammals, birds, insects and herptiles, are listed by Canada and/or the U.S. as endangered. In addition, there are 400 species in the basin listed by provincial or state jurisdictions as endangered, threatened, or of special concern. Of the 400 species, nearly 300 are plants. The preparation of recovery plans or conservation strategies is underway for 26 species.

Little work has been done to monitor and classify the status of amphibians and reptiles in comparison to other vertebrates, although the planning of a basin–wide monitoring program for herptiles is underway. Thirty–seven species of reptiles and amphibians have been documented including seven salamanders, 12 frogs, six turtles, two lizards and one snake. As with many vertebrates, the widespread changes in habitat cover across the landscape have had a dramatic effect on the community composition of amphibians and reptiles. However, local population declines of many amphibians (Table 1) are becoming a concern worldwide. Many possible reasons exist for these declines; monitoring programs are being initiated to document trends.

Species	Relatively Stable	Increasing	Decreasing	State Endangered	Special Concern	No Trend Data Available
Wood frog	●	■				
Northern leopard frog	●		●■			
Pickerel frog			■			
Mink frog						●■
Green frog	●■					
Chorus frog	■					
Northern spring peeper	●		■			
Eastern gray treefrog	●■					
Copé's gray treefrog			■			
Blanchard's cricket frog					●	
American toad	●■					
Blue-spotted salamander	●■					
Eastern tiger salamander			●			
Spotted salamander	■					
Four-toed salamander					■	
Redback salamander	●					
Mudpuppy						●■

■ Wisconsin ● Minnesota

Table 1. Status of amphibian species found in the Lake Superior basin in the states of Minnesota and Wisconsin.
Source: Casper, 1998, Moriarty 1998, and Mossman *et al.*, 1998

Aquatic Communities

The fish community of Lake Superior is generally good and remains relatively intact compared to the other Great Lakes. Through rehabilitation, lake trout stocks have increased substantially and may be approaching ancestral states. Although the siscowet shows high levels of toxic contaminants, this has not interfered with reproduction (Figure 6). There are more naturally reproducing lake trout in Lake Superior than there are in all the other Great Lakes combined. These trout are reproducing on their own with very little management needed. There are good stocks of whitefish and herring.

Natural reproduction supports most salmonid populations. Some

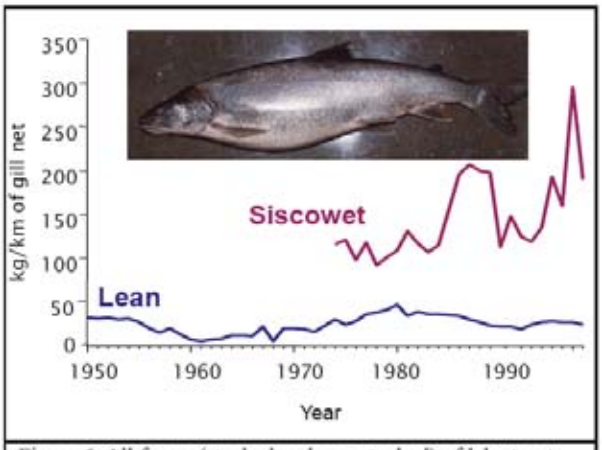

Figure 6. All forms (stocked and non-stocked) of lake trout abundance, 1950-1998.
Source: Great Lakes Fishery Commission

near shore fish populations, especially lake sturgeon, walleye and brook trout, remain below historical levels. Non–native species continue to be introduced to Lake Superior, although the fish community appears to contain enough buffering capacity to withstand and minimize the current levels of non–native species. Sea lampreys still kill thousands of lake trout each year. Round gobies and ruffe have colonized some areas and have the ability to negatively impact the near shore cool–water fish community.

Aquatic Habitat

Nearshore and open water habitat is very good, leading to abundance of trout, and good stocks of whitefish and herring. The problem is mostly in the tributaries and embayments, especially in the Areas of Concern. Lake Superior tributaries have borne the brunt of most of the habitat destruction and loss. These tributaries remain significantly degraded by such stressors as agriculture, mining, hydroelectric dams, industrial effluents and waste, wetland dredging and filling, non–point source pollution, shoreline development and use practices that lead to increased runoff and erosion. There is now naturally reproducing sturgeon, walleye and brook trout. Although the habitat is sufficient to help them increase in abundance, populations are not near historic levels because of past habitat destruction. All three species have active rehabilitation programs and resource management activities.

Invasive Species

Except for sea lamprey, the non–native species in Lake Superior have been manageable up to this point. Lake Superior, however, has the highest ratio of non–native species to native species of all the Great Lakes. Lake Superior represents the dead–end for shipping for many invasive species as it is at the end of the

Lake Superior Statistics	
Elevation[a]	
feet	600
metres	183
Length	
miles	350
kilometres	563
Breadth	
miles	160
kilometres	257
Average Depth[a]	
feet	483
metres	147
Maximum Depth[a]	
feet	1,332
metres	406
Volume[a]	
cu.mi.	2,900
km^3	12,100
Water Area	
sq.mi.	31,700
km^2	82,100
Land Drainage Area	
sq.mi.	49,300
km^2	127,700
Total Area	
sq.mi	81,000
km^2	209,800
Shoreline Length[b]	
miles	2,726
kilometres	4,385
Retention Time	
years	173
Population: USA (2000)[c]	663,606
Population: Canada (2001)	178,656
Totals	842,262
Outlet	St. Marys River

[a] measured at low water datum
[b] including islands
[c] 2000 population census data were calculated based on the total population of each county, either completely or partially, located within the watershed.

Sources:
The Great Lakes: An Environmental Atlas and Resource Book

Statistics Canada, Environment Accounts and Statistics Division, Spatial Environmental Information System and Censuses of Population 2001

U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, 2000 Census of Population and Housing, 1990 Census of Population and Housing

lakes. There is nothing to make us think that Lake Superior will not have its own singular invasive species problem (i.e., such as zebra mussels in the lower lakes) and, unless we do something fairly proactive fairly soon, we could have a significant problem on our hands.

Numerous invasive insect, animal and plant species have been also introduced to the Lake Superior basin. A few examples of species likely to have significant impacts include: gypsy moth, Asian long–horned beetle, rusty crayfish and exotic buckthorns. One of the most potentially devastating invasive species is the emerald ash borer. Now located in Lower Michigan and Ontario, it remains outside the Lake Superior basin for now. There is no known natural control or treatment at this time, so it could potentially devastate inland and coastal wetland ecosystems that may contain large areas of ash trees.

Future and Emerging Management Issues

Lake Superior has many existing pressures on its system which will continue to pose problems now and in the future including: continued degradation of tributary and embayment aquatic habitat, shoreline and other habitat development, continued introduction and impacts of non–native species, and continued release and deposition of critical pollutants.

Positive action is now occurring in the Lake Superior basin. The U.S. and Canadian governments have recently reaffirmed their commitment to the Zero Discharge Demonstration Program. The Lake Superior cooperative monitoring program has been working to develop priorities for the 2005–2006 Lake Superior monitoring year. Many habitat inventory, assessment and monitoring programs are being implemented. Rehabilitation of critical aquatic habitats is underway and several wildlife and fish species have been restored.

Global warming, climate change, increasing water temperature, large–scale water export, other chemicals of emerging concern (such as pharmaceuticals and personal health products), and newly proposed or expanded industrial facilities are other critical issues that will require attention now and in the future.

Acknowledgments/Sources of Information

Casper, G.S., Moriarty, J.J., Mossman, M.J., et al. 1998. Status and conservation of midwestern amphibians. In University of Iowa Press, ed. M.J. Lannoo, pp. 507. Iowa City, IA.

Ebener, M.P. (ed.). 2005. The state of Lake Superior in 2000. Great Lakes Fishery Commission Special Publication. http://www.glfc.org/lakecom/lsc/stateofsuperior/index.htm, last accessed June 9, 2005.

Environment Canada. 1993. Environmental Sensitivity Atlas for Lake Superior's Canadian Shoreline, Conservation and Protection Branch.

Lake Superior Lakewide Management Plan (LaMP) Chemical Committee, 2003.

Murphy, Elizabeth. 2004. U.S. Environmental Protection Agency, Great Lakes Fish Monitoring Program, Great Lakes National Program Office. Chicago, IL.

SOLEC 2004 Presentations, Toronto, Ontario. 2004. Lake Superior. http://www.epa.gov/solec/solec_2004/presentations/index.html, last accessed June 8, 2005.

U.S. Environmental Protection Agency. 1994. Inland Spill Response Mapping Project, Digital Database.

U.S. Environmental Protection Agency. 2004. Lake Superior Lakewide Management Plan (LaMP) 2004. http://epa.gov/glnpo/lakesuperior/2004/, last accessed June 8, 2005.