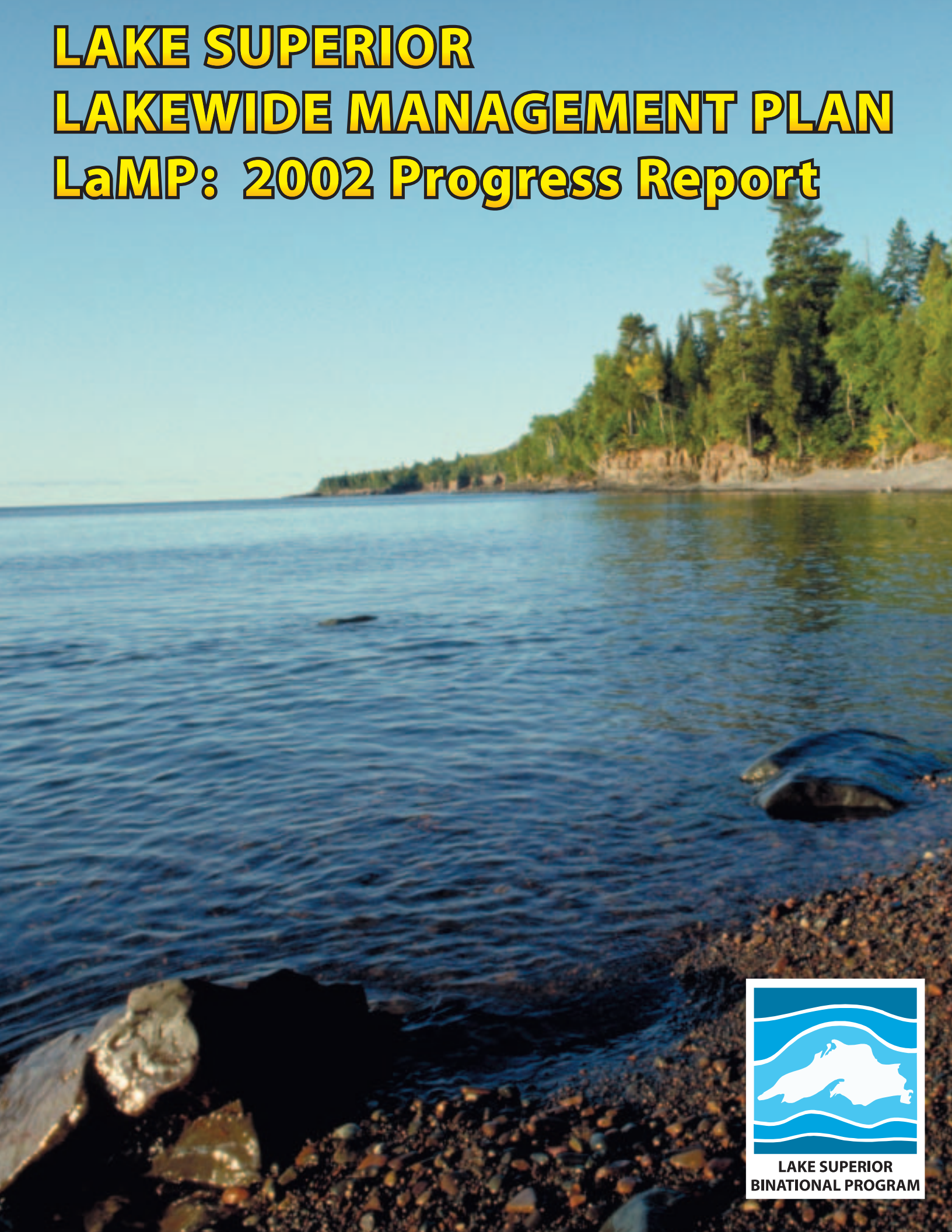
LAKE SUPERIOR LAKEWIDE MANAGEMENT PLAN LaMP: 2002 Progress Report



LAKE SUPERIOR BINATIONAL PROGRAM

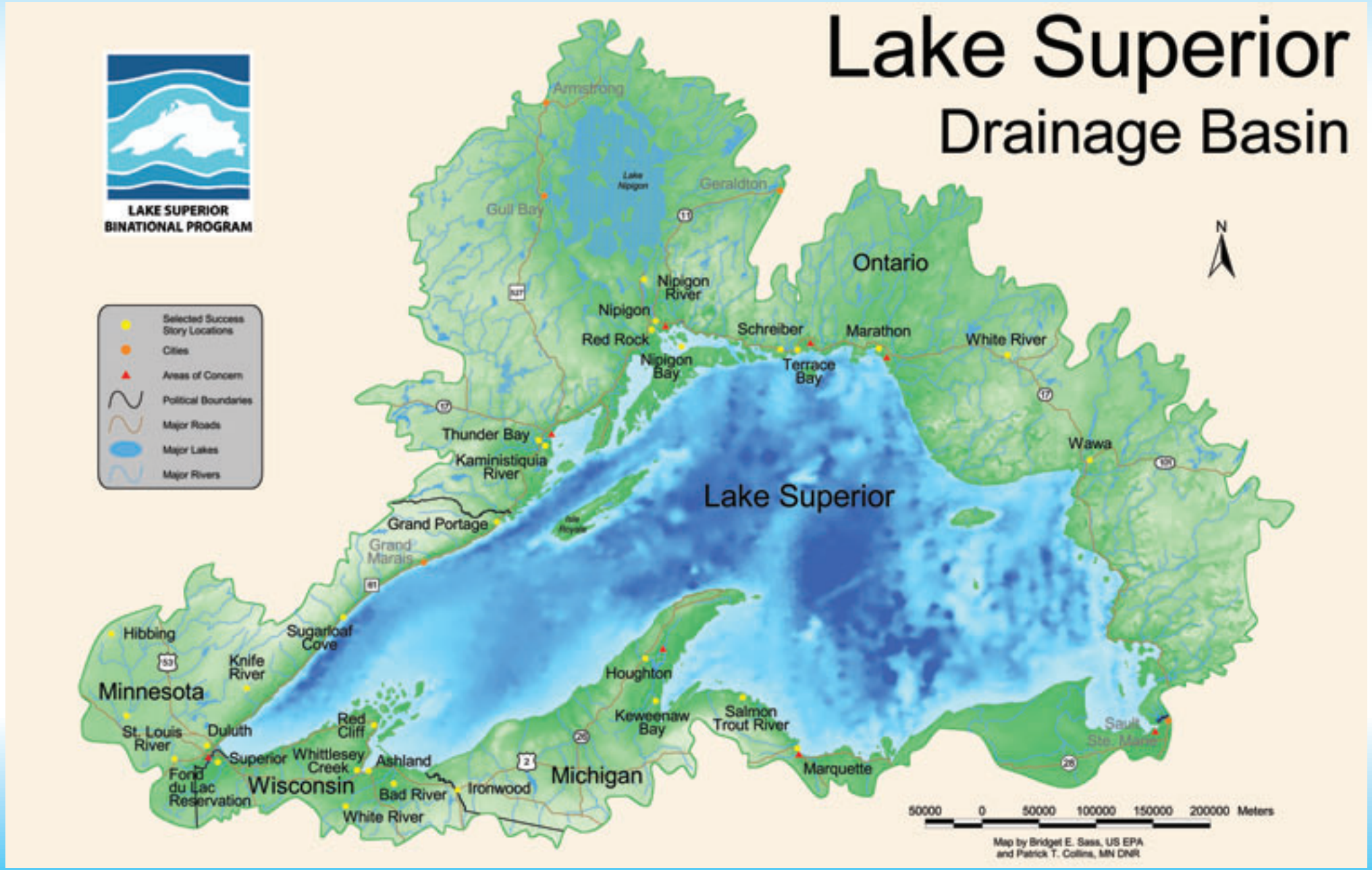
Front cover photo: North Shore Beach of Lake Superior
Photograph by Dave Hansen,
Minnesota Extension Service

LAKE SUPERIOR
LAKEWIDE MANAGEMENT PLAN
LaMP: 2002 Progress Report

April 2002

prepared by the Lake Superior Work Group
Lake Superior Binational Program

Aussi disponible en Français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Photograph by Don Breneman

A Vision for Lake Superior

Endorsed by the Lake Superior Binational Forum on January 31, 1992, as an expression of the hearts and minds of all of us.

Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

As citizens of Lake Superior, we believe...

that water is life and the quality of water determines the quality of life.

We seek a Lake Superior watershed...

that is a clean, safe environment where diverse life forms exist in harmony; where the environment can support and sustain economic development and where the citizens are committed to regional cooperation and a personal philosophy of stewardship;

that is free of toxic substances that threaten fish, wildlife and human health; where people can drink the water or eat the fish anywhere in the lake without restrictions;

where wild shorelines and islands are maintained and where development is well planned, visually pleasing, biologically sound, and conducted in an environmentally benign manner;

which recognizes that environmental integrity provides the foundation for a healthy economy and that the ingenuity which results from clean, innovative and preventive management and technology can provide for economic transformation of the region;

where citizens accept the personal responsibility and challenge of pollution prevention in their own lives and lifestyles and are committed to moving from a consumer society to a conserver society; and

where there is greater cooperation, leadership and responsibility among citizens of the basin for defining long term policies and procedures which will protect the quality and supply of water in Lake Superior for future generations.

We believe that by effectively addressing the issues of multiple resource management in Lake Superior, the world's largest lake can serve as a worldwide model for resource management.

Section 1

The Lake Superior LaMP: 2002 Progress Report

Photograph by Steven Hanson

Introduction

Breathtaking, rocky cliffs towering over shimmering, aquamarine waters…hidden, mysterious coves protecting an astonishing array of terrestrial and aquatic habitat…deep, crystal-clear, frigid waters silently guarding the final resting place for more than 350 shipwrecked vessels…. These are some of the images evoked by the "greatest" of the Great Lakes-Lake Superior, or as the Ojibwe people named it, "Gichigami."

Yet there is a less pleasing side to what appears to be a beautiful and pristine Lake Superior basin. A history of industrial pollution, population growth beyond urban areas, development of rural and waterfront vacation properties without proper planning and regulation, and continuing deposition of contaminants from the air mean that Lake Superior is not immune from human influence. This influence has long-term implications because water that enters Lake Superior stays in the lake for an average of 173 years before it exits through the St. Marys River. Consequently, in 2002, we must still be vigilant stewards as we try to preserve a lake that contains fully 10 percent of the available fresh water on Earth.

Several binational and national programs have been developed to protect, restore, and maintain the Lake Superior ecosystem. Foremost among them is the Great Lakes Water Quality Agreement (GLWQA), which has been hailed as a seminal example of international environmental cooperation. The 1978 GLWQA between the United States and Canada commits the governments to "restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem."

Chapel Rock - Pictured Rocks National Lakeshore
Photograph courtesy of Michigan Travel Bureau

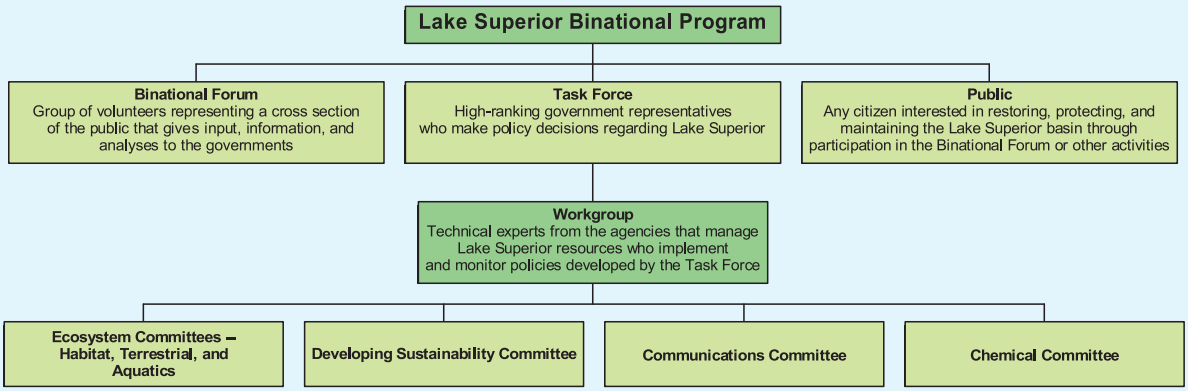
To achieve that goal, the "Binational Program to Restore and Protect Lake Superior" was created in 1991. The Binational Program represents a partnership of federal, state, provincial, and Tribal/First Nation governments working together with citizens to ensure the protection of this international treasure. In 2001, the Binational Program celebrated ten years of progress

What is the Lake Superior Binational Program?

To preserve the unique and pristine nature of the Lake Superior ecosystem, the Binational Program was signed by the Canadian and U.S. federal governments; the Province of Ontario; and the States of Michigan, Minnesota, and Wisconsin. The program identified two major areas of study:

- Zero Discharge Demonstration Program (ZDDP) - a singularly unique program in the world dedicated to achieving zero discharge or emission of nine persistent, bioaccumulative, toxic substances into the Lake Superior basin
- The "Broader Program" focusing on the protection and restoration of the Lake Superior basin ecosystem

Organization of the Binational Program



toward achieving its goals of zero discharge of critical pollutants and protecting and restoring the ecosystem.

Lakewide Management Plan 2000

To accomplish the goals of the GLWQA and the Binational Program and to address the challenges remaining for the basin, a Lake Superior Lakewide Management Plan (LaMP) was developed, to lay out a strategic, action-focused management plan for restoring and protecting the ecosystem. The LaMP focuses on collaborative ecosystem management and partnership activities targeted at zero discharge of nine critical pollutants, protecting and restoring high-quality habitat, and sustaining high-quality terrestrial and aquatic communities. This extensive compilation of scientific information and environmental action plans for Lake Superior and its watershed was released in April 2000.

LaMP 2000 focused on six discrete issue areas, setting goals for each:

- **Critical pollutants:** achieve zero discharge of nine persistent toxic chemicals by 2020
- **Habitat:** protect, maintain, and restore high-quality habitat in the basin
- **Terrestrial wildlife communities:** sustain diverse, healthy wildlife communities
- **Aquatic communities:** sustain diverse, healthy aquatic communities
- **Human health:** define and reduce the risk to people from environmental contaminants

Binational Forum Accomplishments

The Binational Forum has not only provided valuable public input for LaMP development, but it has also made direct contributions to the plan's implementation. Forum efforts to date are identified below.

- Developed load reduction targets for zero discharge
- Provided mini-grants to community groups for outreach activities
- Provided input to the development of ecosystem principles and objectives for "Indicators and Targets for Lake Superior"
- Conducted a community development organization survey
- Provided the Lake Superior Magazine Achievement Award
- Developed a report on basin attitudes toward pollution prevention and zero discharge
- Provided information to governments from a wide variety of input on binational issues

- **Sustainability:** cultivate a society in which humans use but do not degrade the basin's natural resources

LaMP 2000: Accomplishments and Challenges

LaMP 2000 identified 348 priority projects as necessary to help achieve the LaMP goals. To date, 175 projects have been funded, and 173 projects still require funding. Thus, since April 2000, roughly 50 percent of the LaMP's priority projects have been initiated, representing significant progress on the part of the Binational Program toward achieving the LaMP 2000 goals. The remaining projects have not yet been funded primarily because of lack of personnel and financial resources. For more information on the 348 priority projects, please visit the Great Lakes Commitment Tracking Database at *http://www.epa.gov/glnpo/lakes.html.*

Each section in this LaMP progress report highlights specific successes as well as challenges. Below are some of the general highlights of our accomplishments in protecting and restoring the Lake Superior basin.

- A continuing decrease in concentrations of targeted critical pollutants in Lake Superior; the year 2000 goal of reducing mercury emissions by 60 percent has been met.
- Almost complete restoration of the lake trout population to historical levels; the lake trout population had significantly declined in Lake Superior.
- Continued collection of banned or cancelled pesticides through the federally and state-funded "Clean Sweep" programs; these programs have prevented tons of pesticides from being released into the Great Lakes ecosystem.
- Protection of 29,000 acres of land along the St. Louis River and its tributaries in Wisconsin and Minnesota.
- Implementation of a mercury collection and recycling project on the Canadian north shore that has participation from industry, municipalities, and citizens.
- The awarding of grants from the U.S. Environmental Protection Agency's (U.S. EPA) Great Lakes National Program Office (GLNPO) to fund the Western Lake Superior Sanitary District in Duluth, Minnesota, to work with its customers to find alternative products and processes to considerably reduce mercury in wastewater discharges; this pollution prevention approach has been adopted in other areas (such as Marquette, Michigan) as a blueprint for elimination of mercury.
- Support for a watershed-scale geographic information system (GIS) across the Lake Superior basin; this is a practical tool that researchers and decision-makers can apply to support local land and resource decisions.
- Integration of land use planning across jurisdictions, such as in the Whittlesey Creek Refuge in northern Wisconsin.
- A joint Task Force, Workgroup, and Forum meeting at which four priority focus areas were identified for further discussion: mercury retirement from the marketplace, human health, burn barrels, and customized outreach on local land use planning.

Despite these and other successes, challenges remain for the Lake Superior basin, including

- A continuing need for fish advisories
- Continuing releases of mercury from coal-burning electric utilities and taconite mines
- Waste disposal practices that lead to mercury and dioxin contamination
- Continuing use of polychlorinated biphenyl (PCB)-bearing transformers and capacitors
- Poor land use practices that threaten water- and land-based habitats
- The introduction and spread of exotic terrestrial and aquatic species that threaten native plants and animals
- Insufficient resources to implement top-priority commitments of LaMP 2000, including cleanup and restoration of all the Lake Superior AOCs

Public Comments on LaMP 2000

Although public reaction to LaMP 2000 was generally very positive, public comments contained a number of suggestions:

- The LaMP should eliminate the artificial distinctions between habitat, terrestrial wildlife communities, and aquatic communities and take a broader ecosystem approach, recognizing the interaction of land, water, and air with all living things.
- The LaMP should place greater emphasis on the sustainability of the ecosystem. Sustainability is an overarching concept that is key to successful attainment of LaMP goals; social and economic factors should not take precedence over the need for a healthy environment.
- The LaMP should place greater emphasis on public education, as it is one of the most important factors in the success or failure of the restoration of the Lake Superior ecosystem.

A summary of the comments received on LaMP 2000 and the responses to those comments will be available on the Lake Superior web site at http://www.epa.gov/glnpo/lakesuperior.

The LaMP 2002 Progress Report

Federal, state, provincial, and Tribal/First Nation governments have committed to updating the LaMP every two years in order to mark progress and to highlight achievements in restoring and protecting the Lake Superior ecosystem. This document reports on the progress made over the past two years in achieving the actions and goals outlined in LaMP 2000. It also discusses priorities and strategic directions, highlighting the principal ecosystem threats to the Lake Superior basin. In addition, the report discusses immediate next steps for action and emphasizes issues that have emerged as important themes of the LaMP, such as sustainable management of the Lake Superior basin.

The LaMP 2002 progress report is not an update of the 1,000-page technical document prepared in 2000-the various Lake Superior Workgroup committees are updating the LaMP 2000 technical document on an as-needed basis. This progress report is designed to be more reader-and user-friendly for use by local, state, provincial, Tribal/First Nations and federal decision?makers.

Contents of the Progress Report

This report is organized in six sections. Section 2 discusses the status of sustainability in the Lake Superior basin, and Section 3 reports on critical pollutants, including the progress of the ZDDP and the impact of air deposition on the lake. Section 4 describes progress made in restoring and protecting the ecosystem components of Lake Superior, including open lake and near-shore waters, wetlands, uplands, and inland lakes and tributaries. Section 5 describes integration efforts between the LaMP and other Great Lakes programs. Finally, Section 6 outlines the next steps in the LaMP implementation process. Only a continued, sustained, and dedicated effort by the residents, governments, and Tribes/First Nations of the basin will enable us to protect, restore, and maintain the Lake Superior ecosystem.

Areas of Concern

The GLWQA amendments of 1987 called for development of Remedial Action Plans (RAPs) for designated Areas of Concern (AOCs) around the Great Lakes basin. These AOCs are areas of severe environmental degradation and thus have been singled out for high-priority attention. There are eight AOCs in the Lake Superior basin: four in Canada, three in the United States, and one shared between the two countries. An update on the status of the AOCs can be found in Appendix A and on the web at *http://www.epa.gov/glnpo/aoc*.

Photograph courtesy of the Ontario Ministry of the Environment

Lake Superior Pakaskwa National Park, Ontario
Photograph by Robert F. Beltran

Lake Superior Sustainability Progress Report

Accomplishments:

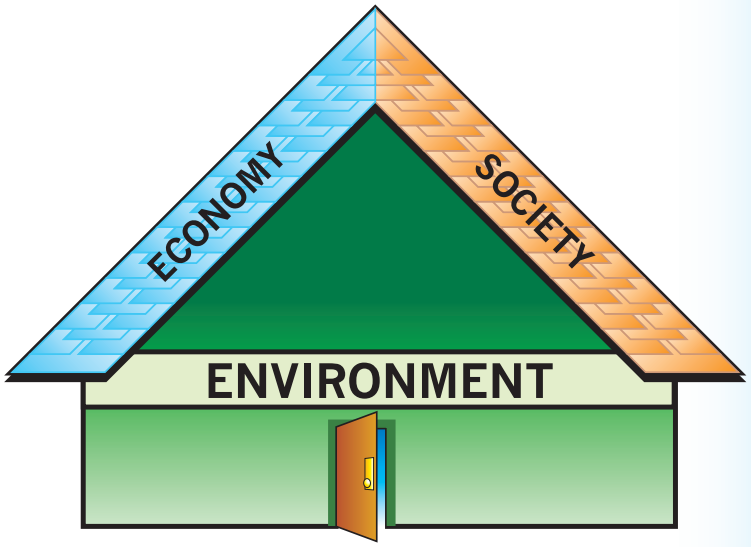
1. The Developing Sustainability Committee completed the Baseline Sustainability Indicators Project-Phase I
2. U.S. EPA/GLNPO awarded a grant for Phase II of Baseline Sustainability Indicators Project in 2001; project is underway
3. Governments are helping to facilitate mercury reduction in the U.S. portion of the Lake Superior basin, modeling efforts on the Canadian thermostat and fluorescent light recycling programs
4. The Lake Superior Binational Program hosted a workshop designed to bring together experts in the fields of ecological and social assessment in order to identify the best ways to monitor the current status of the regional ecosystem
5. The Lake Superior Forum developed a report on basin attitudes toward pollution prevention and zero discharge

Challenges/Next Steps:

1. Inadequate funding to survey the educational opportunities for, existing knowledge of, and attitudes toward sustainability practices in the Lake Superior communities
2. Need for better communication of what sustainability means in real terms to the Lake Superior basin and to the Great Lakes community at large
3. Need for Lake Superior committees to develop their own sustainability initiatives

Section 2:

Building a Sustainable Lake Superior Ecosystem



Sustainability

Environmental programs have historically been reactive in nature - that is, they have primarily been designed to clean up existing contamination problems and address environmental mismanagement. To foster a more productive future, we need to revise our approach to environmental management in order to promote sustainability. This approach involves being proactive in pursuing a balance among the environment, the economy, and social activities as a long-term goal. Lake Superior contaminants and habitat loss will still need to be addressed, but the LaMP also promotes activities to transition to a more sustainable future for the basin.

As an illustration of the necessity for sustainability, the environment, the economy, and society form a triangle whose sides are mutually supportive, as with the roof on a house. The environment's role in relation to the economy and society is similar to that of the beam holding up the roof-if the economy or society places too much of a weight burden on the environmental beam that supports them, the beam could bend, crack, or collapse altogether.

The interrelationship among our environment, economy, and society contradicts the argument that there is always a trade-off between jobs and the environment - that if jobs are created, the environment will suffer harm, or conversely, that if the environment is protected, it necessarily causes unemployment and makes job creation more difficult. Investing in the environment enhances long-term economic and social strength because it is more expensive, both economically and socially, to repair environmental damage in the future than to invest in technologies and practices that prevent such damage today.

Realizing Sustainability

The governments and residents of the Lake Superior basin have taken initial steps toward making the basin sustainable, but more needs to be done. For example, further work must be done on the sustainability indicators discussed below and their measurement so that decision-makers and the public can obtain better information when making broad policy and individual choices and when making decisions about their environment and their lives.

Although the information currently available is limited, strategies are available for pursuing sustainability. Some of these strategies include

- Developing better transportation alternatives
- Developing recycling programs and attracting industries that use recycled material
- Aggressively controlling exotic species by reducing their populations and preventing introduction of new species
- Developing alternative energy sources such as wind power, fuel cells, and other innovative technologies

- Pursuing business and economic development strategies that encourage pollution prevention
- Developing effective worker training programs for existing and new industries that develop the skills and address the technologies required for pollution prevention
- Cleaning up contaminated sites so they can be used more effectively

These are important first steps in building a society in the Lake Superior basin that can sustain itself, the economy, and the natural environment.

The Impacts of Unsustainable Activities

Areas of Concern, the most polluted sites in the Great Lakes basin, show what happens when human activities overwhelm the environment's ability to sustain those activities. Over decades, these sites, eight of which are in the Lake Superior basin, have been polluted by releases from industrial activity and contaminated runoff. They remain contaminated, threatening environmental and human health as well as limiting current and future environmental, recreational, and economic activities in these areas. It could cost tens of millions of dollars to clean up the AOCs, whereas the overall costs to the economy and society would have been much lower had the industrial pollution been prevented in the first place.

Potentially unsustainable activities are not conducted by large, industrial polluters alone. Individual land use choices can either support or undermine sustainability in a given area. For example, construction of vacation homes is significantly changing the natural landscape of the Lake Superior shoreline, which is threatened by uncoordinated and potentially unsustainable growth. Better planning could lessen these threats to the environment while allowing people to continue their enjoyment of the lake.

It should be noted that there are areas where efforts toward building sustainability are working. For example, the southern portion of the Lake Superior basin, once the site of wholesale clear-cutting of forests, now boasts tree replacement programs under which tree planting exceeds harvesting. Currently there are more challenges than success stories, but sustainability opportunities abound in the basin.

Sustainability Indicators and Trends

A major step in restoring and protecting the Lake Superior basin -- and the only way to gauge progress -- is to identify indicators against which efforts in the region can be measured. The Lake Superior Binational Program hosted a workshop designed to bring together experts in the fields of ecological and social assessment in order to identify the best ways to monitor the current status of the regional ecosystem. The workshop resulted in development of the following indicators that can be used to assess how fully the Binational Program's Vision Statement is being realized: "Reinvestment in Natural Capital," "Quality of

Source: Environment Canada

Sustainability Principles

To better manage the relationship among nature, the economy, and society in the Lake Superior basin, the LaMP process embraces five general principles to assist in achieving a sustainable Lake Superior:

1. **Adaptability.** Economic growth and social development should continually adapt to the natural cycles of the environment through decision-making based on the best scientific understanding of how technology, economics, and society affect the sustainability of the ecosystem.
2. **Equity.** No group in the basin should bear an inequitable burden in adapting to the natural cycles of the environment. Decisions based on "sound science" should also consider the social ramifications of choosing one action over another to ensure that all members of the basin community are taken into account.
3. **Knowledge.** Education, more than regulation, is a cornerstone in the process of bringing human activities and the natural cycles of the environment into balance because sustainability depends on citizens understanding that diversity of life and high-quality habitat are essential to their own quality of life.
4. **Unity.** The basin is a system of interconnected environmental, economic, and social systems. Thus, planning must be done in accordance with the cycles of the natural environment by looking at the "big picture" and how individual decisions impact other areas of the basin and its environment, economy, and society as a whole.
5. **Limits.** The environment has a finite capacity to replenish natural capital and absorb waste. Science does not yet provide the information needed to identify the exact balance among the natural environment, the economy, and society. Consequently, various ecosystem indicators, including indicators focusing on social and economic elements, are used to better estimate environmental impacts relative to this capacity.

Human Life," "Resource Consumption Patterns," "Economic Vitality," and "Awareness of Capacity for Sustainability" (see the "Lake Superior Binational Monitoring Workshop Proceedings: Directions for Measuring Progress" at http://www.epa.gov/glnpo/lakesuperior/binatmonwkshp.pdf).

To assess the ability to measure the indicators, researchers completed an initial study that relied on data generated by various agencies at sporadic intervals (see the "Baseline Sustainability Indicators" report at http://emmap.mtu.edu/gem/community/planning/lsb.html). Although it is somewhat incomplete, this "snapshot" of regional ecosystem management in the Lake Superior basin is instructive of the trends that are occurring in the basin.

Currently, the Developing Sustainability Committee of the Superior LaMP Workgroup is building on the initial study to capture a wider range of land use indicators addressing the social dimensions of sustainability, especially those associated with the State of the Lakes Ecosystem Conference (SOLEC). The second phase of work, which is supported by a grant from U.S. EPA/GLNPO, is being conducted by Michigan Technological University and focuses on the relationships among land use planning, citizen groups, and local units of government.

Use of indicators allows us to develop a "report card" for how well we are meeting our general objectives for the basin. For example, the indicators discussed below help us to assess the extent to which we are realizing the Vision Statement for Lake Superior by examining how resources are being used or valued and the physical and social patterns and stressors that affect the environment.

Reinvestment in Natural Capital

"Natural capital" refers to the value of the environment in terms of the goods and services that it provides. A primary goal in managing natural capital is ensuring that consumption of natural resources does not deplete environmental "principal," thereby saving needed resources for the future. To date, researchers have gathered data only on the status of forestry practices, exotic species control, and native fisheries as components of natural capital.

Forestry[1]

- Michigan, Minnesota, and Wisconsin have a number of programs to encourage sustainable forestry, and voluntary compliance with those programs seems to be growing. For example, the Great Lakes Forestry Alliance reported in 1995 that timber growth in Michigan, Minnesota, and Wisconsin exceeded the harvest by 90 percent and that timber volume increased from about 25 billion cubic feet in 1952 to more than 50 billion cubic feet in 1992.
- In the United States, 51.5 million acres of forested land are present in the Lake Superior basin, of which 3.2 million acres are either reserved as parks and wilderness or classified as unproductive. Of the productive land, 26 million acres are nonindustrial, private forest; 18 million acres are publicly owned; and 4 million acres are owned by forest product companies.
- In Ontario, forest sustainability is a legal requirement for Crown (public) land. Because most of the Ontario portion of the Lake Superior watershed is Crown land, a determination of forest sustainability is required in every forest management plan developed for this region. Ontario is implementing sustainable forest harvesting practices, including practices that attempt to emulate natural forest landscape disturbance patterns.

Exotic Species

- The numbers and populations of exotic species in the basin are increasing.
- Actions are being taken on the state, provincial, regional, national, and international government levels to combat these species.
- For example, the State of Michigan passed a law in 2001 that requires ocean-going and non-ocean-going ships on the Great Lakes to report their use of best management practices for control of aquatic nuisance species in ship ballast water. This law also requires the Michigan Department of Environmental Quality (MDEQ) to post lists of ships that use best management practices proposed by shipping associations and to test ballast water treatment methods.

Forest Sustainability: Criteria and Indicators

The U.S. Forest Service has chartered a project to work with individual National Forests in order to develop a forest-level (local unit criteria and indicator development or LUCID) sustainability and monitoring program that would be used to monitor and improve forest management, enhance collaboration between National Forests and other government agencies, and monitor the sustainability of national forest management. The criteria and indicators (C&I) concept provides a way to monitor and assess ecological, social, and economic sustainability.

The LUCID project has been guided by five objectives:

- Test, develop, modify, and evaluate C&I to assess the sustainability of ecological, economic, and social systems at the forest level
- Develop analysis methods that establish relationships between indicators and combine the results for the purposes of sustainability reporting
- Evaluate the relationships between national- and forest-level indicators
- Develop a research agenda to further understanding and application of forest-level C&I
- Develop a strategy to implement forest-level C&I throughout the U.S. Forest Service

Six interdisciplinary National Forest teams working on eight National Forests around the country have been active in the project, including the Ottawa National Forest in the Lake Superior basin. The teams have been working collaboratively to develop a forest-level sustainability and monitoring program that includes

- Review of a preliminary set of C&I to develop forest level-specific criteria, indicators, measures, and reference values for each forest
- Application of these C&I in field tests based on available data
- Implementation of preliminary sustainability assessments to identify areas that are contributing to the sustainability of economic, social, and ecological systems and areas that may be improved through adaptive management

The National Forest teams have completed the field portion of the project, and a national team is currently compiling and analyzing their results in a final report.

[1]Canadian data are not available because of the method of aggregation.

Planning for the Future in Marquette, Michigan

To fully implement the Vision Statement of the Binational Program, communities in the Lake Superior basin have gradually begun to develop comprehensive planning processes aimed at achieving long-term sustainability. One such proactive community is Marquette, Michigan. Since the release of LaMP 2000, various groups have further coordinated their efforts to ensure social and environmental sustainability in the greater Marquette region. A number of initiatives have been developed or strengthened, including the following:

Waste Reduction and Energy Efficiency Workshops Sponsored by MDEQ, these workshops have drawn together industry and government representatives to share information regarding innovative programs and practices. The workshops complement the ongoing mercury reduction program in Marquette coordinated by the local wastewater treatment facility, which contributes to the Binational Program's goal of zero discharge in the Lake Superior basin. For more information, contact Curt Goodman at 906-228-0485.

Regional Watershed Planning In 2001, the Central Lake Superior Watershed Partnership was recognized in Michigan as the most innovative watershed program of the year. This consortium of local government leaders, community activists, and natural resource professionals coordinates conservation programs spread across seven major watersheds in the basin. The Partnership has sponsored research on rural sprawl and sedimentation control projects and has joined forces with both Northern Michigan University and Argonne National Laboratory to monitor regional water quality. For more information, contact Carl Lindquist at 906-226-9460.

Land Protection Initiatives In an effort to protect critical habitat and private resource production lands from the unwanted side-effects of economic development activities, the Central Lake Superior Land Conservancy substantially increased its presence in Michigan's Upper Peninsula. In addition to working with landowners who want to place conservation easements on their holdings, the group has partnered with The Nature Conservancy to protect large tracts of intact forest systems, has monitored use of sustainable forestry practices on affiliated parcels, and has completed a biological community inventory for most of the Marquette County shoreline. For more information, contact Jim Cantrill at 906-249-9518.

[1]Canadian data are not available because of the method of aggregation.

Native Fisheries

- The lake trout has been restored to its historical, self-sustaining population in Lake Superior, the only Great Lake where this has occurred.
- Efforts are underway to restore the lake sturgeon, brook trout, and walleye to self-sustaining populations.

Quality of Human Life

The quality of human life category of indicators measures the incidence of crime, population density, demographics of migration, the demand for social services, transportation infrastructure status, the extent of recreational and cultural opportunities, citizen involvement in decision-making, and public access to lakeshores. These indicators assess the stressors on people's ability to live comfortably in the basin. Thus far, researchers have mostly gathered data regarding population, migration, and transportation, as summarized below.

Population and Migration[1]

- The population in the U.S. portion of the basin has declined by roughly 4 percent in the past 50 years, although 80 percent of the residents tend to remain in the same geographic area for lengthy periods of time.
- The population density remains low except in urban areas.
- Construction of vacation homes is increasing along previously undeveloped sections of the Lake Superior shoreline and throughout the basin.

Transportation

- Between 1980 and 1990, the percentage of basin workers driving alone to work rose from 58 to 73 percent while fewer workers carpooled or walked to work.
- A limited survey of traffic volumes in the Michigan part of the basin from 1987 to 1998 showed that traffic increased by an average of 34 percent. Having more cars on the road increases total car emissions, placing more stress on air quality, human health, and the ecosystem.

Resource Consumption Patterns

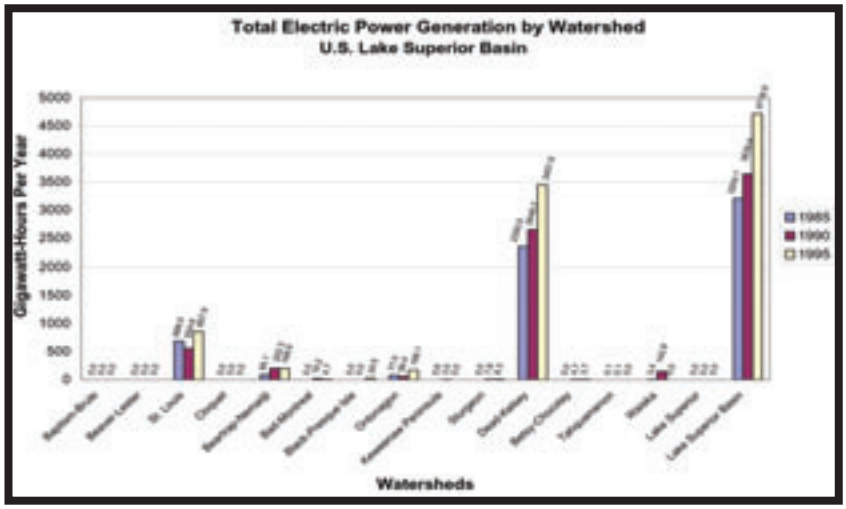
The resource consumption indicators measure the rates at which natural resources and products are consumed and recycled in the basin. This category of indicators assesses the availability of recycling programs, amounts of forest and mining resources that remain in the basin, types and quantities of electric power generation, quality and volumes of aquifers, amount of and stressors related to tourism, depletion of wildlife and fisheries, landfill capacities and incineration volumes, degree of urban sprawl, and loss of native flora. Recycling and energy production, two areas that are often viewed as leading indicators for resource consumption, are discussed below.

Recycling

- Participation in recycling programs is much higher and material recovery is much greater in Minnesota and Wisconsin, where statewide programs are well developed and certain materials are banned from landfill disposal.
- The total amount of postconsumer waste disposed of by landfilling or incineration in the U.S. portion of the basin appears to exceed 2 million cubic yards per year, straining the ability of municipalities to sustain current levels of consumption.
- Many of the larger Ontario communities have instituted municipal, industrial, or community volunteer-based recycling programs.

Energy Production[1]

- About 87 percent of the electric power generated in the basin comes from fossil fuel generators using coal, natural gas, fuel oil, or wood waste.
- The total amount of electric power generated in the U.S. portion of the basin increased 47 percent between 1985 and 1995.
- More than half of basinwide water usage supports energy production.



Economic Vitality

In the past, the Lake Superior basin's economy relied on a few large industries to support most of its residents. The economic vitality category of indicators measures the strength of the economy in the basin. Data have been collected regarding the per capita income, cost of living, extent of poverty, local employment trends, and diversity of community economies. Information related to the regional trade balance, facilitation of transitional economics, value-added industries, and regional and local tax bases has yet to be gathered. Economic diversity and, income and poverty, two areas that have received much attention in the basin during the last few years, are discussed below.

Economic Diversity

- Economic diversity is increasing in the U.S. portion of the basin. There is less reliance on large industries such as mining, which has been downsizing because of shifts in economic demand.
- The Ontario portion of the basin remains very dependent on large, individual industries and continues to support single-industry communities. It is also suffering the consequences of industrial downsizing and, mine and plant closures. The mining, ore processing and milling, sawmills, pulp mill, and tourism industries are major employers in the Ontario basin.

[1]Canadian data are not available because of the method of aggregation.

Income and Poverty[1]

- Although economic diversity is increasing, median family and household incomes within the U.S. portion of the basin are below the national averages.
- Between 1979 and 1989, the extent of poverty among all persons, families, and children increased at a greater rate in the U.S. portion of the basin than in the United States as a whole during that period.
- The decline of the mining industry had a significant impact on the basin's economy, as wages fell and joblessness grew. The basin economic sectors that have grown tend to pay lower wages than did the older industries that operated in the area in the past.

Awareness of Capacity for Sustainability

Any drive toward sustainability must be grounded in the actions of local communities; long-term progress in the Lake Superior basin will require that its citizens be educated in sustainability concepts. Knowledge of and attitudes toward sustainability vary from community to community in the basin. Some residents would embrace sustainable lifestyles if they had more information on sustainable practices.

The Lake Superior Binational Forum has successfully developed a number of initiatives to enhance awareness among basin citizens of the importance of the Binational Program; regional consumption habits; the import, export, and life-cycle of commodities; and local industries' innovative practices. Other educational initiatives aim to enhance awareness of the connection between consumption and exploitation of resources and humans in other parts of the world in order to satisfy local needs.

In addition, the Binational Forum held a workshop that examined the issue of electric power generation in terms of meeting the goal of zero discharge through mercury control technology, alternative sources of electricity, and energy conservation.

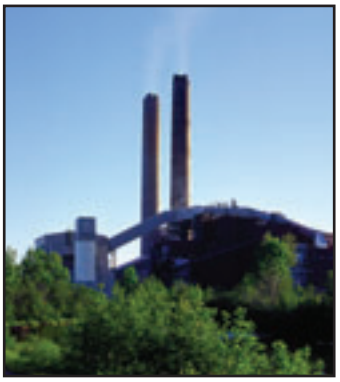
[1]Canadian data are not available because of the method of aggregation.

Next Steps

The Developing Sustainability Committee plans to build on the efforts of the Binational Forum through creation of a Community Awareness Review and Development (CARD) project. As part of this project, basin residents would be surveyed and would participate in discussions led by community-based facilitators in 13 basin communities. The facilitators would determine what people know and feel about sustainability by working with civic organizations, chambers of commerce, school districts, and local government. After assessing this information, CARD researchers would return to the communities in order to help residents build sustainability by viewing their communities as systems dependent on various economic, social, and physical resources. The CARD project would provide education and technical assistance to help the communities take more concrete steps toward sustainability.

Moving Toward Sustainability

The activities and indicators described above constitute the start of a movement toward a more sustainable Lake Superior basin. As important as the concept of sustainability is to the Lake Superior Binational Program, most activities sponsored by the program have thus far focused on addressing problems associated with critical pollutants or species and habitat in the basin ecosystem. The following two sections focus on these issues precisely because they are important to sustaining Lake Superior basin communities well into the future. However, additional work will be needed to ensure that the basin's environment, economy, and society remain mutually supportive.



Marquette Power Plant
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Critical Pollutants Progress Report

Accomplishments:

1. Initiated community-based pollution prevention projects focusing on mercury awareness and product recycling; examples include projects in Duluth, Silver Bay, and Minnesota's north shore communities; the EcoSuperior projects in Thunder Bay and north shore communities; and the community projects in Superior and Ashland, Wisconsin, and Marquette, Michigan. The city of Duluth, Minnesota, was the first local government in the U.S. to ban mercury thermometers
2. Developed voluntary agreements to reduce mercury at eight facilities in the Minnesota portion of the basin.
3. Implementing mercury-free schools program in the U.S. (mercury-free schools in Michigan, Northwest Wisconsin Mercury Shakedown, and Mercury Free Zone in Minnesota)
4. Conducting education and outreach to reduce backyard trash burning that produces dioxin and mercury emissions in Michigan, northeastern Minnesota, northwestern Wisconsin, and Ontario
5. Phasing out the use of PCBs in Canadian pulp and paper mills and the electric power generation sector
6. Introduced Ontario air emissions monitoring and reporting regulation to track 358 pollutants from many sources

Challenges:

1. Achieve 80 percent mercury reduction by 2010 by reducing mercury emissions from coal-burning utility and U.S. mining sectors and reducing individual use of mercury-containing products
2. Remediate AOCs by identifying adequate funding sources and coordinating zero discharge goals and the cleanup end points set by programs such as Superfund
3. Reduce backyard trash burning which releases chemicals known as dioxins by changing individual behavior via education regarding the human and environmental health risks associated with backyard burning
4. Conduct comprehensive U.S. chemical contaminant monitoring of fish for human and environmental purposes by identifying long-term funding sources to conduct trend analyses and coordinating among regional agencies to maximize benefits
5. Coordinate with other national and international efforts such as the Binational Toxics Strategy, the North American Agreement on Environmental Cooperation, and the Global Treaty on Persistent Organic Pollutants (POPs)
6. Track dioxin sources by improving compliance in the United States

Next Steps:

1. Track in-use and in-storage PCBs in the basin more closely
2. Expand outreach efforts to encourage PCB disposal on the Canadian side
3. Complete pilot study on disposal of PCBs from small facilities in Minnesota
4. Develop a mercury retirement strategy
5. Identify out-of-basin sources of LaMP critical pollutants in coordination with Great Lakes Binational Toxics Strategy

Section 3:

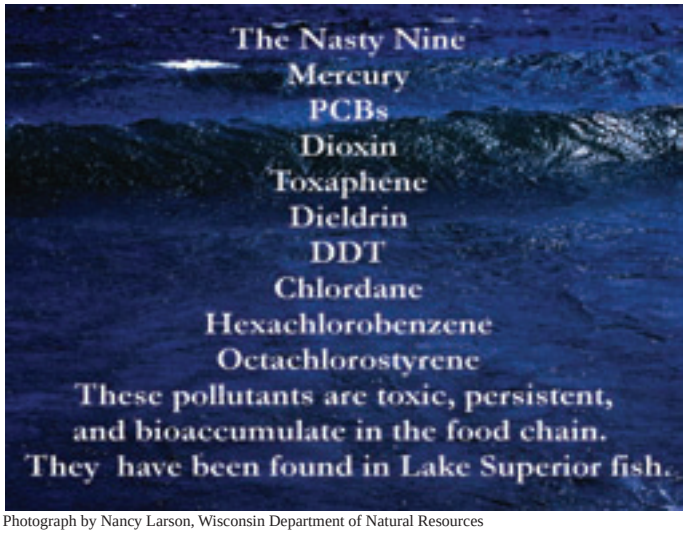
Critical Pollutants

Aguasabon River, Ontario
Photograph by Patrick T. Collins,
Wisconsin Department of Natural Resources

This section addresses the status of critical pollutants in the Lake Superior basin. It is organized in two subsections: 3.1-The Zero Discharge Demonstration Program (ZDDP) and 3.2-Air Transport and Deposition of Pollutants: Local and Long-Range Sources.

3.1 The Zero Discharge Demonstration Program

A key component of the effort to achieve sustainability in the Lake Superior basin is the reduction in toxic loadings to the lake. The goal is to eliminate sources of the nine critical pollutants (The Nasty Nine) in the Lake Superior basin by the year 2020 in a stepwise manner (see the schedule in Table 3-1). The Lake Superior Binational Program's ZDDP is designed to achieve that goal and is unique in the Great Lakes. The key to zero discharge and zero emission is pollution prevention. The ZDDP is an experimental program intended to end the use of the nine critical pollutants in industrial processes and products and to prevent the release of these pollutants in the Lake Superior basin.



Photograph by Nancy Larson, Wisconsin Department of Natural Resources

Why Zero Discharge for Lake Superior?

The idea of a Lake Superior "zero discharge demonstration" received increasing public support during the 1980s and arose from the recognition that Lake Superior provides the best opportunity among the Great Lakes to achieve zero discharge. The Binational Program to Restore and Protect the Lake Superior Basin was announced in 1991 when an agreement was reached among the governments around Lake Superior to work together on the zero discharge demonstration and on broader ecosystem issues. The 1991 agreement stresses voluntary pollution prevention but acknowledges that enhanced controls and regulations may be necessary.

Table 3-1
Lake Superior Load Reduction Schedule
Chemical load reduction schedule for sources in the Lake Superior basin (percent reduction shown against 1990 baseline)

Chemical	2000	2005	2010	2015	2020
Mercury	60	--	80	--	100
PCBs	33	60	95	--	100
Dioxin, HCB, and OCS	--	80	--	90	100
Pesticides	100	--	--	--	--

HCB = Hexachlorobenzene
OCS = Octachlorostyrene

The Lake Superior basin zero discharge goal is challenging. Significant progress has been made over the last ten years by enforcing strong environmental regulations, changing industrial development patterns, encouraging pollution prevention, and altering the habits of individuals; however, a significant amount of work remains to be done.

Pollutant Concentrations in the Environment

Reducing sources contributing toxic pollutants to Lake Superior will eventually result in pollutant reductions in the basin's ecosystem. Within the Lake Superior basin, the ZDDP reduces toxic chemicals at their sources. Reductions in toxicants carried in the atmosphere from distant sources are also important. The relationships between levels of pollutants entering the lake and the levels seen in the water, fish, and wildlife are complex.

Concentrations of toxic organic contaminants in Lake Superior declined more than 50 percent between 1986-87 and 1996-97. Nonetheless, of the nine critical pollutants, concentrations of dieldrin (a pesticide) and PCBs (for example, used in electrical equipment) in Lake Superior continue to exceed the most stringent water quality standards.[1]

Contaminant levels have been monitored in herring gull eggs since 1974. The most recent analysis of data shows that concentrations of five critical pollutants, PCBs, DDE, HCB, dieldrin, and dioxin (TCDD) in herring gull eggs have declined by 51 percent to 97 percent since they were first measured. Current trends show that, with the exception of dioxin, levels continue to decline. TCDD at the Granite Island colony is not exhibiting any trend, though it has declined since 1987. Mercury values have not been tracked as consistently, but they too have declined by approximately 50 percent since 1974.[2]

State and provincial jurisdictions in the Lake Superior basin currently issue sportfish consumption advisories. Concentrations of toxic substances in fish tissue are expected to decline as toxic inputs to the lake decrease. However, the time required for toxic substance levels to fall below health concern thresholds may be on the order of decades, and agencies will likely continue to issue fish advisories for some time to come.

Working Together to Meet the Zero Discharge Goal

Efforts to reduce releases of the nine critical pollutants are increasing as governments, industries, communities, and citizens work to identify creative ways to reduce the use and discharge of these chemicals. Progress has already been made through changes in industrial activities and processes and through community-based programs.

Out-of-Basin Sources and Reductions

The ZDDP focuses on air emissions, water discharges, and use or formation of the nine critical pollutants within the Lake Superior drainage basin. However, sources outside the basin greatly affect the lake. With its large surface area, Lake Superior receives a relatively high deposition of airborne

Children are at more risk than adults from toxic substances.
Photograph by Jamie Dunn, Wisconsin Department of Natural Resources

[1]Open Lake Monitoring Program, Environment Canada, 2000
[2]Canadian Wildlife Service, Environment Canada.

toxics from distant and local sources. Atmospheric deposition is further discussed in Subsection 3.2.

National and International Activities

Actions taken on the national and international levels play an extremely important role in protecting Lake Superior. National programs in the 1990s led to reduction of the mercury content in house paints and small-voltage batteries. In the United States and Canada, agreements are now in place with national dental associations for the virtual elimination of mercury use, and there is a similar U.S. agreement with the American Hospital Association. U.S. regulations for waste incinerators will reduce air emissions nationally and will thus have a beneficial effect on Lake Superior. Additional strategies are needed for Lake Superior critical pollutants because they all have airborne components. Long-range transport of toxic substances is an issue for all the Great Lakes. Efforts under the LaMPs are coordinated with the Great Lakes Binational Toxics Strategy to address pollutant reductions on a broader scale.

Industry Changes Affecting the Lake Superior Basin

Significant progress has been made in reducing releases of the Nasty Nine pollutants from large-source categories. Between 1990 and 2000, mercury use and releases in the Lake Superior basin decreased to the extent that the LaMP's 60 percent target was met. Consumer and commercial products have been significant sources of mercury. Mercury-containing products can include thermometers, switches, dental amalgams, thermostats, button batteries, and fluorescent lamps. Industrial raw materials can also contain unwanted mercury. The elimination of mercury from latex paints and batteries was a significant pollution prevention success of the manufacturing sector in the 1990s.

The 1990s were also a decade of mining facility closures in the basin, which reduced mercury emissions but at a large social and economic cost to the region. Additionally, Lake Superior pulp and paper mills converted to chlorine dioxide bleaching of pulp and thus have dramatically reduced their dioxin discharges to the lake. In addition, PCB use in mills is being phased out in Canada and reduced in the United States.

Sniffing Out the Hidden Mercury

Schools in the Lake Superior basin are getting help from Clancy in finding and eliminating mercury. Clancy is a floppy-eared former dog pound inmate. Clancy can detect mercury vapor at low levels. With assistance from the St. Paul Police Department, he was trained by a Minnesota Pollution Control Agency (MPCA) employee to sit when he detects mercury. Some of Clancy's training was conducted in schools in northeastern Minnesota, where he detected not only the mercury used in the training but also mercury in laboratory sinks and a used mercury spill kit. Now that he has graduated from training, Clancy and his trainer and handler, Carol Hubbard, will be visiting schools that are participating in MPCA's Mercury-Free Zone program. This program was funded by U.S. EPA's GLNPO and is based on a successful program in Sweden. Thus far, Clancy and the two mercury-sniffing dogs in Sweden have not experienced any health problems associated with mercury exposure.

Clancy the mercury-sniffing dog and Carol Hubbard, his handler.
Photograph by Anne Moore,
Minnesota Pollution Control Agency

Community Pollution Prevention and Outreach in the Lake Superior Basin

Many communities around the basin are working on ways to prevent pollutants, particularly mercury, from entering the Lake Superior environment. Lake Superior basin communities are working to teach and motivate their citizens to use alternatives to mercury-containing products. By working with its

What is a Lumex?

A) A Doctor Seuss character?

B) A glow-in-the-dark watch?

C) A portable mercury vapor analyzer?

A Lumex is a portable mercury vapor analyzer. Developed in Russia to detect mercury leaking from mercury ballast in submarines, it is now being put to use in North America. It is faster and a thousand times more sensitive than the standard industrial hygiene instrument for detecting mercury (the Jerome meter), and it is more portable than other sensitive instruments. The Lumex measures only elemental mercury in air; it does not measure other forms of mercury.

MPCA, MDEQ, and WLSSD own Lumex instruments. U.S. EPA's GLNPO funded WLSSD's purchase of the Lumex. They are using the Lumex in a wide variety of applications and are finding mercury hot spots in both commercial and residential settings. Lumex readings in outdoor air are typically less than 5 nanograms per cubic meter (ng/m3). Indoor readings are usually 10 to 20 ng/m3, and the breath of individuals with amalgam fillings produces readings ranging from 100 to 5,000 ng/m3.

Jamie Harvey uses a Lumex unit to test for mercury at an industrial site.
Photograph by D. Hansen,
Minnesota Pollution Control Agency

wastewater-generating customers and by conducting hazardous waste collections, the Western Lake Superior Sanitary District (WLSSD) in Duluth has reduced mercury discharges from its treatment plant. In 1997, WLSSD developed a "Blueprint for Mercury Elimination" guide for wastewater treatment plants. The community-based approach has caught on around the basin. Education and outreach are major parts of all these community efforts. In the U.S. portion of the basin, projects are underway in Duluth and at the Fond du Lac and Grand Portage Reservations in Minnesota; in Marquette and at the Keweenaw Bay Indian Community in Michigan; in Superior, Ashland, and at the Red Cliff Band of Lake Superior Chippewa Reservation in Wisconsin. In addition, EcoSuperior, a Thunder Bay nonprofit community group, is leading a multiyear mercury recycling and outreach project on the Canadian north shore. Examples of cooperative outreach include a project jointly carried out by the City of Superior, Wisconsin, and EcoSuperior in Thunder Bay and a "twinning" project involving schools in the two communities.

Progress on LaMP 2000

LaMP 2000 lists 23 general strategies for pollutant reduction. Various individual actions are listed under each of these strategies along with information on which agencies are committed to initiating or pursuing funding for the actions between 2000 and 2002. Fulfillment of the actions will bring us closer to the 2005 and 2010 milestones.

A complete list of actions for the Lake Superior basin will be contained in a new "Great Lakes Commitment Tracking Database" that will be posted at *http://epa.gov/glnpo/lakes.html*. The following is a summary of the strategies in LaMP 2000 and some accomplishments to date.

Mercury Strategies and Related Actions

Voluntary programs for mercury reduction in the basin range from national programs to those that apply in a particular jurisdiction to very specific voluntary reductions. Examples of voluntary reduction programs include the following:

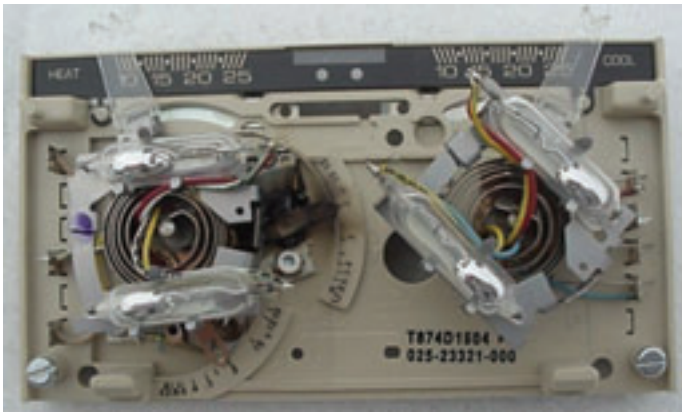
- Training programs for health care and dental professionals to learn about pollution prevention

in Thunder Bay, Duluth, Superior, and Marquette and at the Fond du Lac Reservation

- A statewide, voluntary, mercury emission reduction program in Minnesota that includes seven facilities in or near the Lake Superior basin
- Outreach efforts that led to a Minnesota taconite mineral processing facility removing over 400 kilograms of mercury through process controls and replacement of mercury-bearing equipment

Incentives to reduce mercury use can cover a wide range of efforts:

- Federal, provincial, and state governments fund LaMP pollution reduction activities. Some of the state funding comes from the Great Lakes Protection Fund.



Mercury switches in a thermostat.
Photograph courtesy of EcoSuperior

- Several U.S. programs provide mercury-free laboratory thermometers, barometers, and blood pressure measuring equipment to schools and hospitals.

Mercury release in the utility and mining sectors can be reduced through use of new technology and by changing patterns of energy consumption. Cost-effective pollution control technologies are being explored for coal-fired power plants and may be applicable to some mining operations. While these technologies are being developed, energy conservation continues to be an important option for the basin.

Current actions to reduce mercury from the utility and mining sectors include the following:

EcoSuperior Merc-Divert Superior Program

Thermostat Recycling Project

The nonprofit environmental group EcoSuperior operates a program to recycle standard, wall-mounted thermostats that have been removed during home and industrial heating renovations. Most thermostats contain approximately 3 grams of mercury, but some contain substantially more than this.

The program operates in major communities along the north shore of Lake Superior, including Thunder Bay, Nipigon, Schreiber, Terrace Bay, Marathon, White River, and Wawa. The goal of the program is to divert the mercury that the instruments contain from both the waste stream and the environment.

Recycling depots are located at heating supply outlets and hardware stores. Collected thermostats are sent to Honeywell Inc., and the mercury that they contain is reused rather than landfilled. To date, the program has diverted approximately 1.2 kilograms of mercury from landfills.

Fluorescent Light Recycling

EcoSuperior leads a program to recycle fluorescent lights in Thunder Bay and other north shore communities. Conventional fluorescent lamps are the most commonly used light source in commercial and consumer lighting and close to 600 million fluorescent lamps are disposed of annually in North America. As each bulb contains between 9 and 40 milligrams of mercury, used bulbs contribute significant quantities of this toxic substance to the environment.

Fourteen industries, institutions, and municipalities participate in the program in Thunder Bay, Red Rock, Terrace Bay, and Marathon. The program includes every paper mill on the north shore of Lake Superior. All mercury in the lamps disposed of is recovered and recycled for further use. To date, approximately 1 kilogram of mercury has been diverted from landfills.

EcoSuperior's thermostat and fluorescent light recycling programs are supported by Environment Canada's Great Lakes Sustainability Fund, the Ontario Ministry of the Environment, and the City of Thunder Bay.

- EPA's nationwide Energy Star program, which was recently adopted in Canada
- Mercury emission regulations for utilities, including Wisconsin's 2001 proposed mercury emission regulation
- U.S. EPA's determination in December 2000 that it would regulate mercury emissions from coal-fired power plants (U.S. EPA will propose the associated regulations by the end of 2003 and will publish the final regulations by 2004.)
- Development of Canada-wide mercury standards for the electrical utility sector by the federal and provincial ministers
- Efforts are ongoing by the Bad River, Grand Portage, and Keweenaw Bay Tribes to relamp, conserve energy, and explore use of alternative energy

The strategies for mercury-bearing products organize actions to reduce use of mercury- containing devices and promote use of alternative products. There has been significant recent activity in identifying, collecting, and disposing of mercury-bearing products. Efforts include the following:

- Implementing mercury thermostat take-back programs in Canadian north shore communities and Superior, Wisconsin.
- Signing of agreements between Environment Canada and major pharmacy retailers in Ontario to voluntarily remove mercury thermometers from pharmacy shelves.
- Encouraging the public to return thermometers to participating pharmacies in a pilot program in Thunder Bay.
- Conducting thermometer swaps at schools, at reservations, and in surrounding communities and clinics in the United States.
- Implementing policies in several jurisdictions to limit purchases of mercury-bearing products.
- Instituting various school programs, including a U.S. EPA "Mercury in Schools" outreach effort in 2001 and 2002, mercury-free schools in Michigan by 2004, and a variety of basin-specific mercury education efforts such as Minnesota's "Mercury-Free Zone" and the "Northwest Wisconsin Mercury-Free Schools." School programs are also used as opportunities for education and often incorporate curricula developed to teach school children about sources of mercury and its effect on the environment.
- Conducting incentive and collection programs in Michigan, Minnesota, and Wisconsin to remove mercury manometers from dairy farms; pollution prevention projects in the health care sector, including a project in Michigan's Upper Peninsula; workshops in Superior, Wisconsin; and a workshop for tribes hosted by the Fond du Lac Band.
- Signing of a harmonizing standard by federal and provincial environment ministers under the Canada-wide Standards Process in 2001 to reduce the release of mercury from dental practices by 95 percent by 2005, using 2000 as the base year. Application of best management practices is to include use of ISO-certified amalgam traps.

Although the Lake Superior Binational Program stresses voluntary reductions, it is recognized that regulations are sometimes needed and often have the beneficial effect of leveling the playing field for permittees. Some of the regulatory efforts that have been made by various jurisdictions to reduce mercury use include the following:

- Resolutions in Duluth, Minnesota; Superior, Wisconsin; and Douglas County, Wisconsin, have banned the sale of mercury fever thermometers.
- The sale of most mercury thermometers has been banned in Minnesota (some exemptions have been granted).

PCB Strategies and Related Actions

Various voluntary PCB reduction activities have already taken place or are underway in the Great Lakes region and the Lake Superior basin. Because of technical differences in the ways that PCB use and storage are reported in Canada and the United States, a binational inventory is not feasible at this

time. Reduction data will be reported separately in an update to the technical edition of the LaMP. Recent and current actions to identify, remove, and dispose of PCBs include the following:

- Revisions to Canadian federal PCB regulations and PCB storage regulations that phase out all PCB-containing equipment by 2008, allow storage for no longer than two years, and prohibit storage of all PCB-containing equipment by 2010.
- New Ontario draft regulations that require destruction of some 99,000 tonnes of PCBs (including contaminated soils) currently in storage in Ontario.
- Educational outreach to 30 facilities in the Canadian portion of the basin.
- A survey of U.S. facility decommissioning plans and a survey of voluntary commitment letters from Canadian PCB-containing equipment owners.
- Two workshops in Wisconsin and Minnesota in 2001 to train demolition and remodeling contractors to recognize PCB-containing equipment and become aware of disposal rules.
- A pilot project using state and federal funding to identify and dispose of PCBs at certain Minnesota facilities in the Lake Superior basin.

Pesticide Strategies and Related Actions

Various jurisdictions in the basin continue to carry out "clean sweep" collections of remaining stockpiles of banned pesticides from farmers and commercial appliers and to educate residents about their proper disposal. Household hazardous waste collections also continue in the basin. In the United States, tribal governments have conducted household hazardous waste collection and education activities within reservation boundaries as well as in surrounding communities.

Because of reporting differences between jurisdictions, compiling the quantity of pesticides collected in Michigan, Minnesota, and Wisconsin is difficult. Table 3-2 presents the amounts of pesticide estimated to have been removed from the U.S. portion of the basin.

In Ontario a two-year, province-wide collection program for obsolete pesticides in the agricultural and commercial sectors was initiated by the Crop Protection Institute in 2000 with assistance from provincial government agencies. In the first year of operation, the program collected 110,870 kilograms of outdated, unusable, or unregistered pesticides from 35 sites in southwestern Ontario. Continuing in eastern and northern Ontario in fall 2001, the program gathered 17,929 litres and 9,235 kilograms of pesticides from agricultural and commercial pesticide users. A licensed contractor was hired to

Table 3-2
Clean Sweep Collections of Pesticides in the Lake Superior States (U.S. Programs)

State	Dates of Collection	Substances Collected (pounds)					
		Aldrin/Dieldrin	Chlordane	DDT	Silvex	Toxaphene	Total Pesticide
Michigan[a*]	1995	147	25	193	Not estimated	0	365
Michigan[b]	2001	--	--	--	--	--	3,540
Minnesota[c*]	1992–1998	74	535	4,959	6,000	83	11,651
Wisconsin[d*]	1996-1998	0	36	97	28	480	641

[a] Compiled by Michigan Department of Agriculture (MDA). The Lake Superior counties collect about 9 percent of the pesticides collected in the state. The pesticides collected in these counties were calculated as 9 percent of the total for each pesticide collected.

[b] MDA estimates that the department removed 3,540 pounds of pesticides from the Lake Superior watershed in fiscal year 2001.

[c] Compiled by Minnesota Department of Agriculture Waste Pesticide Collection Program. Data include all Lake Superior counties' waste pesticide collections.

[d] Compiled by Wisconsin Department of Agriculture, Trade, and Consumer Protection for 1996. Compiled from collection event summaries of the Northwest Regional Planning Commission for 1997 and 1998.

* Data from Lake Superior LaMP 2000.

dispose of the pesticides at approved facilities in Quebec and Alberta.

Dioxin, HCB, and OCS Strategies and Related Actions

Because HCB and OCS can be formed along with dioxin during combustion, these three substances are dealt with as a single group. Projects conducted to identify and reduce sources of these substances range in scope from entire jurisdictions to individual reservations. Examples of dioxin, HCB, and OCS reduction actions include the following:

- Michigan, Minnesota, and Wisconsin have supported Hearth Products Association projects to provide incentives for individuals to switch to more efficient wood stoves. Natural Resources Canada has partnered with EcoSuperior to conduct a similar program in Thunder Bay.
- Ontario has drafted regulations that will phase out hospital incinerators and set new requirements for safe handling, transport, and treatment of biomedical waste.
- Various outreach efforts have been undertaken to discourage people from burning garbage in burn barrels, including a pair of Michigan brochures, a Superior and Douglas County brochure called "Slow Death by Fire," and a burn barrel campaign conducted by WLSSD featuring "Bernie the Burn Barrel."
- Ontario developed a survey based on one prepared by WLSSD to track burn barrel use in its portion of the Lake Superior basin.
- Wisconsin funded a project to develop a video for local officials on the problems associated with using burn barrels and various options for local garbage burning ordinances.
- The Grand Portage Tribe in Minnesota and the Red Cliff Tribe in Wisconsin are leading Native American efforts to eliminate the use of burn barrels.
- Wisconsin is continuing its site investigation at a wood preserving facility in Superior.

Open Burning of Garbage

Backyard burning of household trash endangers your health and the Lake Superior environment. Don't turn your trash into dioxin. Reduce your waste by making better purchasing choices and recycling. Use a garbage collection service or an approved landfill instead of burning trash. You can also reduce your purchases of toxic materials and take advantage of household hazardous waste collections to properly dispose of those materials that you no longer use.

Resource Materials:

The "Burning Household Waste" brochure developed by MDEQ lists pollutants emitted from burn barrels, some of the health consequences, and national household burn barrel emissions. It is available at the MDEQ Environmental Assistance Center, from district staff, or at *www.deq.state.mi.us/aqd/publish/95sblist.html*.

"Bernie the Burn Barrel" information, brochures, and posters that explain the problems associated with burn barrels and provide information on disposing of a burn barrel and its ashes at no charge are available from the WLSSD hotline at 218-722-0761.

The "Slow Death by Fire" brochure developed by the Lake Superior Toxic Reduction Committee is a pictorial storybook addressing the burn barrel issue. It is available at *thospond@ci.superior.wi.us*.

Burn barrel
Photograph courtesy of U.S. EPA

Efforts Across Jurisdictions

While the Lake Superior Binational Program continues to develop new projects specific to the Lake Superior basin, there are other initiatives that can have a significant impact on the basin. Examples

of efforts to integrate goals for Lake Superior include the following:

- Development in the United States of Lake Superior-specific standards for state water quality regulations.
- Coordination of chemical reduction schedules with Total Maximum Daily Loads in the United States.
- A partnership with the Great Lakes Binational Toxics Strategy to coordinate implementation activities for both programs

Continuing Challenges

Reaching the goal of zero discharge requires significant work by the residents and governments of the Lake Superior basin. Cooperative efforts among local, state, provincial, and federal governments will be required to achieve pollutant reductions that benefit the basin. Significant progress has been made in meeting the initial discharge targets, and this progress has been achieved through reduction of pollution from large sources of the critical pollutants. Meeting the next set of targets will be more difficult, as the sources are smaller and more dispersed and are not all controllable from the Lake Superior basin itself. This section outlines the remaining large-scale challenges facing the basin, challenges related specifically to control of PCBs and mercury, and challenges related to control of specific pollutant sources such as burn barrels and contaminated sediments.

Large-Scale Challenges

Meeting some challenges will require either national cooperation or very large amounts of money, and these challenges will be met only in the long term. Other challenges will require persistent effort to meet targets. Partnering with programs that address sources outside the Lake Superior basin (for example, the Great Lakes Binational Toxics Strategy) will serve to accelerate Lake Superior pollutant reductions. Some of these large-scale challenges include the following:

- Final retirement of mercury from the marketplace.
- Cleanup of 29 contaminated sites in harbors, in river mouths, and upland from Lake Superior as identified in LaMP 2000. Although these sites vary in their severity of contamination and size, remediation is usually an expensive and time-consuming undertaking (for example, at the Ashland Coal Tar site). Also, the

Contaminated Site Cleanup:
Ashland Coal Tar Site

The Ashland Coal Tar site includes a 10-acre area with high concentrations of PAH in bottom sediments and degraded aquatic habitat off Ashland's Kreher Park in Chequamegon Bay. The contamination originated from the on-land location of a former manufactured gas plant. Cleanup options are being considered by all the affected parties, including the public. In one on-land area of the Ashland city park, however, highly contaminated groundwater is "seeping" to the surface, posing a significant human health risk. In 2001, WDNR began remediation of the seep to reduce this risk. U.S. EPA recently designated the Ashland Coal Tar site as a Superfund site. The total price tag for site cleanup will likely exceed $100 million.

Cleanup of the "seep" area at the Ashland Coal Tar site.
Photograph by Jim Bishop,
Wisconsin Department of Natural Resources

endpoints chosen for cleanup efforts are not always compatible with LaMP goals.

- Tracking of compliance with federal, state, and provincial regulations governing incineration of wastes and dioxin releases.

PCB Challenges

An essential first step in the virtual elimination of PCBs in the basin is completing the inventories of in-use and destroyed PCBs. Moreover, an expanded outreach effort for PCB disposal is necessary. Canadian owners of PCB-containing equipment responded to outreach efforts in the 1990s, but challenges remain to monitor and promote targeted decommissioning of PCBs in use and PCB destruction. Passage of new national legislation requiring phase-out of PCB use and prohibiting PCB storage together with new Ontario regulations for destruction of PCBs in storage would greatly increase the likelihood of meeting the 2010 target of 90 percent destruction.

In the United States, U.S. EPA and Minnesota are funding a pilot project to identify and dispose of PCBs used in smaller facilities such as municipal utilities and electrical cooperatives. If this pilot project is successful, additional projects in other parts of the basin might be funded.

Thunder Bay AOC
Sediment Remediation Partnership

Abitibi Consolidated Inc., Northern Wood Preservers Inc., Canadian National Railway Co., Environment Canada, and the Ontario Ministry of the Environment have been working in a unique partnership to isolate sources of contamination, clean up contaminated sediments, and enhance fish habitat at the Northern Wood Preservers pier in Thunder Bay Harbour. Commencing in 1997, remediation activities included construction of a rockfill containment berm, dredging, treatment of contaminated sediments, and isolation of the pier with low-permeability barriers and groundwater control facilities. Restoration of fish habitat and wetlands has progressed, bringing the project near to completion by the end of 2001. Monitoring programs will ensure that groundwater and sediment conditions and aquatic habitat continue to improve around the pier. Completion of this project will mark a milestone as we bring Thunder Bay Harbour closer to delisting as an AOC.

Mercury Challenges

Between 1990 and 2000, the Lake Superior basin exhibited decreases in mercury use and releases that met the Binational Program's 60 percent reduction target. However, mercury releases in the Lake Superior basin continue at a rate of over 800 kilograms per year. Most of the mercury enters Lake Superior and its watershed through air emissions, with the two largest sources being the utility (energy production) and mining sectors. Atmospheric release of mercury has been an unregulated emission, meaning that when air permits are issued, no limits are placed on mercury releases. To meet the reduction targets for the next decade, mercury emissions from coal and ore processing and use of mercury in products and processes would need to be significantly reduced.

A global challenge for the future is to develop national strategies that "retire" mercury by completely removing it from the marketplace. The current practice of taking old mercury-containing products to recyclers who sell the recovered mercury to manufacturers that use it in their products does not result in a net reduction in mercury use. Mercury in certain forms is extremely toxic, and collection and recycling do not reduce the risk of its entering the food chain.

Dioxin - a Burning Issue

In 1990, many thousands of small, inefficient incinerators were a major source of dioxin emissions in the basin. Air emission controls required by basin governments in the 1990s have largely controlled this dioxin source, although the governments need to confirm that the incinerator sector is in compliance. Hospital incineration remains a significant source of dioxin in the atmosphere. Use of burn barrels for backyard garbage burning is a continuing challenge in the rural portion of the Lake Superior basin. This practice produces dioxin that can be deposited on crops, posing human health risks through food consumption.

Peninsula Harbour, Ontario, AOC

The Town of Marathon, with support from Environment Canada, and the Ontario Ministry of the Environment, FedNor, and the Ontario Great Lakes Renewal Foundation, has commenced a feasibility study for removal and disposal of mercury- contaminated sediments in conjunction with development of marina facilities in Peninsula Harbour. To maximize land use in the harbour, some of the land-based portion of the marina may be situated over the containment and disposal facility. The feasibility study, which began in 2000, includes compilation of existing data, investigation of current contaminated sediment conditions, and investigation of potential locations for the facility and marina. A risk assessment of dredging and disposal options and detailed conceptual designs for the facility and marina will be completed by the end of 2002. These activities will provide direction and focus for the remedial work as Peninsula Harbour moves toward delisting as an AOC.

Contaminated Bottom Sediments

Although Lake Superior is the cleanest of the Great Lakes and the other Great Lakes have more contaminated sites, Lake Superior's history of heavy industry in its harbor communities has left a legacy of contaminated bottom sediments. Some of these areas have been designated as AOCs. Sites with polluted bottom sediments can serve as source areas for contaminants that bioaccumulate in Lake Superior fish and wildlife. These harbors and bays should be restored to productive shallow-water habitat that serves as the biological engine for the Lake Superior ecosystem. Considerable funding is required to investigate these sites, determine their degree of contamination, remediate them, and finally restore them to important aquatic habitat.

Recent activities at the Deer Lake, Michigan, AOC include sediment sampling and a U.S. EPA GLNPO-funded feasibility study to determine cleanup options for the site. The sediment sampling was performed by MDEQ, Michigan State University, and U.S. EPA. The feasibility study, which is nearing completion, examines various cleanup options for the AOC, including fish and dam removal, dry and wet dredging, in situ gel and sand capping, and natural attenuation.

There is still a need to investigate and remediate other sites that may contain chemicals of concern. Funding for these activities has thus far been limited, but projects include the following:

- Characterization and a search for funding sources for cleanups at the Newton Creek/Hog Island inlet site in Superior and the Ashland Coal Tar site in Wisconsin.
- Site investigation at a wood preserving facility in Superior, Wisconsin.
- Public meetings on remediation options for Stryker Bay in Duluth, Minnesota.
- Remediation of contaminated sediments at a wood preserving facility in Thunder Bay Harbour (Ontario) is nearing completion and investigation of other issues within the harbour continues.
- U.S. EPA Superfund Division's removal program will be undertaken with WDNR beginning in the spring of 2002. Superfund will provide On-Scene Coordinator (OSC) personnel to work with WDNR to complete a "sweep" of the Superior area to identify hazardous waste sites for potential time-critical removals.

What You Can Do

National programs and programs that target individual economic sectors will make great strides toward meeting the zero discharge goal, but zero discharge can only be achieved if the residents of the Lake Superior basin make informed choices. Community-based programs are key to promoting such decision-making.

People often feel that reducing pollution, protecting habitat, and building sustainable local economies are beyond their control. In reality, everyday choices made by consumers, investors, and community volunteers can make a great difference for Lake Superior. Listed below are some of the things that you can do on a day-to-day basis to protect Lake Superior from toxic chemicals.

What Can You Do to Reduce the Nasty Nine?

Conserve energy and water

If you use less energy and conserve water, you'll be saving more than money because conservation reduces releases of pollutants overall, and specifically reduces mercury emissions from coal-fired electricity production.

Purchase "green" electricity

Explore the option of purchasing "green" electricity from wind or solar power suppliers in your community.

Be mercury-wise

Buy products such as thermometers, thermostats, appliances, medicine, and fishing and hunting equipment that are mercury-free. If you find it hard to believe that sporting goods could contain mercury, be aware that some fishing tip-ups, dog training collars, and hunting bows contain this chemical. When buying medicine and pharmaceuticals, avoid products containing the compounds phenyl mercuric acetate (PMA) and thimerosal, which might be listed as preservatives. When you are ready to dispose of mercury-bearing products, recycle them rather than throwing them in the trash or down the drain.

Use less plastic

Reduce use of plastic, especially polyvinyl chloride (PVC), which may release dioxin during manufacturing and later if it is burned. Recycle plastic products when they are no longer useful.

Know what to do if you find hazardous materials in your home

If you find mercury or other hazardous materials in your home, contact your local household hazardous waste program.

Know what to do with mercury spills

Know what to do if you spill mercury in your home or workplace. This is especially important in places where children are present. Don't let children play with mercury. Check out the following web sites for mercury cleanup advice:

http://www.uwm.edu/Dept/EHSRM/LAB/PPT/sld001.htm
http://www.mpshu.on.ca/EnvironmentalHealth/mercury%20CLEANUP.htm

Know the alternatives to mercury amalgam fillings

Talk with your dentist about mercury and silver amalgam fillings. Discuss the alternatives, and ask what the dentist is doing to limit and dispose of mercury waste.

Dispose of trash properly

Dispose of your trash properly. Burning or dumping garbage creates environmental problems.
See the discussion of open burning in this report for more information.

Dispose of fluorescent lamp ballasts properly

If you have a fluorescent lamp made before 1981), don't dispose of it without checking whether it has a PCB-containing ballast that should be removed. If the ballast is not labeled "No PCBs," consider it hazardous waste and contact your local household hazardous waste program. In addition, the lamp itself may contain mercury and should be recycled or disposed of during a hazardous waste collection.

Remove mercury and PCBs from old appliances and cars

When disposing of large household appliances and cars, ask the trash service, recycler, or salvage yard whether mercury switches will be removed. Old refrigerators can also have PCB-containing ballasts, so if you are disposing of an old refrigerator, ask about that too.

Switch to more efficient woodstoves

By switching to more efficient woodstoves, you can reduce releases of toxic substances to the atmosphere. One example of the efforts to support such switches is the Hearth Products Association's woodstove exchange program. For more information, see *http://www.woodstovechangeout.org*

Find out what devices contain mercury

You can get a list of mercury-containing devices from a new educational software tool on mercury in buildings designed for use by the construction and demolition industry at:

http://danpatch.ecn.purdue.edu/~mercury/scr/frame.htm

3.2 Air Transport and Deposition of Pollutants: Local and Long-Range Sources

The atmosphere is the major pathway through which the nine critical pollutants enter the lake. The large surface area of the lake collects materials and toxic contaminants from rain and snow and directly from the air. Air emissions of critical pollutants from sources such as incinerators, power plants, mining operations, and burn barrels within the basin can be deposited directly to the lake or can enter the lake via its tributaries in watershed runoff. Air emission sources in the Lake Superior basin are included in the scope of the ZDDP. Strategies and actions for addressing these sources are discussed in Section 3.1. Provided below is an overview of the deposition of critical pollutants that highlights actions being taken by Lake Superior basin jurisdictions to control air emissions.

Critical pollutants from distant sources also travel through the atmosphere to be deposited in Lake Superior. For example, organic chemicals and metals such as mercury readily travel long distances in their vapour states. Figure 3-1 summarizes the many pathways taken by pollutants in the atmosphere. Computer modeling suggests that 85 percent of the dioxin deposited in Lake Superior originates from sources over 400 kilometers away. Incineration, metal processing, and fuel combustion are the main sectors that comprise the thousands of dioxin sources for Lake Superior. In 1996, the largest 100 of these sources were estimated to contribute over two-thirds of the dioxin deposited to Lake Superior. Although they have not yet been proposed, U.S. Maximum Achievable Control Technologies (MACT) standards that will apply to municipal and medical incinerators are expected to significantly reduce the relative contribution of this sector.

Atmospheric Deposition of Toxic Chemicals to Lake Superior

The binational Integrated Atmospheric Deposition Network (IADN) measures the magnitude and trends of atmospheric loadings of toxic contaminants to the Great Lakes. These measurements integrate loadings from local in-basin sources, continental out-of-basin sources, and even global sources. Since 1990, IADN has maintained Lake Superior monitoring stations at Eagle Harbor, Michigan; Brule River, Wisconsin; Sibley, Ontario; and Turkey Lakes, Ontario. At these stations, concentrations of toxic chemicals are measured in both the air and precipitation phases.

IADN reports decreasing atmospheric deposition of the pesticide hexachlorocyclohexane (HCH) throughout the Great Lakes Basin. This decrease is partly a result of decreases in global use of HCH. Trends in atmospheric concentrations and loadings of HCH reflect changes in its production and use, as shown in Figure 3-2. Annual global use of technical HCH from 1980 to 1995 (Li 1999)

Figure 3-1 Pathways of transport and accumulation of continental pollutants

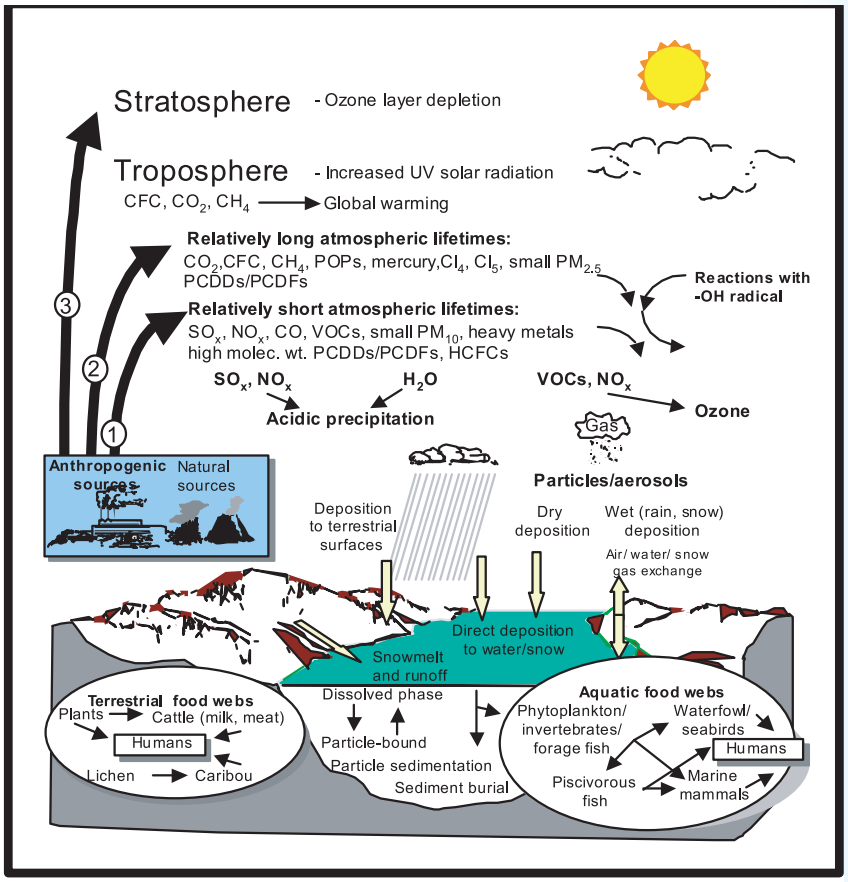


Figure credit: North American Commission for Environmental Cooperation

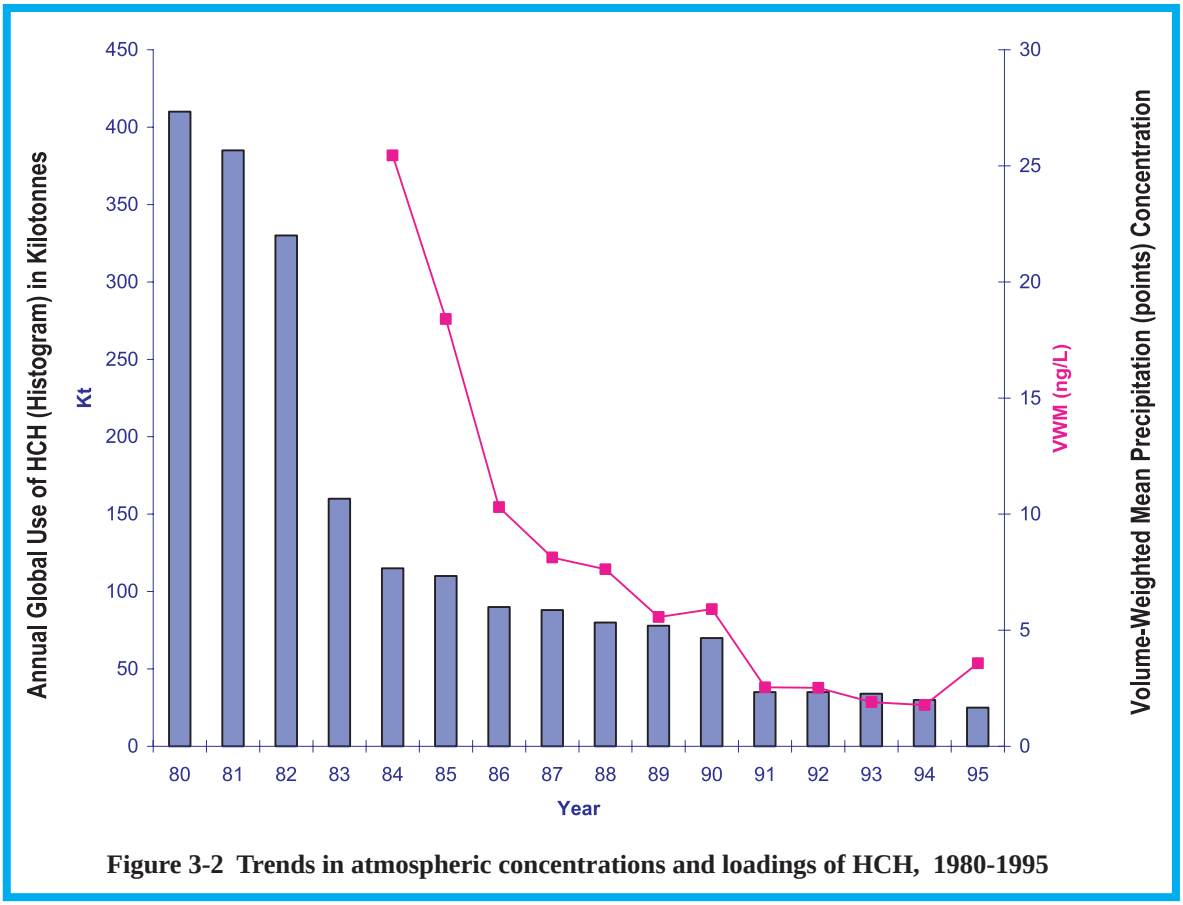


Figure 3-2 Trends in atmospheric concentrations and loadings of HCH, 1980-1995

and the resulting trend in volume-weighted mean precipitation concentrations of a-HCH as measured at Sibley are shown in the figure (Chan, unpublished data). Three main declines in the global use of HCH have occurred. The first began in the 1970s when countries such as Canada, Japan, and the United States restricted use of HCH. A second decline occurred in 1983 when China banned its use. The third decrease began in 1990 when the former Soviet Union completely banned its use and India banned its use for agricultural purposes. These governmental actions to protect our air, water, and food have resulted in significant decreases in the concentration of HCH in the environment as demonstrated by measurements made in the air (Figure 3-2).

Although HCH is not a critical pollutant for Lake Superior, its patterns of manufacture, use, and transport are similar to those of pesticides found in Lake Superior; therefore, the behavior of HCH can serve as a surrogate for their behavior.

As shown in Figure 3-3, trends in wet deposition inputs (from snow and rain) of organochlorine pesticides to Lake Superior have declined since 1992, much like trends observed across the basin, while PCB inputs appear to be remaining constant. The lower Great Lakes showed increasing wet deposition inputs of selected polynuclear aromatic hydrocarbons (PAH); in contrast, the PAH wet deposition trend for Lake Superior appeared to remain stable from 1992 to 1998.

IADN estimates wet, dry, and gas deposition to the Great Lakes and, based on air-water exchange information, is able to determine amounts of pollutants that are volatilizing from the lakes. IADN's results indicate that the concentrations of pollutants deposited in Lake Superior from the air are generally decreasing. However, for some chemicals, the atmosphere is a source of pollutants for the lake (by deposition), and the lake is becoming a source for the atmosphere-that is, the amount of a chemical volatilizing or degassing from the lake exceeds the amount that is being deposited in the lake through precipitation or direct absorption. When the net loading of a given chemical is out of the lake, this contributes to decreasing in-lake concentrations.

The most recent (1998) IADN loading estimates indicate that volatilization of a-HCH, dieldrin, cis- and trans-chlordane, and PCBs from Lake Superior is far greater than the total deposition to the lake; that is, the lake is a source of these pollutants for the atmosphere. In contrast, the atmosphere is still increasing the in-lake concentrations of DDT, lindane, a-endosulfan, HCB, and several PAHs.

Pesticide Clean Sweeps

U.S. EPA Region 5 has compiled data from agricultural clean sweeps conducted between 1988 and 2000 by Great Lakes states (excluding New York). An estimated 1.9 million pounds (900,000 kilograms) of pesticides was collected from stockpiles held by farmers and commercial appliers in the Great Lakes basin. Figure 3-4 summarizes the amounts collected in the six states. Although some of the pesticides removed are measured by IADN, it is not currently possible to link the pesticide data sets.

What is Being Done About Air Deposition of Pollutants

Many activities have been undertaken by national, state, provincial, and Tribal/First Nations governments to protect the Lake Superior basin from air pollution sources. This section addresses mercury reduction activities by jurisdiction. For a more comprehensive summary of activities in each jurisdiction, please visit the web sites cited in the text. The section ends with an overview of international initiatives.

Federal Governments

Atmospheric deposition of mercury from nearby and distant sources is the major pathway for this chemical into Lake Superior and its watershed. The two largest sources of mercury emissions to air in the Lake Superior basin are energy production and ore processing. Atmospheric releases of mercury from

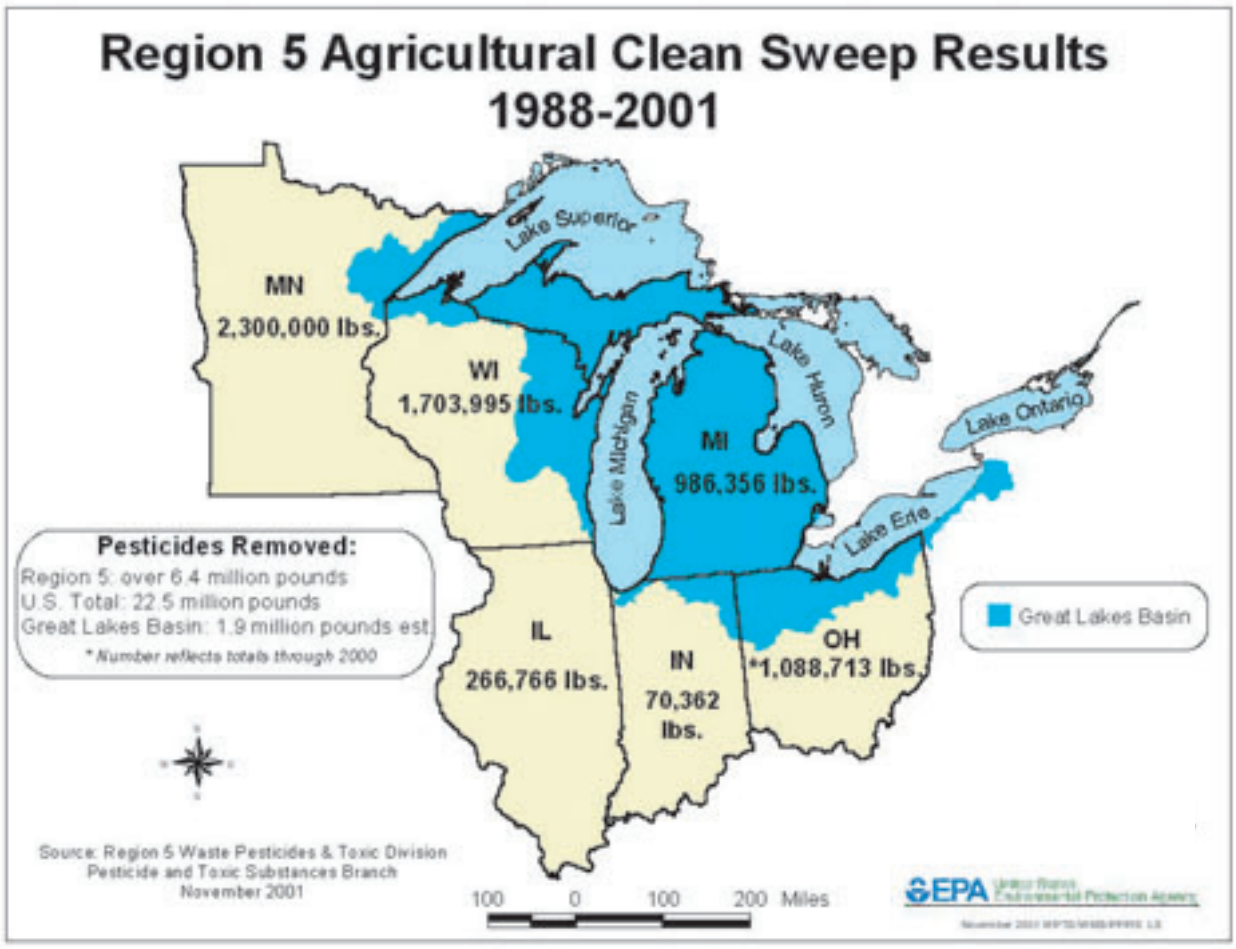


Figure 3-4 Pesticide clean sweeps in U.S. EPA Region 5 states

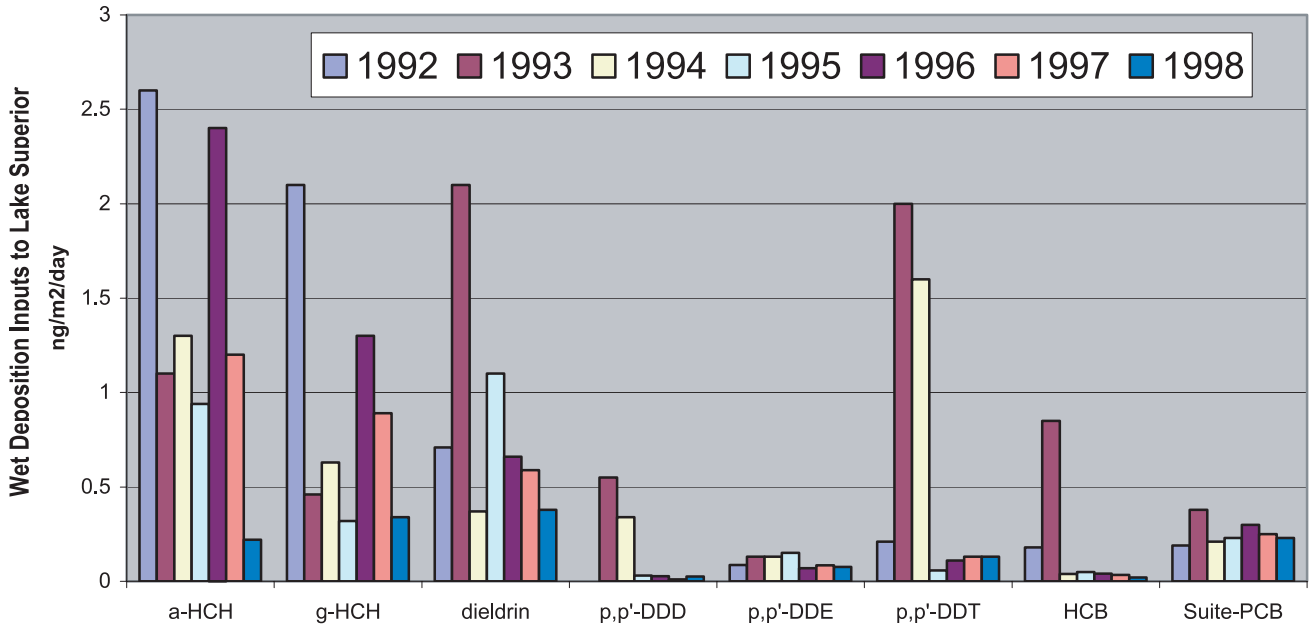


Figure 3-3 Trends in Lake Superior wet deposition inputs 1992-1998

coal combustion and the mining sector have been unregulated emissions.

Recently, U.S. EPA made a determination to regulate specific mercury emissions to air. Mercury is already a regulated chemical in some circumstances. Federal government actions to regulate mercury include the following:

- Mercury Emissions from Electric Utilities: In December of 2000, U.S. EPA announced that it is appropriate and necessary to regulate mercury emissions from electric utility plants. U.S. EPA is scheduled to propose the regulation by December 15, 2003, and promulgate a final regulation by December 15, 2004. The President proposed another approach in February 2002 -- development of a nationwide cap and trade program that would reduce electric utility mercury emissions 69 percent from current levels. Congress is considering this initiative.

- Regulate Mercury Emissions from Other Electric Producers: Industrial, commercial, and institutional boilers, found in businesses and industrial plants throughout the United States, may use coal, oil, or natural gas as fuels. As with utility boilers, emissions of mercury occur when mercury present as a trace contaminant in the fuels is volatilized and released in the gas exhaust stream. Mercury emissions from this source category were estimated to be approximately 3 tons per year in the 1993 NTI. U.S. EPA plans to propose a rule to limit emissions of hazardous air pollutants from industrial, commercial, and institutional boilers under Section 112 of the CAA. A proposal is scheduled for the summer of 2002.

- Mercury Phase-out Proposal: In lieu of TMDLs for water bodies in U.S. EPA Region 5, including the Great Lakes, U.S. EPA is proposing a mercury phase-out. The proposal would allow Region 5 states to forego development of TMDLs for all mercury-impaired waters if they commit to specific conditions such as expediting air and National Pollutant Discharge Elimination System (NPDES) permitting for mercury sources.

Other specific incinerator sources of mercury emissions to air in the United States have been regulated. U.S. EPA has already addressed three of the major mercury emission source categories (medical waste incinerators [MWI], municipal waste combustors [MWC], and hazardous waste combustors [HWC]) through promulgation of emission control regulations. Based on 1990 mercury emission levels, these MACT regulations are expected to reduce mercury emissions from

MWIs and MWCs by approximately 90 percent and from HWCs by approximately 60 percent.

By 2004, the U.S. federal government will be setting mercury air emission limits by 2004 for the energy (utility) sector and the states will then apply these limits to their permitted facilities.

In Canada, the federal and provincial ministers of the environment have developed Canada-Wide Standards (CWS) for sectors releasing mercury to the environment. The standards are voluntary, but provinces may choose a regulatory framework to implement them.

- In 2000, a CWS for waste incineration was endorsed that would apply numerical targets to exhaust gases from existing, new, or expanded municipal, hospital, hazardous waste, and sewage sludge facilities. The timeframe for achievement is 2003 to 2006.
- In 2001, a CWS was endorsed for an industry-led initiative to reduce the mercury content of mercury-containing lamps (mainly fluorescent tubes).
- In 2001, a CWS was signed that requires use of best management practices for dental amalgam. The national goal is a 95 percent reduction in mercury releases associated with dental waste discharges by 2005.
- In 2002, ministers are expected to formally consider a standard for electrical power generators.
- CWSs for air are under development for base metal smelting, incineration, the iron and steel industries, and fuel combustion.

State, Provincial, and Tribal/First Nations Governments

States, Tribes/First Nations, and the Province of Ontario have been implementing air emission control programs for over 25 years. The following case study from Michigan is illustrative of a jurisdiction's actions over time.

Michigan's Air Program: A Case Study

Michigan's environmental and health departments have been very concerned about releases of mercury for decades. Some of their activities include the following: requiring best available control technology for new and modified permits for all toxic pollutants, including mercury; adopting strict federal controls for all municipal waste incinerators; and adopting standards that are even stricter than the federal controls for mercury emitted from MWIs. Michigan has also supported development of federal regulations for coal-burning utilities.

In 1996, the Michigan Mercury Pollution Prevention (M2P2) Task Force released a report that listed high-priority mercury reduction activities to be implemented by a variety of stakeholders. Such stakeholders included healthcare facilities, dentists, automobile manufacturers, schools, dairy farmers, and laboratories. For a summary of the reduction activities, visit MDEQ's web site at *http://www.deq.state.mi.us/ead/p2sect/mercury/*.

Other specific mercury reduction activities in Michigan include the following:

- Developed an air toxics emissions inventory for air toxic pollutants *(see http://www.glc.org/air/rapids/rapids.html)*.
- MDEQ and Wisconsin, using settlement funds, awarded the University of Michigan a grant to conduct research in the Lake Superior basin in order to better understand atmospheric deposition.
- MDEQ, working with the University of Michigan, received a grant from the Michigan Great Lakes Protection Fund to establish a mercury monitoring network in the state.
- MDEQ adopted one of the strictest standards in the nation for controlling mercury emissions from hospital, medical, and infectious waste incinerators. Michigan regulations also require hospital incinerator operators to submit a waste management plan that demonstrates that the generator of medical waste has eliminated known mercury-containing materials.
- MDEQ worked with the Multimedia Pollution Prevention Task Force to eliminate bulk mercury from dental offices, worked with automobile

manufacturers to phase out the use of mercury in automobiles and sent letters to Michigan hospitals asking them to phase out mercury use. Numerous education and outreach materials have also been developed to promote mercury reduction.

Ontario Emission Monitoring

The first phase of Ontario's emission monitoring and public reporting initiative began on May 1, 2000. In this phase, the electricity sector was required to monitor and report on 28 pollutants, including mercury (Hg) and the key contributors to climate change, smog, and acid rain: carbon dioxide (CO2), nitrogen oxides (NOx), and sulphur dioxide (SO2).

The next phase, which began on May 2, 2001, covers 358 pollutants. Additional key contributors to climate change and smog, such as nitrous oxide, methane, carbon monoxide, particulate matter (PM 2.5), and volatile organic compounds, were included in the new regulation. The regulation also includes pollutants addressed in the National Pollutants Release Inventory (NPRI).

Beginning on January 1, 2002, other industrial, institutional, commercial, and municipal emitters will be required to monitor and report on their seasonal and annual emissions of the 358 regulated pollutants. This new monitoring and reporting program is a vital step toward improving air quality, addressing long-range transport of critical pollutants, motivating companies to lower their emissions, leveling the environmental playing field for companies in all economic sectors, setting and enforcing new emission limits, and laying the groundwork for innovative new initiatives like Ontario's proposed emission reduction trading system. Moreover, the new monitoring information will provide valuable, comprehensive data that can be used to determine actual air transport loadings of mercury and dioxin to the Lake Superior basin from all the commercial and industrial sources in Ontario.

Minnesota Voluntary Mercury Reduction Initiative

Minnesota is experimenting with a voluntary mercury emission reduction approach through the Voluntary Mercury Reduction Initiative. Under a Minnesota statute, all facilities that emit more than 50 pounds of mercury per year have been asked to participate in a voluntary reduction program. To date, MPCA has received 15 voluntary agreements to reduce mercury emissions. Some of the agreements were even submitted by companies that release less than 50 pounds of mercury per year.

The law required that MPCA report on progress made on mercury emission reductions in October 2001 and again in 2005. The 2001 report can be found at http://www.erc.state.mn.us/. The Minnesota statewide inventory shows that significant emission reductions have already occurred as a result of the decrease in use of mercury in products. In one case, a taconite mineral processing facility removed over 400 kilograms of mercury through use of process controls and replacement of mercury-bearing equipment. Future emission reductions will depend on progress in economic sectors where mercury is incidentally released during such processes as fuel combustion and ore processing.

The Minnesota initiative program has a special Lake Superior connection. The statewide mercury reduction goal of 60 percent by 2000 is the same as that for Lake Superior, and the statewide goal of 70 percent reduction by 2005 is bracketed by the Lake Superior reduction milestones of 60 percent by 2000 and 80 percent by 2010.

Wisconsin's Proposed Rule to Reduce Mercury Emissions

Wisconsin is working on a mercury emission regulatory program targeting coal-burning power plants and other large mercury sources. Believed to be the largest source of mercury pollution in the state, coal-fired power plants have been identified as crucial in addressing the problem of mercury in the environment. In 2001, Wisconsin issued a statewide fish consumption advisory because of mercury contamination. Regulatory actions that Wisconsin and some other states are taking may influence and inform federal mercury reduction policy and actions.

In December 2000, the Wisconsin Natural Resources Board adopted a resolution that granted a citizen petition seeking rule-making to reduce mercury emissions to the air. At the direction of the board,

WDNR developed a proposed rule that would reduce mercury emissions but would not interfere with the ability of electric utilities to supply the state's energy needs. The proposed rule calls for a phased reduction of 30, 50, and 90 percent in the mercury emissions from coal?burning power plants in Wisconsin over 15 years. The rule would set mercury emission ceilings for large sources and would require new sources to offset increases in mercury emissions. The rule would allow sources to earn emission reduction credits based on voluntary activities such as pollution control equipment installation, process changes, and pollution prevention. The emission reduction credits would allow a major utility to achieve up to 50 percent of its emission reduction requirement. The proposed rule also provides for ongoing evaluation of the feasibility of mercury reduction, federal regulatory development, and review of long?term mercury storage and disposal issues.

Public review of the proposed rule provisions and alternatives is scheduled to conclude in October 2001. The current proposal states that within two years of rule promulgation, major utilities and large stationary sources must provide baseline mercury emission information *(see www.dnr.state.wi.us/org/caer/ce/mercury/)*.

Tribal/First Nations Governments of Lake Superior (U.S. Focus)

Tribal/First Nations governmental agencies within the Lake Superior Basin have programs or have undertaken projects that monitor physical and chemical contamination in the air. The Fond du Lac Band of Lake Superior Chippewa (FDL) and the Bad River Band of Lake Superior Chippewa have ongoing air monitoring programs that measure mercury deposition and particulate matter as well as other elements. In addition to mercury, FDL monitors weekly for acid, quarterly for dioxin, seasonally for ozone, and continuously for fine particulates (PM2.5) and will soon add continuous monitoring for NOx. The Inter Tribal Council of Michigan Inc. is collaborating with Environment Canada, Ontario Ministry of the Environment, U.S. EPA, and the Michigan Department of Environmental Quality to conduct joint U.S.-Canadian air monitoring in the Sault Ste. Marie area. The purpose of the monitoring is to characterize the amounts of fine and course particulate matter in the air. Keweenaw Bay Indian Community (KBIC) completed a study to characterize overall ambient air quality on the L'Anse Reservation. Between February 2000 and February 2002, KBIC monitored the levels of particulate matter in the air as well as analyzing those samples for mercury and other trace heavy metals. KBIC's preliminary results verify that PM2.5 levels are indeed low in the vicinity of the Reservation. U.S. EPA provided support for many of these projects and programs.

The Tribal governments listed above as well as Tribal governments like the Grand Portage Band of Lake Superior Chippewa and the Red Cliff Band of Lake Superior Chippewa are at various stages of investigating or pursuing either air monitoring programs or federal authorization through Treatment as a State to regulate air quality on reservations. Some Tribes, like the Red Cliff Band, are interested in increasing their air quality designation to a more stringent level (Class I), which would give them protections similar to National Parks.

International Initiatives

Recognition of the threat of air deposition of pollutants led to the signing of the Global Treaty on Persistent Organic Pollutants (POPs) in May 2001 by 122 countries, including the United States and Canada. The treaty requires countries to reduce or eliminate production, use, or release of 12 POPs. An international treaty was required because POPs linked to adverse health effects can travel thousands of miles through the atmosphere. Domestic implementation of the treaty's provisions is required of the signatories, and regional implementation is encouraged. For more information on the POPs Treaty, including an informational brochure, please see *www.epa.gov/oia*.

The current list of POPs includes

- Pesticides: aldrin, dieldrin, endrin, DDT, mirex, chlordane, heptachlor, HCB, and toxaphene
- Industrial chemicals: PCBs and HCB
- Unintentional by-product pollutants: dioxins and furans as well as PCBs and HCB

Except for mirex, all the POPs are on the list of critical pollutants for Lake Superior. The complete list of critical pollutants, which includes heptachlor and endrin, for example, can be viewed at *http://www.epa.gov/glnpo/lakesuperior/chapter1.html*.

In the United States and Canada, there is no production, import, or export of any of the POPs pesticides. However, the United States expects HCB to be produced and used as a closed-system, site-limited intermediate consistent with the provisions of the POPs Treaty. Both governments have banned manufacture of PCBs, and the United States has imposed stringent controls on releases of dioxins and furans to the atmosphere.

The 1994 North American Agreement on Environmental Cooperation among Canada, Mexico, and the United States provides the framework for cooperation regarding environmental issues. North American Regional Action Plans (NARAP) have been developed and approved for DDT, chlordane, PCBs, and mercury. NARAPs for cluster dioxins, furans, and HCB and for environmental monitoring are also under development. Lindane and lead are candidates for future NARAPs.

Specific actions associated with the NARAPs include a North American air emission inventory for mercury sources and releases and a proposed mercury air monitoring network for Mexico. Alternative PCB disposal technologies were analyzed in 2001. Mexico has implemented the DDT NARAP two years ahead of schedule. With the cessation of chlordane manufacture, the associated NARAP was successfully concluded. In 2001, a baseline air emission inventory was prepared for dioxins and furans; this inventory will be linked with existing national inventories. Collaborative work will soon commence to set up a dioxin and furan monitoring network in Mexico.

Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

Ecosystem Progress Report

Accomplishments:

1. Restoring coaster brook trout habitat on the Salmon-Trout River
2. Implementing a water management plan for hydroelectric facilities on the Nipigon River
3. Implementing mark-and-recapture studies to estimate the number of sea lampreys entering Lake Superior
4. Implementing spring lake trout surveys throughout Ontario by the Ontario Ministry of the Environment
5. Acquired funds through U.S. Geological Survey and Great Lakes Environmental Research Laboratory to begin acoustic surveys on Lake Superior
6. Applied the ECOSIM and ECOSPACE whole fish community models to Lake Superior
7. Implementing Sugarland Cove and Michigan Upper Peninsula wetland restoration projects
8. Began the planning process for Lake Nipigon Basin Signature Site
9. Completed a biological diversity inventory and developing a management plan for the Lake Superior highlands
10 Implementing the peregrine falcon recovery program in Ontario; documented all peregrine activity in the province

Challenges:

1. Determining the “healthy” mammalian community structure in the basin
2. Continuing neotropical migrant bird population monitoring
3. Placing greater emphasis on amphibian and reptile restoration and protection
4. Managing shoreline development
5. Promoting local land use management laws and projects to protect wetlands

Next Steps:

1. Conduct greater outreach to local communities and provide resources to support habitat restoration and protection projects
2. Continue developing a comprehensive set of ecosystem targets
3. Continue working on balancing effective control measures for exotic species with preservation and restoration of native species
4. Implement the “Great Lakes Action Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species”

Section 4:

The Lake Superior Ecosystem - Status and Challenges

Aguasabon River, Ontario
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Introduction

Lake Superior and its watershed comprise one of the most complex ecosystems in North America. An ecosystem consists of the interactions between biotic (animals, plants, and microorganisms) and abiotic (rocks, soil, air, and water) elements in the environment. These interactions define the function of the plants and animals that live in a particular ecosystem. Stresses on the ecosystem, such as land uses that disturb the soil and result in increased siltation in streams and lakes, have differing effects on the plants and animals that live there.

LaMP 2000 examined stressors and their impacts on individual components of the Lake Superior ecosystem. This section discusses these stressors; provides an update on the status of the Lake Superior ecosystem, and describes some of the protection and restoration work done by local communities in cooperation with state, provincial, tribal, and federal agencies; and offers strategies for addressing future challenges.

Stressors on the Ecosystem

The list of plant, animal, and habitat stressors identified in LaMP 2000 is long and diverse. Most stressors are directly associated with human activities (a short list is provided in Table 4-1). For example, species such as wild rice, caribou, and loons can be negatively affected by human activities. Habitat functioning can be reduced or eliminated by human activities such as construction of barriers on tributaries or fire suppression in valuable terrestrial habitat. Habitat structure is simplified by human activities such as separating large forests into smaller parcels during development and stabilizing water levels to eliminate flood events. In addition, people affect biological communities, such as fish populations or native plants, by introducing invasive, exotic species into forests, wetlands, lakes, and streams.

One of the difficulties with having such a diversity of stressors is that there is no short list of indicators that could be used to monitor the health of the Lake Superior ecosystem. To this end, a set of five biological, community-based indicators has been explored and is now being developed to assess the "health" of the terrestrial system: (1) breeding migratory birds, (2) medium-sized carnivores, (3) reptiles and amphibians, (4) soil invertebrates and mosses, and (5) lichens and fungi (see Table 4-1). Additional indicators are being developed for the

Table 4-1. Stressors Identified in the Habitat and Terrestrial Wildlife Chapters of LaMP 2000

Stressor	Examples of Species Affected	Examples of Habitat Structure or Function Affected	Examples of Communities Affected
Contaminants	fish-eating animals	increased mortality rates	aquatic communities
Dam construction	spawning fish, wild rice	stream flow, lake level increases	aquatic and wetland communities
Eutrophication	rare aquatic species	increased competition	submerged and emergent wetlands
Fire suppression	sharp-tailed grouse	fires that set back succession, nutrient cycling	boreal forests, pine barrens
Fragmentation	neotropical migrants	increased predation, isolation effects	mesic forest community
Global climate change	reptiles and amphibians	increased mortality rates	all communities
Groins, dykes, breakwalls	native plant communities and wetlands	sedimentation and nutrient cycling reduction	coastal wetland communities
Invasive exotic species	native plants	increased competition	aquatic, wetland, and upland forests
Logging	caribou	habitat simplification	boreal forests
Loss of conifers	neotropical migrant birds	loss of protective cover	mesic forest community
Overabundant species	yew, hemlock	increased herbivory	northern forest communities
Recreation	loons, shore birds (plovers)	increased disturbance	lakes and lakeshores
Road construction and maintenance	Fish and aquatic plants and animals	sedimentation	northern forest communities
Shoreline residential development	reptiles and amphibians, some migratory birds	habitat simplification	lakeshores, dunes
Water level manipulation	wild rice	reduction of water-related disturbance events	coastal wetland communities

GIS Mapping of Lake Superior Fish Spawning and Nursery Areas

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has utilized a GIS to identify historic spawning and nursery areas of Lake Superior fish. The GIS data have been used to create maps of 1,566 Lake Superior spawning sites for various species of interest. The maps generated have been produced at a lake-wide scale, along with 41 detailed maps giving more precise locations. The Lake Superior spawning and nursery locations will be made available through GLIFWC's internet map server, allowing public viewing of information for fish species in combination with other information on navigation routes, lake bathymetry, and the lake and rivers in the Lake Superior watershed.

Contact Sandra Hellman at 312-353-5006 or e-mail at *hellman.Sandra@epa.gov*
or Duane Heaton at 312-886-6399 or e-mail at *heaton.duane@epa.gov*

The St. Louis River estuary provides habitat for colonial waterbirds such as common terns and great blue herons. Its wetlands, bays, and river channels are important spawning areas for fish such as lake sturgeon and walleye. Migrating birds use the estuary as a critical stopping point in both spring and fall.

Photograph by Eric Epstein, Wisconsin Department of Natural Resources

aquatic portions of the Lake Superior ecosystem. A few of those indicators are included in Table 4-1.

Although this section does not assess all the stressor indicators described above, it does address the current status of four components of the Lake Superior ecosystem: open lake, wetlands, upland communities, and inland lakes and tributaries. This section also reviews some of the accomplishments in managing ecosystem stressors since LaMP 2000.

Ecosystem Status

Open Lake and Nearshore Waters

Overall, the aquatic community of Lake Superior more closely resembles the original community of the lake that existed prior to European settlement than any of the other Great Lakes. However, the aquatic community continues to face significant human-induced stresses that reduce its diversity and impede its proper functioning. Sea lampreys continue to kill many fish, and shoreline development slowly continues to reduce and alter available habitat. Although toxic chemicals have minimal effects on the abundance of fish in Lake Superior, the chemicals continue to enter the lake and accumulate in fish to the point where consumption advisories are necessary to protect human health.

Effluent from mining operations, pulp and paper mills, and other industrial sources continues to be a problem in urban areas and elsewhere. Chemical and biological pollutants continue to enter the waters of Lake Superior, limiting reproduction of aquatic organisms, and damaging nearshore habitat. Effluent from the pulp and paper industry has resulted in accumulation of contaminated sediment, habitat loss, degradation of nearshore areas, and loss of species abundance and diversity. These discharges contributed to the creation of many of the AOCs.

In Canada, the federal and Ontario pulp and paper regulations have led to significant improvement in the quality of the effluent from pulp and paper mills. Biochemical oxygen demand levels have decreased by over 90 percent, effluents are non-acutely lethal and no longer contain measurable concentrations of 2, 3, 7, 8-TCDD. Sub-lethal toxicity data obtained

Monitoring of Aquatic Ecosystems

Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

Many coordinated, long-term monitoring programs are in place to assess Lake Superior's aquatic ecosystem. A few examples include the following:

- A coordinated, long-term monitoring program to evaluate populations of lake trout in Lake Superior has been in place since the late 1950s. State and provincial agencies and Tribes/First Nations conduct spring gill net surveys of lake trout. Results from these surveys are used to set harvest limits and stocking policies, evaluate the effectiveness of the sea lamprey control program, and determine interactions between native and nonindigenous species both within and among jurisdictions.
- The federal governments monitor the abundance of adult sea lampreys in Lake Superior and larval lamprey in tributaries. This information is used to assess the effectiveness of the sea lamprey control program.
- State agencies monitor the abundance of trout and salmon in tributaries to Lake Superior.

through the federal, regulated environmental effects monitoring program (EEM) indicate that the installation of secondary treatment at Ontario mills has significantly lowered the sub-lethal toxicity of pulp mill effluent to aquatic organisms. Subsequent to the installation of secondary treatment and other process changes at the Jackfish Bay, Ontario, mill some improvements were noted; however, fish collected in 2000 still exhibited some signs of altered reproductive function. Research work to characterize effluent compounds and evaluate the effectiveness of current treatments is ongoing. The effectiveness of the regulations in protecting the aquatic communities downstream will continue to be assessed through the EEM program.

Hydroelectric facilities that generate power using dams on rivers can also stress aquatic life. By reducing the need for coal-fired power plants, this energy source helps reduce toxic loadings, but it can also artificially alter river flows and degrade habitat for aquatic creatures. In addition, hydroelectric plants hold water in summer, which leads to an increase in the temperature of the remaining,

The Fall and Rise of the Lake Trout

Lake trout once supported a major commercial and small sport fishery in the Great Lakes. By the 1950s, the lake trout was nearly extinct because of overfishing and predation from the sea lamprey. Annual harvesting of lake trout fell from about 17 million pounds to next to nothing. For some time, it was unclear whether the lake trout would survive in the Great Lakes.

During the 1950s, state, provincial, and federal governments began stocking lake trout, placed limits on sport and commercial fishing, coordinated sea lamprey control, and worked to improve Great Lakes water quality. The program has been a great success. Today, Lake Superior is the only Great Lake that supports a self-sustaining lake trout population.

shallower water. This in turn leads to reduced dissolved oxygen levels and thus affects aquatic life.

Success Stories/Remaining Challenges

This section addresses successes and remaining challenges in restoring aquatic native species and controlling aquatic nuisance species. Contaminated sediments are also a source of impairment in Lake Superior; they are addressed in Section 3.

Restoring Native Aquatic Species

Great successes have been achieved in restoring native fish populations in Lake Superior. After years of effort, greater numbers of naturally reproducing lake trout are present in Lake Superior than in all the other Great Lakes combined.

The success with lake trout restoration has allowed the focus to shift to restoring other aquatic species, including brook trout, walleye, and lake sturgeon. Although brook trout, walleye, and lake sturgeon have not yet reached their historical population levels, they are making a comeback in Lake Superior. Much of this success is attributable to local communities and fishery agencies that are taking a lead in restoring tributaries to the lake, where fish are once again spawning. Examples of restoration projects include the following:

- The Central Lake Superior Watershed Partnership is restoring critical habitat along and within the Salmon-Trout River. Working with funds received from the U.S. Fish and Wildlife Service and U.S. EPA, this consortium of private, public, and citizen groups is working to enhance resident populations of coaster brook trout.
- A Nipigon River water management plan was created to regulate input and output of water by hydroelectric facilities on the Nipigon River in Ontario. This plan was developed specifically to restore the coaster brook trout, the original native species of brook trout in the Great Lakes. The plan successfully defined the minimum flows necessary to promote reproduction by coasters in the Nipigon River. A new harvest restriction establishing a daily bag limit of one fish of 51 centimeters or greater total length was instituted to better protect mature coaster brook trout.
- Wisconsin DNR is working with local watershed groups and other partners to implement its Lake Superior Basin Brook Trout Management Plan through protecting tributary watersheds.

The most effective strategies for restoring native fish in Lake Superior require strong local participation as well as cooperation with agencies at various levels of government. Restoration efforts must be conducted on a watershed scale to ensure that

A larval lake sturgeon captured in the White River. It is a product of reproduction in the wild.
Photograph by William Mattes,
Great Lakes Indian Fishery and Wildlife Commission

spawning grounds are restored, allowing the species to reproduce in a self-sustaining manner.

Controlling Aquatic Nuisance Species

One of the greatest threats to the restoration and viability of native aquatic species in Lake Superior is aquatic nuisance species, or invasive exotic species.

Sea lampreys and alewives entered Lake Superior because of construction of the Welland Canal, while more recent arrivals such as the zebra mussel, round goby, and ruffe entered the lake through ballast water release. Humans purposely introduced other species such as the Pacific salmon, carp, and brown trout into Lake Superior for sport fishing purposes.

To reduce sea lamprey abundance in Lake Superior, governments have been using various integrated measures. One such control measure is use of barriers to prevent movement of the sea lamprey into tributary rivers and streams, where the lamprey spawn. However, in addition to stopping new infestations of lampreys, these barriers prevent movement of native species into tributaries and reduce the diversity of native fish species. Barriers can also protect native lamprey from lampricides. Barrier technology has evolved such that inflatable crest barriers are now used and only for a few months of the year. Specially formulated chemicals are used to target and kill larval sea lampreys, but these chemicals sometimes also kill native invertebrates and fish.

The sea lamprey attaches itself to fish with its mouth. Photograph courtesy of U.S. Fish and Wildlife Service

No Ballast on Board (NOBOB) Vessels

U.S. EPA is jointly working on a project with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Coast Guard to examine the impact of NOBOB vessels as a significant vector for the introduction of invasive aquatic species. NOBOB vessels account for over 75 percent of the vessels entering the Great Lakes each year. Although they do not contain ballast water, these vessels do have a large amount of sludge and sediment at the bottom of their tanks that have the potential to harbor a whole community of aquatic organisms. The project will examine the potential risk of discharges from these unregulated NOBOB vessels.

The Great Lakes Fishery Commission (GLFC) is a critical partner in achieving a balanced and healthy fish community in Lake Superior, both in terms of controlling exotic species and rehabilitating native species in the lake. GLFC has adopted and implemented an integrated management of sea lamprey (IMSL) approach to control sea lamprey in the Great Lakes. The IMSL process involves using a variety of control methods instead of relying solely on chemicals. For example,

- GLFC is reducing the minimum lethal concentrations of chemicals used to kill larval sea lampreys in order to protect young lake sturgeon and is scheduling chemical treatments later in the summer to reduce the effects on young lake sturgeon. GLFC has reduced chemical use by 50 percent compared to the amounts used in the 1990s.
- GLFC is also using sterile-male releases to impede the reproductive success of sea lampreys, conducting mark-and-recapture studies with juvenile and adult sea lampreys to measure population trends, and researching other strategies to reduce populations of sea lampreys without harming other parts of the ecosystem.
- GLFC technical committees have also developed lakewide lake trout population models that estimate total allowable catches of lake trout, evaluate various fishery management strategies,

and estimate damage by sea lampreys to lake trout populations.

Despite the great progress made, sea lampreys continue to kill many fish each year, threatening the restoration of lake trout to Lake Superior. The principal challenge in controlling the sea lamprey and other exotic species in the lake lies in balancing the use of effective control measures for exotic species with preservation and restoration of native species.

Since the publication of LaMP 2000, two additional recommendations have been made by the Great Lakes community to address aquatic nuisance species:

1. Continue to develop and promote the use of technologies to safely and effectively treat ballast water discharges

2. Investigate the possibility of developing a "rapid response" team with the authority to make effective decisions on how to best respond to a new invader once discovered.

An additional important activity is the work of the Great Lakes Panel (GLP) on aquatic nuisance species. In March 2001, the GLP finalized a "Policy Statement on Ballast Water Management to Control Aquatic Nuisance Species." The objectives of the policy are to (1) eliminate ballast associated with aquatic nuisance species introductions into waters of the Great Lakes-St. Lawrence River system and (2) reduce aquatic nuisance species dispersal between the lakes through regional development and application of a timely, effective, scientifically sound, and economically viable binational water management program.

In summer 2001, the GLP finalized "A Great Lakes Action Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species." The overall goals of the plan are to raise the visibility of the aquatic nuisance species issue in the Great Lakes and to enhance the health of the Great Lakes ecosystem by designing and implementing timely and effective prevention and control measures. The plan has been signed by all eight governors and two premiers in the Great Lakes-St. Lawrence River region.

Wetlands

Wetlands in the Lake Superior basin feed water and nutrients to lakes and streams, a process that is critical for upper food chain animals such as migratory birds and fish as well as humans. Because Lake Superior is so deep, cold, and otherwise inhospitable to many warm-water aquatic animals, these wetlands are critical for keeping the lake alive. Wetlands are found in the Lake Superior basin at all elevations but are prevalent at upper reaches of streams; along slow-moving stretches of streams; in large, shallow depressions in the landscape; and on the Lake Superior coastline.

The greatest threats to Lake Superior's wetlands are water level regulation and site-specific stresses such as shoreline development. Modified water

Sanctuary Island
Thunder Bay, Ontario

Constructed during the winter of 1993, this crescent-shaped island is designed to foster natural development of a wetland and restore some diversity to an area affected by harbour development. The island is 205 meters long and was built using 25,000 tons of quarry stone. Underwater features, such as rock shoals and sediment traps, and pockets of topsoil add habitat value to the standard armour stone berm construction. Birds are now nesting on the island, waterfowl are often found in the inner bay, and fish are using the new habitat. A "Name the Island" contest held in local schools drew 114 entries. The winning name, Sanctuary Island, was submitted by a 9-year old girl.

Photograph courtesy of
Ontario Ministry of Natural Resources

Students restoring native plants at Sugarloaf Cove
Photograph by Diane Destolle

Sugarloaf Cove: A Unique Restoration

A joint effort between the Minnesota Department of Natural Resources and the Sugarloaf Interpretive Center Association (SICA) restored coastal wetland and upland habitats at the Sugarloaf Point Scientific and Natural Area and surrounding property owned and managed by SICA.

Long ago, the bedrock island just offshore at the site became connected to the mainland by a pair of gravel beaches, forming what is known as a tombolo. This protected the enclosed wetland area from the energy of the lake and allowed a wetland plant community to develop. The tombolo also formed a natural protected cove that was used from the 1940s through the 1970s by Consolidated Paper. The site was used to create log rafts bound for Ashland, Wisconsin where they were loaded on railcars headed for inland paper plants. During the time the land was used for moving logs, low areas were filled and much of the forest was cut so that buildings and roads could be constructed. When the paper company stopped using the site, most of the buildings were removed.

After being considered as a site for a safe harbor development, the Sugarloaf Point natural area was expanded and the surrounding land came under the management of the nonprofit Sugarloaf Interpretive Center Association. Restoration of native plant communities is a priority both for SICA and for the DNR's Division of Ecological Services which manages the natural area. Cooperation between the DNR and SICA, as well as grant money from the EPA's Great Lakes National Program Office, allowed a thorough survey of remaining natural plant communities as well as an investigation under the surface of the fill placed on the wetland in the past. Using the results of these surveys to carefully define restoration targets for both uplands and wetlands, restoration began in earnest in 1999. Fill removed from over the wetland soil was used to restore upland areas such as an old road site.

The strong educational focus of the Sugarloaf Interpretive Center Association will assure that the lessons learned in restoring wetland and upland plant communities on the shores of Lake Superior are available to residents and visitors alike.

Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Whittlesey Creek Watershed

Photograph courtesy of
Wisconsin Department of Natural Resources

The Whittlesey Creek Watershed project is designed to protect coastal wetlands, restore habitat in the watershed, and involve both citizens and agencies. The project was initiated by the Bayfield County Land Conservation Committee using state nonpoint source pollution funds. A plan for improving watershed health was developed. Since 1996, Wisconsin has provided over $120,000 to cost share with landowners to restore wetlands, re-plant critical habitat, and stabilize eroding stream banks. Whittlesey Creek National Wildlife Refuge was established in 1999 to protect coastal wetlands and restore wetland and stream hydrology. Private landowners are given technical and financial assistance for habitat restoration projects that improve both aquatic and terrestrial community health in the watershed. State, federal, and nonprofit organizations are working cooperatively to restore the native coaster brook trout to Chequamegon Bay and Whittlesey Creek. A fishery assessment of Whittlesey Creek was conducted in summer 2001 as a precursor to restoration work. The U.S. Fish and Wildlife Service is offering to purchase conservation easements from landowners in the watershed to protect fish and wildlife habitat. Bayfield County and the U.S. Geological Survey are completing a hydrologic study of surface water and groundwater flows and of the effects of land use on those flows. The study results will help direct future habitat protection and restoration work.

level fluctuations pose significant threats to Lake Superior wetlands because they alter the community composition of native animal and plant life in and near wetlands. Lake Superior's coastal wetlands rely on natural fluctuations in water levels associated with daily and annual cycles to maintain their biological diversity and productivity. Native aquatic species also face difficulties because the increased loss of wetlands degrades water quality, damages aquatic habitat, and impedes fish reproduction.

Many important plants and animals in the Lake Superior basin depend on wetlands for all or part of their life cycles. For example, wild rice is a culturally important plant in the basin even though its distribution is not extensive. Although a number of factors can harm wild rice, it is particularly sensitive to water level changes. Many lakes and rivers have been dammed, and even small water level changes can destroy wild rice habitat.

Success Stories/Remaining Challenges

Many wetland protection and restoration efforts have been driven by changes in state and provincial laws and by local communities (such as the Whittlesey Creek Watershed project and the Sugarloaf Cove restoration). In addition, the Michigan Upper Peninsula Coastal Wetlands Partnership has protected or restored several thousand acres of wetlands. New laws and locally driven projects are accelerating wetland protection and restoration, but challenges remain as the drive to fill and develop wetlands continues.

Upland Communities: Terrestrial Flora and Fauna

Terrestrial flora and fauna occur on lands not covered by standing water. These uplands encounter stresses similar to those faced by wetlands-primarily land use and land development changes. Habitat and land use changes have significantly affected uplands in the Lake Superior basin, especially over the last 150 years. In the three states bordering Lake Superior, timber harvesting, land clearing for agriculture, and fires caused by the advance of settlement removed almost all the pre-existing forest cover. Similar land-clearing for settlements and agriculture occurred in the eastern (Sault Ste. Marie) and western (Thunder Bay) portions of the basin in Ontario. Forest cover in the northern basin area of Ontario has primarily been influenced by forest fires, lumber harvesting,

Michigan Upper Peninsula Coastal Wetlands Partnership
Two Rounds of Success

This highly successful partnership of some 15 local natural resource entities, communities, and tribes has performed nearly $8,000,000 worth of work to protect, restore, and manage coastal wetlands and associated uplands in the Lake Superior and St. Marys River watersheds. Working in two phases, the partnership has obtained nearly $2,000,000 in North American Wetlands Conservation Act (NAWCA) grant funds (in two phases) and has provided nearly $6,000,000 in matching funds and activities.

The initiative brought together all the major natural resource entities in the basins to begin breaking down barriers in working relationships and to combine technical, biological, and cultural expertise in order to create the most efficient working group to address resource needs. This working group has identified coastal shoreline areas on Lake Superior and on river corridors as being threatened by fragmentation and development. Preventing the destruction of these areas has been a priority for the partnership in Phases I and II of the work.

Phase I Accomplishments:

- 1,237 acres of wetlands and 1,573 acres of associated uplands protected from development
- 7,847 feet of Lake Superior shoreline protected from development
  -- including 3,347 feet of "essential" breeding habitat for piping plover recovery
- 77 acres of wetlands restored in the Rudyard Clay Plain

Phase II Accomplishments:

- 1,619.4 acres of wetlands and 1,689.97 acres of associated uplands protected, including breeding habitat for a variety of waterfowl; wetland-dependent, threatened, and endangered species (the piping plover); fish (the coaster brook trout); and wildlife
- Approximately 4,000 feet of Lake Superior shoreline protected
- River frontage on the Gratiot River, Presque Isle and Yellow Dog Rivers protected
- 144 acres of acquired lands enhanced
- 86 acres of wetlands restored
- 76 acres of wetlands enhanced

road and rail construction, and, to a lesser degree, mining activities. Restoration is thus complicated by uncertainty regarding how reintroduced native species will respond to these changes in the ecosystem.

Forest fragmentation occurs when large blocks of forest are broken up into smaller forest patches. This is happening at an increasing rate in the Lake Superior basin. Dividing a forest into fragments with cleared land, roads, and developments makes the fragments more vulnerable to ecological stress. Stressors such as overabundant wildlife species and habitat isolation are more likely to adversely affect smaller patches of forest. Moreover, animals in forest edges experience greater rates of predation than animals in areas deeper in the forest because of these exposures. Forest fragmentation and

Moose on the shore of Isle Royale National Park
Photograph by Glenn Miller, US Fish and Wildlife Service

Photograph courtesy of Canadian Wildlife Service

Peregrine Falcon

loss of mature forest cover threaten forest-dwelling birds such as the veery, black-and-white warbler, ovenbird, and northern waterthrush, as well as some medium-sized carnivores such as the American marten. In Ontario, forest fragmentation and increased access to the forest have contributed to the reduction in woodland caribou range.

Species relying on more open habitat are also under stress. Fire suppression has allowed increased conversion of some upland habitat that was previously maintained in more open conditions (such as pine barrens) and has resulted in a decline of open habitat- dependent species like the sharp-tailed grouse and upland sand piper.

Where they can dominate the landscape, invasive exotic plant species are beginning to cause a reduction in diversity. Prevention and control measures are necessary to address these species, but little work has been done to survey the extent

Lake Nipigon Basin Signature Site

The Lake Nipigon Basin Signature Site was identified as one of nine featured areas under Ontario's Living Legacy as having a range of highly significant values that warrant special strategies. Ontario's Living Legacy Land Use Strategy resulted from an intensive provincial Lands for Life planning process. The resulting Land Use Strategy (LUS) provides direction regarding land designations, permitted land uses, and future planning and consultation needs. Planning decisions presented in the LUS govern development of objectives and options during the signature site planning exercise.

The goal of the Lake Nipigon Basin planning project is "to protect, enhance and where necessary, restore the natural ecosystems, populations and wilderness quality of the Lake Nipigon Basin while allowing for tourism, recreational and industrial developments that will not compromise the integrity and environmental values of the Basin ecosystem."

Three primary land use categories are proposed for the Lake Nipigon Basin: provincial parks, conservation reserves, and enhanced management areas. These areas cover almost 370,000 hectares of land and water.

The project team is developing an Ecological Land Use and Resource Management Strategy to protect the basin ecosystems while allowing for tourism and recreational development opportunities. This is being achieved by working with the public, aboriginal groups, various agencies, and interest groups to gather background information and develop options. Opportunities for the public to actively participate in the decision-making process will be provided throughout the planning period (January 2001 to September 2002).

The Lake Nipigon Watershed Advisory Committee, a standing committee of local citizens, and the newly created Lake Nipigon Basin Aboriginal Advisory Committee, which has representation from the eight aboriginal communities in the area, will also be instrumental in the decision-making process.

To date, a background document and management options discussion paper have been developed and two series of public information centres have been held. Comments on the management options paper were received in March 2002 and preparation is underway to develop a preliminary management strategy for Spring 2002. Further public consultation will occur at this stage and a final management strategy will be developed.

Lake Superior Highlands Inventory and Community Initiative

Hat Point, Minnesota
Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

This project was coordinated by The Nature Conservancy of Minnesota with funding from U.S. EPA's Great Lakes National Program Office. This project helped launch a major new conservation program for the region along Minnesota's Lake Superior shoreline. The work began with identification of landscape study areas in each Land Type Association in the North Shore Highlands Subsection to target areas for further inventory of biological diversity of the Subsection. Inventory work was conducted by staff from MN DNR's County Biological Survey. It included collaboration with numerous scientists, land managers, community leaders, and landowners to gather information and communicate results of the survey so inventory data could begin to be used to achieve conservation objectives. Resulting accomplishments included helping to develop the St. Louis River Habitat Plan, identification and protection of 3,000 acres of ecologically-significant forest areas within the Manitou Landscape Study Area, establishment of a collaborative partnership in the Manitou Landscape to manage lands and waters within ecological parameters, initiation of agreements to protect significant aquatic features along the Pigeon River, and development of a memorandum of understanding between The Nature Conservancy (TNC) and the City of Duluth to use inventory data to develop a natural area designation of ecologically significant city-owned lands. This work formed the basis for the Minnesota portion of TNC's Great Lakes Ecoregion Plan, which is the first comprehensive plan for the conservation of the native species and natural communities of the Great Lakes.

of current invasions or to develop strategies to minimize the impact of invasive species on upland and wetland communities on a basinwide basis.

Dunes contain habitat for a number of endemic species. Dunes are threatened primarily by residential development and road construction. Most sand beaches depend on the natural processes of erosion, longshore sediment transport, and sand deposition. Interference with the hydrologic cycle and barriers to sediment transport can interfere with these critical processes.

Success Stories/Remaining Challenges

The push to develop uplands continues as local communities seek new economic development and residential development. Projects like the Lake Nipigon Basin Signature Site (see box) are providing a new model for future upland protection and restoration work. Leadership by local communities and partnerships with federal, state, and provincial agencies and Tribal/First Nation groups are essential to the long-term protection of upland habitat.

Many people think of wildlife in terms of species such as deer, grouse, ducks, and songbirds. They

Bald Eagle
Photograph courtesy of The Canadian Wildlife Service

think less often of wildlife in terms of plants, herptiles, and microorganisms and their functions in the overall ecosystem. Many questions remain about the effects of contaminants on amphibians, reptiles, and mammals as well as the roles that invertebrates and microorganisms play in terrestrial ecosystem health.

One of the biggest challenges concerning management of mammals is to define which mammalian community structure represents a "healthy, sustainable wildlife community." The community profile of ungulates has changed because of alterations in land use and elimination of predators. The major question in restoration of northern forests revolves around whether current conditions represent a healthy wildlife community. Mammals are significantly affected by changes in land cover as development encroaches on their habitat. Some mammals like the caribou are negatively affected by forest fragmentation, while the populations of mammals that thrive on forest edges are increasing as forest edges increase.

Lake Superior forests provide very important habitat for migratory songbird populations, some of which probably serve as source populations for other areas. With concerns expressed across the continent about the decline of neotropical migrant birds, the Lake Superior basin should be considered an important region for migratory songbird conservation. Significant work continues on population monitoring, some of which is being linked to habitat changes on the landscape scale.

Amphibians and reptiles may be highly observable at certain times of the year and are also harvested, yet they have been essentially ignored in management plans in the past. Because the Binational Program is concerned with overall ecosystem health, closer attention should be paid to amphibians and reptiles during inventories, planning, and monitoring.

Inland Lakes and Tributaries

Literally thousands of inland lakes are found in the Lake Superior basin. These lakes range in size from small, winter kill lakes to Lake Nipigon which has a surface area of 448,000 hectares. Fish communities in the inland lakes and tributaries range from cold-water trout and whitefish communities lakes to warm-water bass and bluegill complexes.

The principal threat to inland lakes and tributaries is shoreline development. Although the human population in the Lake Superior basin has remained steady or has fallen slightly, recreational and summer home construction continues to grow. The resulting development disturbs basin soils and increases erosion and runoff to lakes and tributaries. Maintenance of developed properties may also increase deposition of pesticides to the lake.

Additional stresses include overfishing and exploitation of individual water bodies. Such practices result in reduction in the abundance of important fish species and alterations in the predator-

Project WILDSPACE™

For over 30 years, Canadian Wildlife Service has studied wildlife in Ontario and beyond, particularly bird species and their habitat in Canada. Project WILDSPACE™ was initiated in 1996 to develop a repository for wildlife data that would be accessible for use as a decision support system. The WILDSPACE™ web site (http://wildspace.ec.gc.ca/intro-e.html) provides access to this information by supporting searches by name (Species Search) or by an area on a map (Spaces Search). The Lake Superior Workgroup is considering how best to maintain the Lake Superior GIS (http://oden.nrri.umn.edu/lsgis/index.htm) and potential linkages with Project WILDSPACE™.

prey balance that may in turn result in stunted populations of panfish.

Iron ore mining also continues in the basin, although at reduced levels. Historically, mining practices have been associated with reduction in water quality and increased acidification of lakes, which decreases fish reproduction.

Success Stories/Remaining Challenges

Funding is being devoted for controlling nonpoint sources of contamination for lakes and streams. Michigan has provided more than $900,000 for projects addressing nonpoint source pollution and sediment control. The legislation under which the funds are provided requires a watershed management plan. Funded projects include the Munising Bay Watershed Project and the Central Lake Superior Watershed Partnership.

Wisconsin is funding local watershed organizations to develop watershed plans and strategies to help reduce the hydrological degradation common to the red clay watersheds of the south shore of Lake Superior.

Addressing inland lake and tributary stressors will also require actions at the federal, provincial, state, and Tribal/First Nation Levels, such as the following:

- In Minnesota, develop new policies with the timber industry to require use of best management practices to protect water quality
- In Wisconsin, purchase undeveloped shorelines and protect them
- In Ontario, conduct long-term experiments to evaluate the effect of logging on boreal forest lakes
- Develop monitoring programs to evaluate the status of important fish species

These actions will in turn support local management initiatives such as the Lake Nipigon Basin Signature Site.

Photograph courtesy of the Canadian Wildlife Service

Next Steps

The greatest opportunity for addressing habitat and land use change is to reach out to local units of government and provide them with information and tools so that their local land use decisions will help fulfill the Lake Superior Vision statement. Most successful projects are conducted at the local level with strong participation from local communities and in cooperation with state, provincial, Tribal/First Nation, and federal agencies. A greater effort needs to be made to build coalitions that together can work to restore the Lake Superior ecosystem as a dynamic entity.

In addition, a comprehensive set of ecosystem targets should be developed to guide management actions over the long term. In keeping with the public's recommendation of integrating the habitat, terrestrial wildlife, and aquatic committees, the three committees have started work on developing a set of ecosystem goals. The ecosystem goals being developed are for (1) uplands, (2) wetlands, (3) tributaries and inland lakes, (4) open lake, and (5) basin-wide considerations. Specific draft examples are provided below.

Uplands: Provide sources of native plants and seeds in an ecologically appropriate manner for use in restoration projects by 2006. Write and implement ecologically based integrated watershed management plans for all watersheds in the Lake Superior basin by 2025.

Great Blue Heron
Photograph courtesy of The Canadian Wildlife Service

Wetlands: Create and distribute a spatial database of coastal wetlands organized by type and condition and identify areas where restoration can occur by 2006. Restore 25 percent of the degraded wetland acreage in the Lake Superior basin by 2010.

Tributaries and Inland Lakes: Restore or protect 25 percent of the riparian conifer forest acreage by 2010. Rehabilitate 50 percent of 64 tributaries to Lake Superior in order to achieve Fish Community Objectives for indigenous lake trout, brook trout, walleye, and lake sturgeon. Rehabilitate the remaining tributaries by 2050.

Open Lake: By 2006, implement lake-wide acoustics monitoring to measure the abundance and species composition of the pelagic fish community. By 2010, quantify and describe the bottom substrates in 50 percent of Lake Superior waters that are less than 30 meters deep, and by 2015, quantify and describe the bottom substrates in the remaining waters that are less than 30 meters deep.

Basin-Wide: Develop and establish a unified, binational, GIS-based database that includes the most current and functioning basin-wide decision support models needed for ecosystem and watershed management and methods for providing data access and distribution by 2006. Complete an inventory and control plan for existing priority exotic species in the Lake Superior basin by 2010. By 2020, transfer knowledge of best management practices and LaMP goals to all affected units of government (townships, counties, and municipalities) within the 15 watersheds of Lake Superior.

Achieving Success: Strategies for Improving the Lake Superior Ecosystem

Although the status of the Lake Superior ecosystem is mixed, much work remains to improve the health of Lake Superior and its watershed. A number of success stories described in this section have resulted in improvements to the Lake Superior ecosystem. Although these successes involve a variety of partners, habitat types, and remedial activities, they have several common elements. Learning from these successes will help foster greater Lake Superior ecosystem improvements in the future. The common elements of the success stories include the following:

Strengthening Planning - Most stressors associated with problems in the Lake Superior basin are caused by human activities. As noted above, local land use plans should focus on protecting and restoring ecosystems and natural communities while at the same time maintaining the economic viability of human communities.

Developing a More Complete Inventory of Environmental Assets and Problems - Significant ecological inventory needs exist in the Lake Superior basin. For example, the extent of exotic species infestation of terrestrial ecosystems is still largely unknown.

Monitoring the Ecosystem More Effectively - Although the participants in the Binational Program have made much progress in identifying and testing monitoring protocols, there is a further need to refine and implement monitoring techniques and strategies. Several community-based indicators do not have standardized monitoring protocols.

Restoring and Maintaining Important Habitat - The Lake Superior basin has numerous important habitat sites. The locations of these sites have been stored in a spatial database on a GIS. Conservation actions should be implemented to maintain habitat function and structure at these habitat sites, and habitat restoration projects should use native plant species. Strategies should be developed for protection, maintenance, and restoration of ecologically important wildlife species and communities, and restoration plans for threatened or endangered species should be fully implemented. In addition to identifying high-quality habitat sites, the Binational Program should identify sites that have lost their ecosystem function or structure.

Improving Public Outreach and Education - Public outreach and education form one of the most important strategies for meeting the goals of LaMP 2000 and the Binational Program. It is critical to communicate the Lake Superior ecosystem approach as well as the vision and management plan developed for the basin. There should be greater emphasis on communicating with local governments and land management agencies so that the goals of LaMP 2000 can be incorporated into local laws and land use plans.

Reducing Contaminant Loads - Persistent contaminants affect wildlife and the habitat where they live. Although considerable information is available on the human health effects resulting from exposure to many contaminants, these substances may have detrimental effects on native flora and fauna. More effective biological indicators should be identified for contaminants in the ecosystem, particularly for plants and wildlife. These indicators should be identified in addition to the species that are most susceptible to the contaminants.

Increasing Research Efforts - Basin-wide research gaps should be identified with the cooperation of individuals and organizations on both sides of the international border. Groups of scientists should meet to prioritize research topics, and agencies should define and fund projects that address the research gaps, especially those associated with high-priority issues.

Securing Additional Funding - To meet the goals and vision of LaMP 2000 and the Binational Program, a more effective strategy should be developed to identify diverse funding sources that can be leveraged to secure additional funding.

Cloquet River, Minnesota
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Isle Royale National Park, Michigan
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Section 5:

Integrating Great Lakes and Lake Superior Management Activities

Grand Sable Dunes
Photograph by Jeffrey Foltice, Michigan Travel Bureau

Since the release of LaMP 2000, much effort has gone into integrating and coordinating LaMP activities and other toxics reduction, human health, monitoring, and pollution prevention programs in the Great Lakes basin. Specifically, the following efforts have been initiated since April 2000: (1) addressing human health concerns, including developing a Great Lakes Human Health Network, holding a Great Lakes Beach Conference, and making progress in implementing fish consumption advisories; (2) beginning to develop a coordinated binational Great Lakes monitoring strategy; (3) promoting further mercury reduction and retirement efforts in conjunction with national and international efforts; (4) coordinating and integrating activities with the Great Lakes Binational Toxics Strategy and the Lake Superior Forum; and (5) improving the linkages between the LaMP and RAP development for Lake Superior AOCs.

Human Health

LaMP 2000 focused on addressing human health concerns associated with contaminants in the Lake Superior basin. The LaMP Human Health Committee gathered studies, data, expertise, and public health information to create a comprehensive LaMP chapter on human health. The chapter also presented a work plan for implementing programs, projects, research, and outreach activities to protect and improve human health in the Lake Superior basin. However, progress on these activities has been limited because of agency resource constraints.

Efforts to better protect human health in the basin face challenges similar to those associated with protecting the entire Lake Superior ecosystem. Local leadership is critical to ensure that people receive information concerning threats to human health. In addition, continuing research on the dangers posed by contaminants is critical to protecting human health, as is the distribution of relevant information locally.

Human Health Network

At the May 2001 Binational Executive Committee (BEC) meeting, the Lake Superior Task Force and Workgroup recommended that a Great Lakes-wide human health network be formed to maximize resources and efficiencies of scale. BEC agreed with their recommendation to form such a network, with U.S. EPA's GLNPO providing the staff resources for a year.

The human health network will bring together experts from throughout the basin to share information and provide technical assistance on human health issues. The network will be holding initial meetings to discuss terms of reference, its mission, and other details. In the interim, preliminary work on human health issues has begun, including the holding of a Great Lakes Beach Conference.

In addition, information to support the network will be obtained through the National Health and Nutrition Examination Survey (NHANES).

NHANES is a survey conducted by the National Center for Health Statistics and the Centers for Disease Control and Prevention to collect information about the health and diet of people in the United States. In March 2001, the "National Report on Human Exposure to Environmental Chemicals" was released, providing a compilation of ongoing biomonitoring exposure data for both the general U.S. population and special-exposure populations within the United States. For more information, see http://www.cdc.gov/nceh/dls/report/.

Great Lakes Beach Conference

The Great Lakes Beach Conference was held in Chicago in February 2001 and was jointly sponsored by U.S. EPA Region 5 and the City of Chicago. The focus of the conference was the science and technology of beach monitoring and closure, beach management, and resources to support beach programs. Breakout sessions at the conference provided opportunities for interactive discussions focused on developing specific recommendations for policy, regulatory, and technical needs to support beach management programs for the Great Lakes, Lake St. Clair, and inland beaches.

Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

At the conclusion of the conference, U.S. EPA presented a technical workshop on the Federal Beach Bill that was passed in early 2001. This workshop provided conference participants with the opportunity to understand the purpose of the beach bill and the funding available under the bill. Additional information regarding the Federal Beach Bill is available at *http://www.epa.gov/OST/beaches*.

Progress on Fish Consumption Advisories

Significant progress has been made in further developing and implementing fish consumption advisories in the Lake Superior basin. Federal, state, provincial, and tribal government actions have focused on two areas: (1) outreach and education regarding fish consumption advisories to at-risk populations and (2) chemical monitoring of fish tissues.

- The Agency for Toxic Substances and Disease Registry (ATSDR) has provided funding to state and tribal agencies to assist them in communicating fish consumption advisory information. A consortium of Great Lakes states developed outreach materials for women of childbearing age and minority groups. These outreach materials have been adapted by each of the states for their specific needs and are being distributed at women's and children's clinics, health fairs, state fairs, and fishing shows to increase health advisory awareness. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is distributing GIS-based maps to its member tribes depicting the levels of mercury in walleye in various lakes.

- With funding from the U.S. EPA's Coastal Environmental Mangement Program as well as other funding sources, the Fond du Lac Band, Grand Portage Band, and Minnesota Departments of Health and Natural Resources worked together to analyze fish collected from reservation waters and to report those results the to tribal members in a culturally appropriate manner.

- GLIFWC has analyzed commercially harvested species of Lake Superior fish with a focus on the chemical reductions achieved by trimming and processing fish fillets with funding from the Administration for Native Americans as well as other funding sources. Outreach materials and U.S. Food and Drug Administration hazard analysis and critical control point seafood safety

information were used to communicate the findings.

- A pilot fish consumption indicator was proposed at the SOLEC in 2000. SOLEC Indicator 4083, "Chemical Contaminants in Edible Fish Tissue," would promote reporting of contaminant levels in edible portions of fish collected by state agencies responsible for issuing fish consumption advisories. The indicator would also be used to track these contaminant levels over time.
- The amounts and pathways of exposure to chemical contamination in Lake Superior are understudied. GLIFWC and the 1854 Authority are undertaking separate studies to document the amount of fish consumed by tribal members. GLIFWC's study is in its fifth year.

Coordinated Great Lakes Monitoring Strategy

The Lake Superior Binational Program has initiated many excellent monitoring efforts and programs as documented in the proceedings of the Lake Superior

Photograph courtesy of the Ontario Ministry of Natural Resources

Monitoring Workshop held in October 1999. However, a real need exists for better coordination and collaboration efforts across the Great Lakes basin to promote data comparability, enhance data utility, maximize resources, and conduct efficient and timely reporting on environmental change and progress. To help address this need, the BEC requested agencies to investigate the opportunity to enhance monitoring coordination and to prepare a status report for the BEC's summer 2002 meeting and a set of options for the fall 2002 meeting.

In the interim, monitoring meetings were held in the United States in January 2002 and in Canada in February 2002 to discuss the monitoring needs for the Great Lakes individually and as a whole. Specifically, these meetings set the stage for initial development of a Great Lakes basin-wide monitoring strategy.

Promotion of Mercury Reduction Efforts

To ensure that the Lake Superior mercury reduction goal of 80 percent by 2010 is reached, the Lake Superior Workgroup and Task Force asked the BEC to take a leadership role in further promoting mercury reductions at mining operations, utilities, and other coal combustion sources. The BEC agreed to highlight and promote mercury reduction activities through the regular course of its national and international meetings. BEC's new leadership role will help highlight and promote specific issues of major importance to the Lake Superior Binational Program.

Integration with Binational Toxics Strategy and Binational Forum

Steps have been taken to improve coordination between the Lake Superior LaMP and the Binational Toxics Strategy and Lake Superior Binational Forum:

- A joint Binational Toxics Strategy-LaMP meeting was held in November 2001 to discuss joint priorities, projects, and activities. Planning for a joint meeting on long-range air transport of pollutants is underway.
- A joint Lake Superior Binational Forum, Workgroup, and Task Force meeting was held in November 2001 to celebrate the ten-year anniversary of the Lake Superior Binational Program. The joint meeting was attended by over 70 people from local, state, federal, Tribal/First Nations, provincial, and citizen groups. Key focus areas included outreach and information to influence land use decisions, mercury retirement, human health concerns, and burn barrels.

LaMP and RAP Connections

In addition to development of LaMPs, the 1987 amendments to the GLWQA called for development of RAPs for specific AOCs. Information on the Lake Superior AOCs is provided in Appendix A. The LaMPs focus on those environmental problems that are lakewide in nature and that need a combined Canadian and U.S. effort to be resolved. A RAP, however, encompasses a much smaller geographic area, concentrating on a single embayment, watershed, or stretch of the river. Most of the beneficial use impairments associated with Lake Superior can be directly related to sources within the AOCs. Any improvement in an AOC will eventually help to improve Lake Superior as a whole, but the local effect may be more immediately visible and measurable. Implementation of most RAPs has been underway for a number of years using a combination of federal, state, provincial, and local resources.

Forging a strong relationship between LaMPs and RAPs is important to the success of both programs. In 2001, with a view to improving program coordination, Environment Canada's Restoration Programs Division reorganized to strengthen the LaMP and RAP linkage. Division staff members are now organized by lake, with a Lake Coordinator being responsible for both the LaMP and the lake-specific AOCs. Efforts are also underway to better coordinate work plans generated by various branches within Environment Canada.

Photograph by Carol Y. Swinehart,
Michigan Sea Grant Extension

Section 6:

Conclusion

As described in the Vision Statement for Lake Superior, the lake is "a worldwide model for resource management." It is the cleanest and least developed of the Great Lakes, and it is the only lake for which a goal of zero discharge of critical pollutants has been established. An aggressive timeline for meeting that goal by 2020 has been set.

Lake Superior has had some notable successes. The 60 percent mercury emission reduction target has been met; lake trout populations have been restored to historical levels; and 29,000 acres of land along the St. Louis River and its tributaries in Wisconsin and Minnesota has been protected, among other things. These successes as well as the scores of other activities described in this report represent significant progress in achieving the vision for Lake Superior. However, much more needs to be done. Not all interim goals for achieving zero discharge have been met; critical habitat continues to be lost to development; and a large number of expensive projects, including cleanups of contaminated sediments, remain to be initiated.

The Lake Superior Binational Program continues to demonstrate its resilience as a successful partnership focused on making a safe and healthy Lake Superior environment where

- We can all eat any fish.
- We can swim in the water.
- We can drink the water.
- All habitats are healthy, naturally diverse, and sufficient to sustain viable biological communities.

Apostle Islands National Lakeshore, Wisconsin
Photograph by Meg Turville-Heitz,
Wisconsin Department of Natural Resources

The Next Steps

To ensure continued progress toward achieving a sustainable and healthy Lake Superior ecosystem, the LaMP will continue to emphasize key, long-term goals, including achieving zero discharge, developing a strategy for reducing out-of-basin sources of pollution, engaging Lake Superior basin communities in fulfilling the Binational Program's vision for the lake, increasing citizen participation in conservation activities and practices, coordinating local land use planning, gathering data on sustainability indicators, and encouraging and pursuing more diverse economic development strategies.

Common Tern
Photograph by Sumner Matteson,
Wisconsin Department of Natural Resources

To achieve these goals, the government partners on the LaMP committees have identified a series of highest-priority needs and activities for Lake Superior (for a complete list of actions, see LaMP 2000). These include the following:

- Encouraging better land use practices and developing watershed management plans to decrease the threats to habitat associated with development and forest fragmentation
- Decreasing the transport of exotic species into the basin ecosystem and controlling the populations of existing exotic species
- Restoring natural flows to tributaries
- Decreasing emissions of toxic substances in the basin
- Developing strategies for decreasing the transport of out-of-basin pollutants into the basin
- Eliminating mercury from products used in the basin
- Eliminating improper incineration in burn barrels, which releases mercury and dioxins
- Increasing public outreach and education programs promoting the goals of LaMP 2000
- Remediating contaminated sediments
- Developing a human health network
- Developing achievable goals for the broader ecosystem program

Building Broader Partnerships at the Local Level

Although the federal, state, provincial, and tribal governments have been effective in setting the broad goals for the LaMP and in identifying government initiatives, the key to achieving the LaMP 2000 goals and priorities lies in involving communities and individuals in Lake Superior protection and restoration. The most successful recent efforts to restore basin ecosystems and reduce pollution have involved partnerships between local communities and appropriate state, provincial, Tribal/First Nations, and federal agencies. These partnerships have been especially effective in restoring and protecting habitat, such as at Whittlesey Creek, Sugarloaf Cove, and Lake Nipigon.

The need for local action is also becoming increasingly important for the control of critical pollutants. The ZDDP will succeed only if the residents of the Lake Superior basin are aware, informed, and willing to make changes. For example, use of burn barrels must be controlled, and alternatives to mercury-containing products must be promoted. Programs that target industrial sources will bring about large reductions in critical pollutant emissions, but getting to zero means changing from a consumer society to a conserver society within the basin. Moreover, in-basin efforts alone will not achieve reduction targets. Further efforts outside the basin are also needed.

The water, air, land, plants and animals of the Lake Superior ecosystem should be viewed as resources of global importance. The decisions we make today regarding where to spend our limited funds and how to shape our society will influence the ability of subsequent generations to live healthy and productive lives. Developing sustainability in the region depends on forging durable partnerships among government, industry, and local citizens in Canada and the United States. The progress made to date demonstrates that the Lake Superior ecosystem can be protected and restored. If we work together to address the multiple stressors affecting Lake Superior, the world's largest lake can serve as an international model for resource management and truly remain the "greatest" of the Great Lakes.

For More Information….

For more information on the Lake Superior Binational Program, consult the following web sites: www.on.ec.gc.ca/glimr/lakes/superior and http://www.epa.gov/glnpo/lakesuperior/index.html.

Additional information on the Lake Superior Binational Forum is available at 1-888-301-LAKE.

The following web sites provide additional information on efforts to restore and protect the Lake Superior ecosystem:

- Great Lakes Fisheries Commission, Lake Superior Committee: *http://www.glfc.org/lakecom/lsc/lstc.htm*
- Great Lakes Information Network, Lake Superior Page: *http://www.great-lakes.net/lakes/superior.html*
- Lake Superior Binational Forum: *http://www.northland.edu/soei/LSBF*
- National Wildlife Federation, Lake Superior Page: *http://www.nwf.org/lakesuperior*
- Lake Superior Habitat Coordination: *http://www.d.umn.edu/~pcollins/main.html*
- St. Louis River Citizens Action Committee: *http://www.stlouisriver.org*
- Walk Around Lake Superior: *http://www.protecttheearth.com/lakewalk.html*
- Western Lake Superior Sanitary District: *http://www.wlssd.duluth.mn.us*
- EcoSuperior: *http://www.ecosuperior.com*
- Lake Superior Decision Support Project: *http://oden.nrri.umn.edu/lsgis/index.htm*

Appendix A
Lake Superior Areas of Concern

For more information, visit the AOC website *http://www.on.ec.gc.ca/glimr/raps/aoc-map.html*

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
Deer Lake **Michigan**	• Mercury	A 906-acre impoundment in central Marquette County, Michigan that includes the Carp River watershed comprised of Carp Creek, Deer Lake, and the Carp River downstream 20 miles to Lake Superior at Marquette.	• Contaminated sediments • Copper mining waste material	• Fish and wildlife consumption restrictions • Dredging activities restrictions	• Dredging	• Sewer separation and primary treatment plants secondary wastewater treatment	• Identify and restore beneficial uses of the Carp River watershed	• Funding sources to manage sediment and contamination issues on an AOC-wide, bi-state basis • Funding sources to eliminate Sanitary sewer overflows	• Complete analysis of beneficial use impairments • Complete contaminated sediment feasibility study • Identify other contaminated sites • Urban watershed storm water management • Sanitary sewer improvements • Implement Habitat Management Plan
Jackfish Bay **Ontario**	• Solids (i.e., wood fiber) • AOX	The 14 km reach of Blackbird Creek between Kimberly-Clark Canada Inc. pulp mill and Jackfish Bay, including Lake A, Moberly Lake and Jackfish Bay itself.	• Wastewater discharges • Nonpoint source pollution • Spills • Contaminated sediments	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Bird or animal deformities or reproductive problems • Degradation of benthos • Aesthetics degradation • Loss of fish and wildlife habitat	• Great Lakes Sustainability Fund	• Effluent quality from paper mill improved • Chlorine dioxide bleaching plant upgraded resulting in lower AOX levels (not 100% of time)	• Eliminate mill discharge from ecosystem cycling	• Natural recovery takes time • Available technology needs to be utilized at all times	• Continued natural recovery and monitoring
Nipigon Bay **Ontario**	• Solids • Pathogens • Biological oxygen demand (BOD)	A large portion of Nipigon Bay and the Nipigon River downstream of Alexander Dam. Two communities are located in the vicinity of the Bay: Red Rock (population: 1,400) and Nipigon (population: 2,400).	• Wastewater discharges • Nonpoint source pollution	• Fish and wildlife population degradation • Degradation of benthos • Eutrophication or undesirable algae • Aesthetics degradation • Loss of fish and wildlife habitat	• Great Lakes Sustainability Fund • Canada-Ontario Infrastructure Program	• Created water management plan for Nipigon River to regulate hydroelectric facilities' water use to help restore brook trout • Land use strategy under development	• Upgrade primary STPs in Redrock and Nipigon	• Lack of dedicated resources	• Continued education and stewardship activities • Work toward STP upgrades
Peninsula Harbour **Ontario**	• Mercury	Peninsula Harbour proper, and a portion of open Lake Superior immediately south of the peninsula.	• Wastewater discharges • Contaminated sediments • Loss of fish nursery and habitat • Loss of wetlands	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Degradation of benthos • Dredging activities restrictions • Loss of fish and wildlife habitat	Great Lakes Sustainability Fund	• Pulp kraft mill installed secondary treatment for effluent	• Complete contaminated sediment assessment		• Complete feasibility study

Lake Superior Areas of Concern

(continued)

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
St. Louis River **Minnesota/ Wisconsin**	• Pathogens • Mercury • PCBc • Nutrients •PAHs	St. Louis Bay, the Nemadgi River basin and the St. Louis River Basin to Cloquet, Minnesota	• Contaminated sediments • Abandoned hazardous waste sites • Poorly designed or leaky landfills • Industrial discharges chemical spills, • Improperly sewered wastes • Municipal and industrial runoff •Turbidity	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Degradation of benthos • Dredging activities restrictions • Eutrophication or undesirable algae • Beach closings • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Navigational dredging •RCRA - CA •Wisconsin Great Lakes Protection Fund •Minnesota Great Lakes Protection Fund •NRDA • Minnesota and Wisconsin Coastal Management Programs	• Wastewater treatment • Sediment contamination studies to identify hotspots •Evaluation of cleanup options at two Superfund sites •Prioritization of remaining hotspots per the Stage 2 Sediment Assessment Strategy •Habitat Management Plan	• Dredging	• Lack of dedicated resources •Lack of funding sources to manage sediment contamination issues on an AOC-wide, bi-state basis.	• Contaminated site remediation • Mercury reduction • Habitat restoration and protection
St Marys River **Michigan/ Ontario**	• PAHs • Mercury •Arsenic • Cyanide •Phosphorus •Benzene •Toluene •Oil and grease • Phenols • Ammonia • Pathogens	From the head of the river at Whitefish Bay (Point Iroquois - Gros Cap), downstream through the St. Joseph Channel to Humburg Point on the Ontario side, and to the straits of Detour on the Michigan side.	• Combined sewer overflows • Loss of wetlands • Point and nonpoint source pollution • Wastewater discharges • Urban/industrial development • Navigational structures	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Degradation of benthos • Dredging activities restrictions • Eutrophication or undesirable algae • Beach closings • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Clean Water Act • Navigational dredging •Canada-Ontario Infrastructure Program	• One superfund site restored • Combined sewer separation for Sault Ste. Marie, Michigan. • Steel and paper mills in Sault Ste. Marie, ON improved quality of effluent • Environmental Management Agreement among Algoma Steel, Canada and Ontario •Infrastructure upgrades by Sault Ste. Marie, Ontario.	• Complete contaminated sediments assessment • Upgrade East End STP to secondary treatment		• Superfund monitoring at cleaned site • Implementation of sediment management program

Lake Superior Areas of Concern

(continued)

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
Torch Lake **Michigan**	• Copper • Mercury • Arsenic • Lead • Chromium • Heavy metals	The lower portion of the Keweenaw Peninsula, totaling approximately 368 square miles, encompassing the Keweenaw Waterway, (North Entry Harbor of Refuge, Portage Lake, and Torch Lake), its watershed, portions of two other adjacent watersheds (Trout River and the Eagle River Complex), and several miles of its western Lake Superior shoreline	• Contaminated sediments • Copper mining waste material	• Fish and wildlife consumption restrictions • Degradation of benthos • Dredging activities restrictions • Drinking water consumption restrictions, or taste or odor • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Dredging	• One Superfund site restored • Breached mine stabilized	• Dredging	• Lack of dedicated resources	• Superfund site remediation • Sediment remediation
Thunder Bay **Ontario**	• Pathogens • Mercury and other metals • Dioxins and furans • PCP • PAHs	About 28 km along the shoreline and up to 9 km offshore.	• Contaminated sediments • Industrial and municipal sewage • Nonpoint pollution	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Degradation of benthos • Dredging activities restrictions • Beach closings • Aesthetics degradation • Phytoplankton and zooplankton population degradation • Loss of fish and wildlife habitat	• Canada-Ontario Infrastructure Program • Great Lakes Sustainability Fund	• Process improvements and enhanced effluent treatment at four pulp and paper mills • Northern Wood Preservers remediation	• Nonpoint pollution prevention • Upgrade STP from primary to secondary • Incorporate RAP water use goals into official plans and new waterfront developments		• Complete contaminated sediment assessment for harbour adjacent to Provincial Papers

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1854 Authority
Bad River Band of Lake Superior Chippewa
Department of Fisheries and Oceans
Chippewa-Ottawa Resource Authority
Environment Canada
Fond du Lac Band of Lake Superior Chippewa
Grand Portage Band of Lake Superior Chippewa
Great Lakes Indian Fish and Wildlife Commission
Keweenaw Bay Indian Community
Michigan Department of Environment Quality
Michigan Department of Natural Resources
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Pollution Control Agency
Ontario Ministry of Natural Resources
Ontario Ministry of the Environment
Parks Canada
Red Cliff Band of Lake Superior Chippewa
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. National Park Service
Wisconsin Department of Natural Resources

The Lake Superior LaMP: 2002 Progress Report will be available at:
http://www.epa.gov/glnpo/lakesuperior
and **www.on.ec.gc.ca/glimr/lakes/superior**