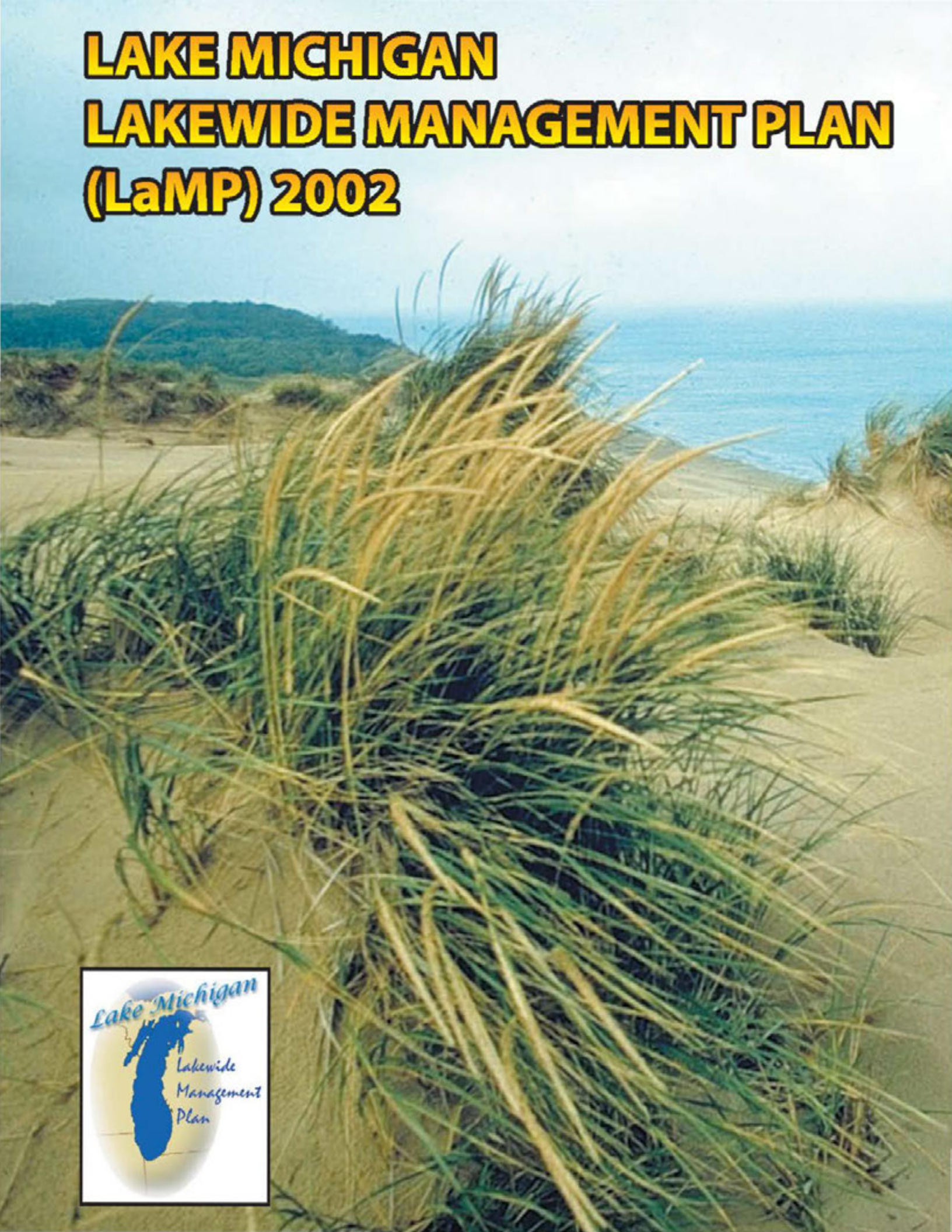
LAKE MICHIGAN LAKEWIDE MANAGEMENT PLAN (LaMP) 2002



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Photos courtesy of U.S. EPA Great Lakes National Program Office "Visualizing the Great Lakes" are indicated by an asterisk(*)
http://www.epa.gov/glnpo/image

1.0 Introduction

The purpose of this Lakewide Management Plan (LaMP) 2002 is to provide:

- An executive summary of the status of the Lake Michigan ecosystem;
- A report on the progress in achieving the Lake Michigan goals described in LaMP 2000 and examples of significant activities completed in the past two years;
- A summary of the current Lake Michigan mass balance data and findings;
- Links to more detailed information in LaMP 2000 or other sources;
- An opportunity to comment on targets and plans for pollution reduction and ecosystem restoration;
- A proposal to identify additional pollutants to be addressed by the LaMP in the future.

What is the Status of the Lake?

"Lake Michigan is an outstanding natural resource of global significance, under stress and in need of special attention." LaMP 2000

Since the release of LaMP 2000, several key indicators point to the continuing concern for the health of the ecosystem.

- Last year's beach season exhibited a growing number of beach closings.
- Studies revealed that a critical layer of the Lake Michigan aquatic food web appears to be disappearing, and with the discovery of two new aquatic nuisance species–there are now a total of 160 in the Great Lakes ecosystem–the integrity of the food web of Lake Michigan is in question.
- Mercury in fish is such a prevalent problem that 41 states now have mercury fish advisories, and a national advisory has been issued for certain ocean fish pointing to a problem of global proportions.
- Climatic pattern changes, whether temporary or permanent, are lowering lake levels as well as raising concerns about groundwater and lake interaction and diversion.

The Lake Michigan-Mississippi River basin divide: Chicago Avenue west of East Avenue in Oak Park, Illinois
Photograph by Jeffrey E. Edstrom

- Following the September 11, 2001 terrorist attacks, the issue of protecting the lake's vast supply of fresh drinking water has become a higher priority.

Despite these concerns, Lake Michigan supports many beneficial uses. For example, it provides drinking water for 10 million people; has internationally significant habitat and natural features; supports food production and processing; supplies fish for food, sport, and culture; has valuable commercial and recreational uses; and is the home of the nation's third-largest population center. Furthermore, significant progress is being made to remediate the legacy of contamination in the basin. Specifically, ongoing actions to restore the Areas of Concern (AOC) have been successful and are outlined in Appendix B.

Background on the LaMP

Under the Great Lakes Water Quality Agreement (GLWQA), as amended in 1987, the United States and Canada agreed " to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem." To achieve this objective, the parties agreed to develop and implement, in consultation with state and provincial governments, LaMPs for open waters. In the case of Lake Michigan, the only one of the Great

Door County, Wisconsin, Lake Michigan Lakeshore
Photograph by Karen Holland, EPA*

Lakes wholly within the borders of the United States, the Clean Water Act (Section 118c) holds the U.S. Environmental Protection Agency (EPA) accountable for the LaMP.

Work on the Lake Michigan LaMP began in the early 1990s with a focus on critical pollutants affecting the lake. At that time, monitoring data showed that point source regulatory controls established in the 1970s and 1980s were reducing the levels of persistent toxic substances such as polychlorinated biphenyls (PCB), DDT, and other pesticides. Monitoring results also indicated that nonpoint sources of pollution such as runoff and air deposition, as well as aquatic nuisance species, were stressing the Lake Michigan ecosystem. The LaMP states that "pathogens, fragmentation and destruction of terrestrial and aquatic habitats, aquatic nuisance species, uncontrolled runoff and erosion are among the stressors contributing to ecosystem impairments."

It has been documented that core regulatory programs at the federal, state, tribal, and local levels have effectively controlled many pollutants. Increased water quality protection is now being addressed with the adoption of higher water quality standards for the Great Lakes basin by each Great Lakes state, with the goal of having the new standards reflected in all permits by 2006. What remains is a set of difficult, persistent, and multifaceted problems. In response, agencies must develop new tools, refocus their strategies and methods, and continually obtain new data. As the 1994 State of the Lakes Ecosystem Conference reported, "governments have traditionally addressed human activities on a piecemeal basis, separating decision making on environmental quality from decision making on natural resources management or on social or economic issues...." In addition, decisions at different levels of government or across political boundaries are being made unilaterally without regard to watershed or ecosystem alignment.

What is LaMP 2000?

The publication of LaMP 2000 was the beginning of a basinwide dialogue on which pollutants and stressors should be prioritized for control, what reduction targets should be applied to them, and which ecologically rich areas should be identified for restoration and protection. Some issues, such as aquatic nuisance species, legacy sites, and drinking water protection, require immediate attention. Others will continue to be the subject of public dialogue, while still other issues may arise that require additional research. In 2000, the Binational Executive Committee determined that an adaptive management approach would guide the LaMP process, making it an iterative approach. This status report provides new information, responds to input received, and sets targets and objectives for public comment.

What was Accomplished and What Challenges Remain?

Areas that were highlighted in LaMP 2000 and have been accomplished include the following:

- Setting targets for reduction of critical pollutants and stressors,
- Reviewing the LaMP list of contaminants and stressors,
- Filling data gaps, including the Lake Michigan Mass Balance Project,
- Identifying ecologically rich areas and habitats,
- Developing the concept of the area of stewardship, and
- Convening public conferences and workshops for development of a Total Maximum Daily Load (TMDL) strategy, beach management, and monitoring issues.

Sailing Along the Milwaukee, Wisoncion Shoreline of Lake Michigan
Photograph courtesy of the Lake Michigan Federation*

Progress made on accomplishing these objectives is outlined in this status report. More detailed sections on TMDLs, mass balance, and adaptive management implementation will become supplements to LaMP 2000 by 2003.

Areas of LaMP Work that Remain a Challenge

Finalization of a monitoring plan and prioritization of indicators are still in progress. A draft monitoring plan was issued along with a set of recommendations in August 2000. To prioritize indicators and gather missing data, two major initiatives have begun that are focused on wetlands and the importance of the "coastal area." The results of these efforts will provide not only new data but also refined indicators for wetlands by 2004, and the LaMP will utilize this work in finalizing a set of LaMP indicators.

What is the LaMP? How and by Whom is it Used?

The LaMP issued in April 2000 is both a large reference document and a set of iterative proposals or strategic agendas for remediating past errors and achieving sustainable integrity in the Lake Michigan basin ecosystem. It was prepared collaboratively and is designed to be used by any number of Lake Michigan entities or individuals. See the back cover of this document for a list of Lake Michigan partners who collaborated on the LaMP.

The LaMP document is being utilized as a guide for decision making on policy issues and to help guide funding like EPA's Coastal Environmental Management Program and the Great Lakes National Program Office grant process. At the state level, for example, Michigan has utilized it for the Clean Michigan Initiative grant program. A number of universities are using it as a text book. Results from grants and research provide the information used in determining the lake status as reported in this 2002 status report.

How is the Process Utilized?

The list of goal, subgoals and activities have produced projects like the Cook County PCB/ Mercury Clean Sweep Project. Other issues have highlighted the need to convene and train managers from around the basin resulting in sessions on the Federal Beach Bill and a number of monitoring conferences. LaMP partners have also participated in the TMDL strategy discussion. For education and outreach, materials have not only been produced, but distribution opportunities have been supported like the State of Lake Michigan 2001 Conference and the Making Lake Michigan Great Boat Tour.

The goal of going beyond regulation requires a focus on ecosystems, partnerships and innovation, shared information, and the future.

A Focus on Ecosystems

In 1995, the Federal Interagency Ecosystem Management Task Force defined an ecosystem as "an interconnected community of living things, including humans, and the physical environment with which they interact. As such, ecosystems form the cornerstone of sustainable economies." With regard to ecosystem management, the Task Force explained that "the goal of the ecosystem approach is to restore and maintain the health, sustainability, and biological diversity of ecosystems while supporting sustainable economies and communities. Based on a collaboratively developed vision of desired future conditions, the ecosystem approach integrates ecological, economic, and social factors that affect a management unit defined by ecological–not political–boundaries."

In 1998, the Lake Michigan Management Committee adopted the ecosystem approach. The significance for the Lake Michigan LaMP was the intent to address not only the 10 areas that had been formally designated AOCs by the 1987 GLWQA amendments, but also other areas that were responsible for impairing the lake's ecosystem. The prime example was the Chicago area. Because of the rerouting of the Chicago River into the Mississippi River system, Chicago's surface water has been diverted out of the basin; however, groundwater from the Chicago area has not been diverted, and the city's large airshed has been shown to be a source of pollutants that are deposited in and affect the lake.

A Focus on Partnerships and Innovation

As the LaMP 2000 points out, this framework "also develops partnerships of organizations brought together to solve problems too large or complex to be dealt with by one agency with a limited mission. This approach also has the potential to leverage and direct local, state and federal, and private resources into a coordinated effort. The challenge is to create the framework for participating organizations to contribute their expertise and resources, often on an uneven basis, but in a manner that allows all partners to participate in the decision making on an even basis."

Nature Class at Chiwaukee Prairie, Kenosha, Wisconsin
Photograph courtesy of EPA Region 5*

A Focus on Shared Information

A key to engaging the necessary partners is a common, accessible, and scientifically sound body of knowledge. Lake Michigan protection and restoration requires open dialogue between academia and government agencies, as well as a collaborative monitoring plan to provide a current database. Reporting of current data and conclusions to the public is an important component of this system. This component presents many challenges, as data quality plans improve data accuracy but hinder the speed of reporting. Current management decisions are often made with gaps in both data and interpretation. These gaps may lead to incorrect problem assessments or incorrect response actions. The Lake Michigan LaMP has formed a basinwide coordinating and monitoring council to coordinate and promote common protocols and comparability in monitoring. The goal is to facilitate data sharing across agencies as well as among academic and research disciplines. Lake Michigan as a studied object is a moving target, and to provide adaptive management, there is a continuing need for monitoring and reporting of the lakes's current status.

A Focus on the Future: Sustainability and Stewardship

While partnerships can leverage resources, they also must be led and supported. Setting shared goals, objectives, and indicators in alignment helps to conserve resources but does not do away with resource needs. The interdependencies inherent in the ecosystem approach require a balance among three fundamental elements: environmental integrity, economic vitality, and sociocultural well-being. The ability of these elements to function in balance over time is one measure of sustainability. Complex ecological processes link organisms and their environment. These processes are often referred to as "ecological services" because they perform functions that combine to sustain life in the ecosystem. The significant natural features of Lake Michigan, such as its encompassing the world's largest collection of freshwater sand dunes, supporting 43 percent of the Great Lakes' large sport fishing industry, and providing drinking water for over 10 million residents, means billions of dollars not only to the economies of the four states that share the lake but also to the nation as a whole.

Yellow Moccasin, Gibson Woods, Indiana
Photograph by Karen Holland, EPA*

Organization of this LaMP 2002 Status Report

This document is intended to provide a status report on the health of the Lake Michigan ecosystem and a summary of the activities related to the Lake Michigan LaMP that have occurred during the last 2 years. Specifically, this report is organized to provide a summary status report on the subgoals identified by the Lake Michigan LaMP. These subgoals are stated as questions and are organized in the following 11 sections:

1. Can we all eat any fish?
2. Can we drink the water?
3. Can we swim in the water?
4. Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?
5. Does the public have access to abundant open space, shorelines, and natural areas, and does the public have enhanced opportunities for interaction with the Lake Michigan ecosystem?
6. Are land use, recreation, and economic activities sustainable and supportive of a healthy ecosystem?
7. Are sediment, air, land, and water sources or pathways of contamination that affect the integrity of the ecosystem?
8. Are exotic species controlled and managed?
9. Are ecosystem stewardship activities common and undertaken by public and private organizations in communities around the basin?
10. Is collaborative ecosystem management the basis for decision-making in the Lake Michigan basin?
11. Do we have enough information, data, understanding, and indicators to inform the decision-making process?

Overall, the finding of this report is that the status of achieving the goals is mixed. Some successes have been achieved in pursuing these subgoals – notably, drinking water quality is generally good throughout the basin– but there is much room for improvement in all the other areas. One objective of the LaMP is to foster activities that will cause the status of the subgoals to be "mixed/improving" by 2010 and "good" by 2020. A summary graphic at the start of each section of this report highlights the current and projected future status of each subgoal. In addition, following this introduction, an executive summary of this status report is provided in the form of a table. The table outlines the status of the subgoals organized under the strategic agendas outlined in LaMP 2000, significant activities completed in the last 2 years, and next steps to achieve the targets for each goal. Comments are requested on the next steps and proposed targets.

Following the status report, this document concludes with a proposal for updating the list of pollutants addressed under the LaMP. The LaMP has adopted an adaptive management approach that requires a continuing review of the LaMP goals and pollutants. The proposed process for updating the LaMP pollutant list along with an updated proposed list of pollutants for 2002 are provided in Appendix A and are being offered for comment. A summary of the status and progress in cleaning up the Lake Michigan Areas of Concern is provided in Appendix B.

Where Can I Find LaMP 2000? Where Do I Send Public Comments?

Lake Michigan LaMP 2000 is available on line at www.epa.gov/glnpo/michigan.html For a CD or printed copy of the LaMP or to make a public comment, contact Janice Carrollo at U.S. Environmental Protection Agency, Mail Code T-13J,

Executive Summary

Details on the Bullets Below are Found in the Individual Subgoal Sections

Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
	END POINT SUBGOALS			
Human Health Actions that prevent human exposure to pollutants in the ecosystem and prevent or minimize sources	**Subgoal 1** We can all eat any fish ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020 **Subgoal 2** We can drink the water ***Status*** • Good in 2000 • Good in 2010 • Good in 2020 **Subgoal 3** We can swim in the water ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• Fish advisories for mercury by USFDA and for dioxin by Michigan and the Tribes • Grand Cal and Fox River AOC sediment cleanup plans underway • Sokaogon Chippewa Community Bans Burn Barrels • Grand Traverse Band of Ottawa and Chippewa Indians ban burning trash/garbage on tribal lands • TMDL workshops with regulators and stakeholders held • Mercury Phase-Out proposal proposed • Drinking water monitoring and reporting information available on the web • Great Lakes Beach Conference held • Beaches Environmental Assessment and Coastal Health Act of 2000	• By 2003, hold a mercury phaseout TMDL stakeholder meeting • By 2004, a TMDL Strategy will be developed for Lake Michigan. • By 2002, EPA will track and report on raw source water for Green Bay, Milwaukee, Chicago, and Muskegon. • By 2003, source water assessments (including security assessment) will be completed and reported. • By 2004, states will adopt criteria, standards, and monitoring programs for beach bacteria.	• By 2006, the Binational Toxics Strategy goals of 90 percent reduction of high-level PCBs, 75 percent reduction of total dioxin and furan releases, and 50 percent reduction of mercury use and release will be reached. • By 2007, concentrations of PCBs in lake trout and walleye will be reduced by 25 percent. These results are based on early Lake Michigan Mass Balance model runs. • By 2005, plans will be in place to address drinking water susceptibility to contamination. • By 2005, achieve a 30 percent reduction from the 1992 per capita loadings from combined sewer overflows (CSO), POTWs, and industry. • By 2005, 95 percent of high-priority beach waters (as defined by the state) will be monitored and a public advisory system will be in place. • By 2007, 90 percent of monitored high-priority beach waters (as defined by the state) will meet federal and state bacteria standards for more than 95 percent of the average swimming season.

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Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
Restoration and Protection Actions that restore, enhance, and sustain the health, biodiversity, and productivity of the ecosystem	**Subgoal 4** All habitats are healthy, naturally diverse, and sufficient to sustain viable biological communities ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• Perch population still dropping • Northwest Indiana Advanced Identification of Wetlands Study underway • Keystone species (diporeia) in Lake Michigan food web vanishing • Supreme Court Ruling narrows wetland regulation • Wisconsin passes wetlands protection law • Piping Plover critical habitat designated by USFWS • Antrim County Wisconsin Wetland Protection ordinance • Wolf populations recovering • Habitat and Land Use Management Tool Box under development • Established a 1994 baseline for land cover • NIPC "Biodiversity Recovery Plan" document produced	• By 2002, a process for developing biodiversity recovery manuals for major ecosystem types in the Lake Michigan basin will be implemented. • By 2004, set targets for critical areas (fish spawning areas, dune and swale complexes, wetlands, alvars, prairies, and oak savannas) will be identified, mapped, and presented on line. • Habitat and Land Use Tool Box published, distributed • Utilize SOLEC and Duluth lab indicators and the Wetland Consortium to finalize Lake Michigan indicators • NACD stream buffer report release • A basin-wide buffer program will be developed • Utilize 2000 landsat data to update 1994 baseline land cover GIS • Critical areas mapped and presented on-line • By 2004, critical areas (fish spawning areas, dune and swale complexes, wetlands, alvars, prairies, and oak savannas) will be identified, mapped, and presented on line	• By 2005, no net loss of wetland acreage and function will be achieved in the basin. • By 2012, the 2004 target acreages will be enhanced, restored, or protected: 1,000 acres of spawning areas (islands under water reefs); (example acreages: 12,500 acres of system wetlands; 1,000 acres of isolated wetlands; 1,000 acres of dunes; and 37,500 acres of stream buffers - comments requested).

Executive Summary

Details on the Bullets Below are Found in the Individual Subgoal Sections

Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
Sustainable Use Actions that concurrently sustain the health of the environment, the economy, and the communities of the ecosystem	**Subgoal 5** Public access to open space, shoreline, and natural areas is abundant and provides enhanced opportunities for human interaction with the Lake Michigan ecosystem ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020 **Subgoal 6** Land use, recreation, and economic activities are sustainable and support a healthy ecosystem ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• Governors and Premiers sign Great Lakes Charter Annex 2001 • Indiana moves into Coastal Zone Management program • Wisconsin Smart Growth act • Historic Agreement to Manage Fisheries in 1836 Treaty Waters • Economic valuation studies by Northeast-Midwest Institute, Lake Michigan Federation, and University of Wisconsin Sea Grant • Lake Michigan Potential Damages study continues in sixth year • USGS Lake Michigan Trends Project funded • USGS Pollutants of Concern list developed • Upland Michigan Land Use report • Federal two-year ban on drilling under the Great Lakes • Michigan moratorium on drilling under the Great Lakes	• By 2003, the LaMP will partner with coastal zone management programs in the Lake Michigan basin to ensure public access to the lake is balanced with protection of the ecosystem • Identify the need for additional facilities and access points (such as boat ramps canoe, and bicycle and walking trails around Lake Michigan). • Expand the Northeastern Illinois water trail to other states around Lake Michigan. • Publication and distribution of a Habitat and Land Use Management Tool Box that provides web-based information sources on environmentally sensitive habitat and land use management policies and programs. • Establishment of a Lake Michigan Watershed Academy to provide training to local planners and policy makers on balancing environmental concerns with economic and social activities in a watershed context. • Convening of a Brownfield to Greenfield Conference to highlight the need for redevelopment of facilities that have mild to medium contamination rather than developing greenspace. • Convene Planning Commissions to partner on identifying societal indicators and gathering data. • On-line habitat atlas operational. • Forum/Grand Valley State University boat tour to AOC ports	• Sustainable management of the basin

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Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
	MEANS (TO AN END POINT) SUBGOAL			
Remediation and Pollution Prevention Actions that achieve substantial pollution reduction by remediating sites, controlling pathways, preventing or minimizing sources	**Subgoal 7** Sediments, air, land, and water are not sources or pathways of contamination that affect the integrity of the ecosystem ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020 **Subgoal 8** Exotic species are controlled and managed ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• Lake Michigan Mass Balance (LMMB) findings published • PCB levels in lake trout achieving equilibrium • U.S. EPA Atrazine Reassessment initiated • IADN results consistent with LMMB findings • Bush administration announced climate change and "Clear Skies" initiatives • Toxic Air Emissions inventory released • U.S. EPA published Air Great Lakes Deposition (GLAD) Strategy • PCB/mercury Clean Sweep • Wisconsin mercury regulations • States act to control animal operations • New aquatic nuisance specie found in Lake Michigan • Michigan Ballast Water Bill • St. Lawrence Seaway Corporation to incorporate ballast water practices • Chicago River invasive species dispersal barrier installed • ANS Task Force and Great Lakes Panel on ANS continue work to control ANS • Great Lakes Governors ANS group created	• A mercury source reduction and sediment remediation strategy will be finalized. • Contaminated sediment sites will be reviewed and their status will be updated. • EPA will compile a report on nutrient contributions from the agricultural sector and on point sources during wet weather. • Fall 2003 State of Lake Michigan Conference will present updated mass balance results. • By 2004 and 2005, develop coordinated monitoring to provide a 10-year trend for the lake • Track and provide information on ANS developments as an important part of the LaMP education and outreach efforts. • By 2003, a multi-agency "SWAT" Team will be developed to respond to newly discovered invasive species with the latest control technology.	• By 2010, remediation of 50 percent of AOC sites • By 2020, remediation of 70 percent of AOC sites • By 2025, remediation of 100 percent of AOC sites • By 2010, vessels entering the Great Lakes will discharge ballast water free of invasive species.

Executive Summary

Details on the Bullets Below are Found in the Individual Subgoal Sections

Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
Information Sharing, Collaboration and Stewardship Actions that provide data access and exchange, facilitate involvement, and build capacity	**Subgoal 9** Ecosystem stewardship activities are common and undertaken by public and private organizations in communities around the basin ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020 **Subgoal 10** Collaborative ecosystem management is the basis for decision-making in the Lake Michigan basin ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• Lake Michigan Forum developing Stewardship trust • State of Lake Michigan Conference held - November 2001 • Forum/Grand Valley State University "Making Lake Michigan Great Tour" continues to educate about Lake Michigan ecosystem during summer cruises • Great Lakes Strategy released in 2002 by U.S. EPA • Great Lakes Human Health Network established • Wingspread Accord signed • Volunteer Monitoring Conference March 2002	• Establish the Lake Michigan Watershed Academy • Publish additional education and outreach materials • Publish the habitat and land use management tool box • On-line habitat atlas will be operational • Hold FY 2002 State of Lake Michigan Conference • Convene a bi-state St Joseph Watershed conference on June 10 and 11, 2002 • Establish the Lake Michigan Watershed Academy • Hold a 2003 State of Lake Michigan conference • Take comments on proposed changes to Lake Michigan pollutant and stressor lists	• Clean up and delist AOCs • Implement the Lake Michigan Watershed Academy

Executive Summary

Details on the Bullets Below are Found in the Individual Subgoal Sections

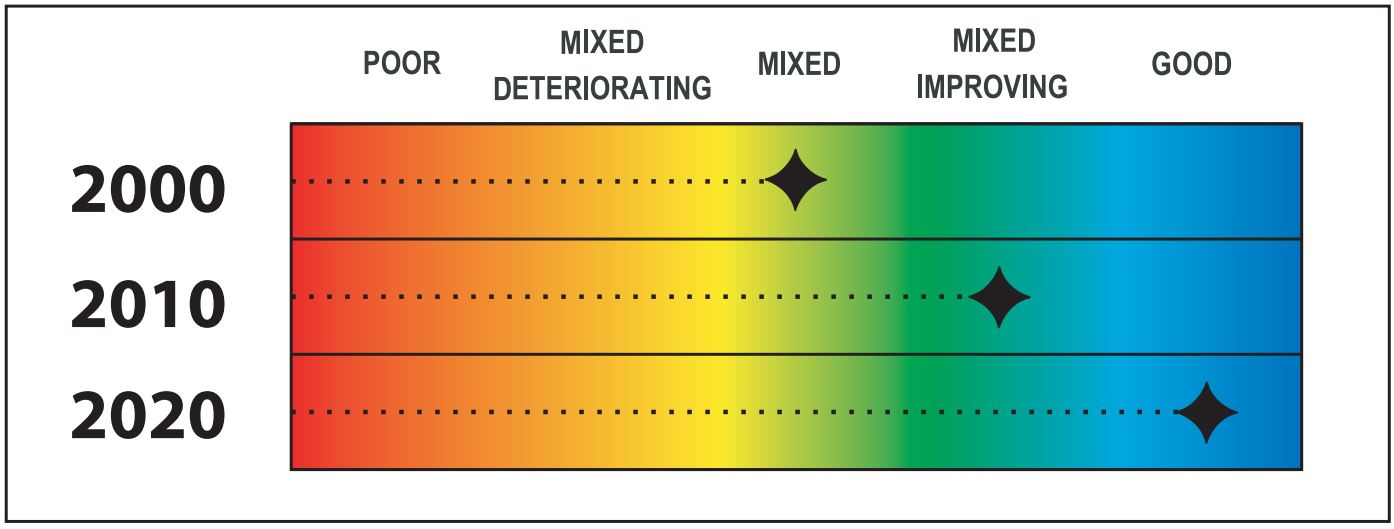
Strategic Action Agenda	Subgoals of the Lake Michigan LaMP	Significant Happenings 2000-2002	Near-Term Objectives 2002-2004	Long-Term Objectives
Research and Monitoring Actions that monitor the ecosystem, reduce uncertainty, and inform our decisions	**Subgoal 11** We have enough information/data/understanding/ indicators to inform the decision-making process ***Status*** • Mixed in 2000 • Mixed/Improving by 2010 • Good by 2020	• LMMB project findings • Lake Michigan Monitoring Coordinating Council monitoring and assessment inventory • Lake Michigan Monitoring Assessment report released • Beach monitoring program (BEACH) created by U.S. EPA • BEC statement and monitoring conference • IJC/Delta Institute/Lake Michigan Forum Air Deposition Workshop • Great Lakes Wetlands Consortium consolidates wetland information • EPA/ORD wetlands indicators • LaMP pollutant list review • Beach Conference, web site, and manager's group	• Monitoring research and development will be presented for the critical pollutant Watch List. • A LMMB Study report will be prepared for each contaminant studied added to the LaMP 2000 online. • Progress will be made in prioritizing indicators for the lake and monitoring them. • The coordinated monitoring plan for the lake will be finalized. • LMMB Study findings will be documented and model runs will be completed.	• Special effort and emphasis on coordinated monitoring in the Lakes Michigan basin by 2004-05

2.0 Lake Michigan Subgoals 2002

The following section describes the status of the 11 Lake Michigan LaMP subgoals. The targets for each subgoal are depicted graphically, followed by a short description of the status of the subgoal and the challenges facing the LaMP process to improve the status of the subgoal. Key activities or updates relevant to the subgoal that have occurred over the past 2 years are then described, followed by a brief description of key next steps to achieve the subgoal targets. Details appear in each subgoal section.

Fishing from the Shore of Lake Michigan
Photograph courtesy of USDA Natural Resources Conservation Service*

Subgoal 1
Can we all eat any fish?



Status

About 40 species of fish currently inhabit Lake Michigan, most of which are native to the lake. Over 43 percent of all Great Lakes fishing is done in Lake Michigan, and both commercial fishing and sport fishing are significant contributors to the overall economies of the states in the basin. Commercial fish production (both nontribal and tribal) reaches over 14.6 million pounds of fish annually.

While fishing is an important Lake Michigan resource, the need exists for all four Lake Michigan states to maintain advisories to warn the public about potential health effects resulting from consuming certain species of fish in the lake. As a result, achievement of the goal in Lake Michigan is mixed.

Challenges

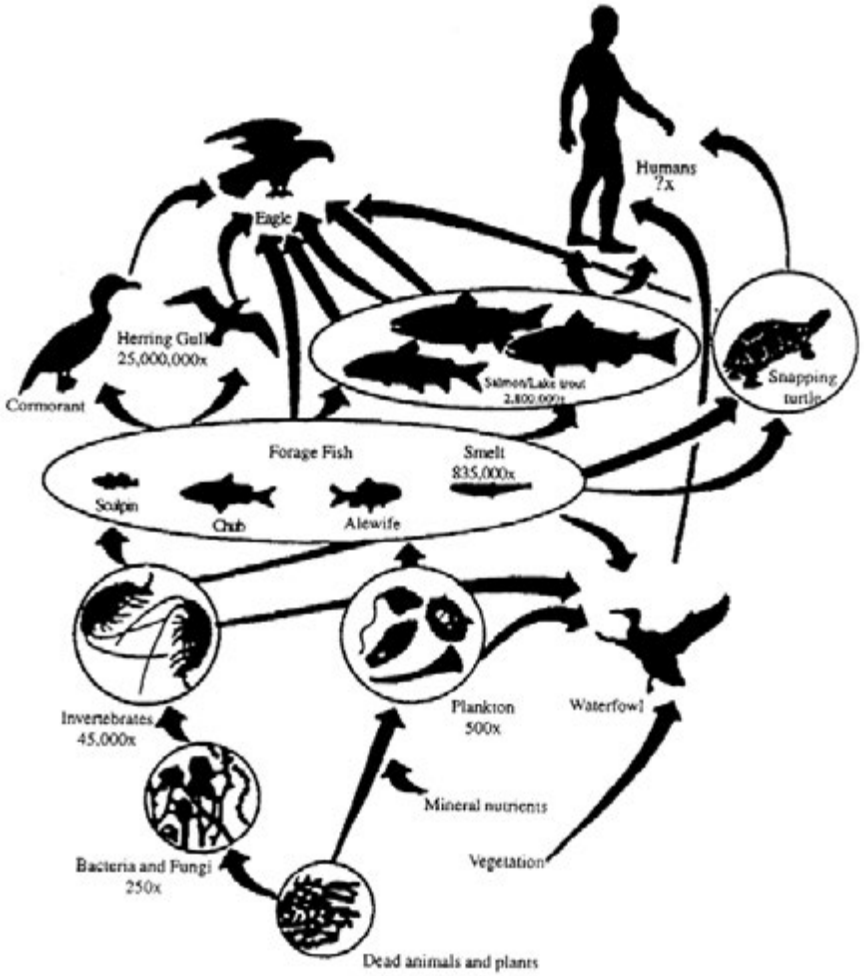
(1) To determine the source of toxic atmospheric deposition to Lake Michigan.

(2) Secure resources to clean up contaminated sediment sites.

(3) To make fish consumption advisory data widely accessible and user-friendly.

Fish Consumption Advisories

Fish accumulate contaminants and become a further source of contamination for larger predator fish. Fish consumption has been shown to be a major pathway of human exposure to persistent toxic substances such as PCBs and mercury because the contaminants biomagnify as they move up the food web (Figure 1). The state fish consumption advisories are necessary to protect people from potential adverse health effects associated with contaminants found in fish. Fish consumption advisories may also include information to educate the public on how to minimize exposure to certain contaminants through proper preparation and cooking of fish.



Great Lakes food web. Heavy metals and many synthetic chemicals are absorbed by organisms and bioaccumulate, with concentrations reaching toxic levels if exposure is great enough. The concentration is magnified at each step of the food web as large organisms eat many small ones. Numbers = Biomagnification of PCBs in Lake Ontario. Source: Johnson et al. 1999 (reprinted with permission)

PCBs are the primary contaminant causing the consumption advisories for fish in Lake Michigan. Mercury is also a cause of Lake Michigan fish advisories, and all four Lake Michigan states have issued warnings about the consumption of mercury-contaminated fish from inland lakes as well. Dieldrin was previously a pollutant contributing to fish consumption advisories, but the Lake Michigan states no longer identify dieldrin as a concern (Figure 2). States frequently use fish consumption advisories as indicators of whether their waters are meeting designated uses, triggering the need for investigation and setting a total maximum daily load (TMDL) for contaminants. TMDLs for PCB and mercury are therefore required for Lake Michigan. The fish consumption advisories are updated annually and can be found at the following web sites:

- Illinois: www.idph.state.il.us/envhealth/fishadv/fishadvisory02.htm
- Indiana: www.in.gov/isdh/programs/environmental/fa_links.htm
- Michigan: www.michigan.gov/mdch/1,1607,7-132-2944_5327-13110--,00.html
- Wisconsin: www.dnr.state.wi.us/org/water/fhp/fish/advisories

Mercury Advisories

Mercury is emerging as a growing concern in fish in Lake Michigan, inland lakes in the basin, and in the ocean. To address this concern, the states and the U.S. Food and Drug Administration (FDA) have issued advisories governing the consumption of fish. States recommend that if a woman is pregnant or could become pregnant, if a woman is nursing or in child-bearing years, consumption of freshwater sportfish caught by family and friends should be limited to one meal per week. For adults, one meal is 6 ounces of cooked fish or 8 ounces of uncooked fish; for a young child, one meal is 2 ounces of cooked fish or 3 ounces of uncooked fish.

The FDA has issued advice concerning mercury in commercial fish in stores and restaurants, which

Lake Michigan Fish Consumption Advisories

1993 to 2001, with deletions in strike out font and additions in italics font

~~Text~~ = no longer a basis for a Lake Michigan open water fish consumption advisory in 2001

Text = new 2001 fish consumption advisory for Lake Michigan open water

Text = fish consumption advisory for open waters of Lake Michigan

The font indicates changed State fish consumption advisories (FCA) for the open waters of Lake Michigan from 1993 to 2001. The strike out font represents toxic chemicals that were the basis for a State FCA in 1993, but are no longer the basis for a State FCA in 2001. The italic font represents toxic chemicals that are the basis for new State FCA in the open waters of Lake Michigan, compared to 1993. The normal font represents no change from 1993 to 2001.

- Lake Michigan
- Watershed
- Illinois
- Indiana
- Michigan
- Wisconsin

Data source: Revised draft Lake Michigan Lakewide Management Plan for Toxic Pollutants in 1993 and States Fish Consumption Advisories 2001.

Map created by: Martha Aviles-Quintero
ORISE Research, US EPA Region 5, 03/21/02

Mercury Methylation

The global cycling of mercury and its transformation to methylmercury is a complex process. Mercury evaporates from soils and surface waters to the atmosphere, is redeposited on land and surface water, and then is absorbed by soil or sediments. After redeposition on land and water, mercury is commonly volatilized back to the atmosphere as a gas or as adherents to particulates.

Once released into the environment, inorganic mercury can be converted to organic mercury (methylmercury) which is the primary form that accumulates in fish and shellfish. Methylmercury biomagnifies up the food chain as it is passed from a lower food chain level to a subsequently higher food chain level through consumption of prey organisms or predators. Fish at the top of the aquatic food chain, such as pike and bass in lakes, and shark and swordfish in oceans, bioaccumulate methylmercury approximately 1 to 10 million times greater than dissolved methylmercury concentrations found in surrounding waters.

includes ocean and coastal fish as well as other types of commercial fish. FDA advises that women who are pregnant or could become pregnant, nursing mothers, and young children not eat shark, swordfish, king mackerel, or tilefish. FDA also advises that women of childbearing age and pregnant women may eat an average of 12 ounces of fish with advisories purchased in stores and restaurants each week. It is important to control the total level of methylmercury consumed from all fish; therefore, in a given week a woman of child bearing age should not eat more than 12 ounces of cooked fish that have advisories

Addressing PCB Sources

Since LaMP 2000, data collected from the Lake Michigan Mass Balance Study (discussed below) and other sources indicate that PCBs entering the lake from contaminated sediments and air deposition continue to be the significant contributor resulting in fish consumption advisories for the lake. As a result, controlling these PCB sources will be critical to eliminating fish consumption advisories in the future and meeting the goal of restoring the fish to good condition by 2020. Cleanup of contaminated sites has been undertaken at 5 of the 10 Lake Michigan Areas of Concern.

Two of the sites most highly contaminated with PCBs in the sediments are found in the Fox River in Wisconsin and the Grand Calumet River in Indiana. Progress has been made in planning for cleanup of these sites, also classified as Areas of Concern (AOC), over the past 2 years.

In 2001, plans were announced for the Fox River/ Green Bay AOC. The proposed $310 million plan calls for the removal of about 7.25 million cubic yards of contaminated sediment containing more than 64,200 pounds of PCBs from the lower Fox River. The plan divides the river into four sections, three of which would be dredged to remove the contamination. The fourth area, between Appleton and Little Rapids, would not be dredged. Instead, the PCB levels would be monitored in that part of the river. The plan also calls for removing the water and stabilizing the dredged sediment from the river, and disposing of it off site at licensed solid-waste disposal facilities, including a possible new disposal facility in the Fox River Valley.

With 24 paper and pulp mills on 39 miles of the Fox River, it is the largest concentration of mills in the world. The Fox River Intergovernmental Partners (partners) signed a proposed agreement with Appleton Papers, Inc. (API) and NCR Corporation (NCR) to provide funding for interim cleanup and natural resource restoration projects on the Fox River and Green Bay while comprehensive cleanup and restoration plans are being developed as part of a remedial investigation/feasibility study (RI/FS)

Using Fish Advisories

Methylmercury is found primarily in the fish muscle (fillets) bound to proteins. Skinning and trimming the fish does not significantly reduce the mercury concentration in the fillet, nor is it removed by cooking processes. Because moisture is lost during cooking, the concentration of mercury after cooking is actually higher than it is in the fresh uncooked fish. In contrast, PCBs adhere to fat, so the removal of skin and fat, as well as broiling the meat, removes up to 90 percent of the contamination.

and natural resources damage assessment (NRDA). Appleton Papers, Inc. reached an agreement with environmental officials in June 2001 to begin paying for its portion of the cleanup. Negotiations with the other six mills are continuing.

Under the agreement, API and NCR will make:

(1) Payments totaling up to $40 million over the next 4 years, based on estimates provided by the partners, to fund cleanup and restoration projects as they are identified.

(2) Four payments of $375,000 over the next 4 years, for a total of $1.5 million, to go to DOI to help pay back expenses it has incurred in putting together the NRDA.

The long-awaited Grand Calumet sediment cleanup will begin in 2002. U.S. Steel has agreed to put the cleanup on the fast track, with construction beginning in January 2002 on a corrective action management unit (CAMU) to contain the dredgings on company property north of the river between Bridge Street and the former American Juice factory.

Removal of PCB-contaminated sediment will start in October 2002 along the eastern 11 miles below the lagoons in Marquette Park at the 16-mile long river's headwaters. Another 575,000 tons of less hazardous waste from the next 31 miles to the Gary Sanitary District will also be piped to the site from two hydraulic dredges that will run 24 hours a day to vacuum the river bottom. PCB dredging is scheduled to be completed in May 2003, 3 months ahead of the compliance date in the federal court decree, dictating the cleanup.

To save money starting and stopping the dredges, they will run 24 hours a day, allowing the completion of the 5-mile Gary stretch by July 2003. Water and air quality will be monitored before, during, and after the cleanup, and efforts will be make to keep noise away from homes along the south side of the river.

To make up for 14 acres of wetlands that will be disturbed by dredging, 32 acres of undeveloped dunes and swales on U.S. Steel's land will be restored and donated to the National Lakeshore in 5 years.

Updates on these and other Areas of Concern are included in Appendix C.

Dioxins Sources – Burn Barrels

Dioxins has also been identified as a fish tissue contaminant resulting in fish consumption advisories. Dioxins is created as a by-product of the manufacture, molding, or burning of organic chemicals and plastics that contain chlorine. Many large combustion sources are now controlled to prevent dioxins formation. One of the major sources of dioxins found in Lake Michigan is the

Photo courtesy of U.S. EPA*

Tribes Address Burn Barrels

The Sokaogon Chippewa Community (Mole Lake Reservation) in Crandon, Wisconsin has made progress in raising awareness about illegal dumping and open burning. The tribe revised their old solid waste ordinance and researched the tribal court authority to hear and rule on violations of the revised ordinance. The Tribal Council then banned the use of burn barrels on the reservation. The burn barrel ban, increased enforcement against illegal dumping, and strong youth and community education have improved proper solid waste disposal and recycling for the tribe. Within the past 2 years, the annual tonnage of solid waste generated on the reservation has averaged about the same, but the annual tonnage of recyclables diverted has nearly tripled.

The Grand Traverse Band of Ottawa and Chippewa Indians also adopted a ban on burning any trash/garbage on all tribal lands.

backyard burning of trash in "burn barrels." The "Burning Household Waste" brochure developed by the Michigan Department of Environmental Quality (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*

Lake Michigan TMDL Strategy

EPA is also moving forward with a TMDL strategy to address sources of PCB and mercury load to the lake that result in fish consumption advisories. The overall goals for fishable, swimmable, and drinkable water are present in both the federal Clean Water Act (CWA) and GLWQA, with each taking a different approach.

Under the Clean Water Act, the states and tribes use the regulatory process to designate water body uses and to set the standards necessary to support those uses. Any request for a permit to discharge into a water body is judged based on the designated use of the receiving water body and state water quality standards. Within the Great Lakes basin, state water quality standards have been upgraded to meet the Great Lakes Water Quality Guidance objectives, which call for the standards to (1) be no less restrictive than the pollutant limits that protect human health, aquatic life, and wildlife; (2) encompass antidegradation policies; and (3) incorporate implementation procedures.

The LaMP process, which implements the GLWQA at the lake level, addresses the goals by bringing together both the public and private sectors to implement voluntary pollution reduction programs

TABLE 1
TMDL/LaMP COMPARISON

	TMDL	LaMP
Scope	Water body quality	Ecosystems
Goals	State designated uses and standards	Adopted goals, beneficial uses
Problem Identification	Problem identification and documented source assessment	Problem identification and documented source assessment
Targets	Numerical targets for loadings	Endpoint target reductions and ecosystem objectives
Research and Development	Link targets/sources = load and waste load allocations	Link target/sources = projects
Tools/Impacts	Monitoring plan for stream reach	Ecosystem monitoring plan
Point Source	Permit limits (per effluent guidelines)	Indicators, compliance assistance projects
Non-point Sources	Voluntary, best management practices, pollution prevention, education	Voluntary, best management practices, pollution prevention, education
Follow-up Plan	Permit/stream specific regulated entity	Sector specific, both public and private projects
Process	CWA, defined in regulation, technical calculation reviewed by EPA	CWA and GLWQA partnership approach to manage pollutants
Tribes	Must have treatment as a State- adopted water quality standards	LaMP committee membership

and strategies in order to reduce pollutant loading to the lakes.

Water bodies are monitored, and when a water body is determined to not be meeting quality standards—even after application of permit-required wastewater treatment technology—regulations require the state to list the water as impaired (Section 303(d) list), collect additional data, and calculate a TMDL.

The Great Lakes and many inland water bodies appear on the Section 303(d) lists of most Region 5 states as impaired by mercury and PCBs based on fish consumption advisories. Given the size and complexity of the Great Lakes and the experience in developing a mass balance model for Lake Michigan, it will take many years and be resource-intensive for the states to collect the necessary data and develop TMDLs for all of their impaired waters. After the TMDLs are developed, their implementation for the Great Lakes will take much longer and will require additional resources.

LaMP 2000 contained a draft strategic planning document that outlined a number of issues to be addressed in developing a final TMDL framework for the lakes by 2004. Workshops held in 2001 for regulators and stakeholders highlighted their common desire to more efficiently address impaired waters. The TMDL strategy development process will continue through 2004 and will include ongoing stakeholder consultation. While the LaMP and TMDL processes are seeking to achieve improvements in the lake, the processes are designed to achieve different end points. The similarities and differences between the two processes are summarized in Table 1.

The National Wildlife Federation proposed an alternative mercury control program in lieu of a mercury TMDL and Region 5 responded by working with its states to develop a mercury phase-out proposal. Implicit in the alternative approach is a monitoring and reporting schedule that measures progress or alerts the public to lack of progress.

Next Steps

- By 2003, hold a mercury phaseout TMDL stakeholder meeting
- By 2004, a TMDL Strategy will be developed for Lake Michigan.
- By 2006, the Binational Toxics Strategy goals of 90 percent reduction of high-level PCBs, 75 percent reduction of total dioxins and furan releases, and 50 percent reduction of mercury use and release will be reached.
- By 2007, concentrations of PCBs in lake trout and walleye will be reduced by 25 percent. These results are based on early Lake Michigan Mass Balance model runs.

Sunset at Indiana Dunes
Photo courtesy of the National Park Service Indiana Dunes National Lakeshore*

Mercury Phase-Out Proposal: Working Draft

The states and EPA have developed a working draft Mercury Phase-Out Proposal that may be accepted in lieu of a TMDL. This working draft is still in discussion. A final proposal will be presented to stakeholders for comments in Spring 2003. EPA has issued guidance indicating that waters may be removed from a Section 303(d) list on the basis that "other pollution controls" are in place that will attain water quality standards within a reasonable time. Existing regulations and guidance will allow implementation of an alternative to a TMDL provided that the alternative will result in the water body attaining water quality standards within a reasonable time.

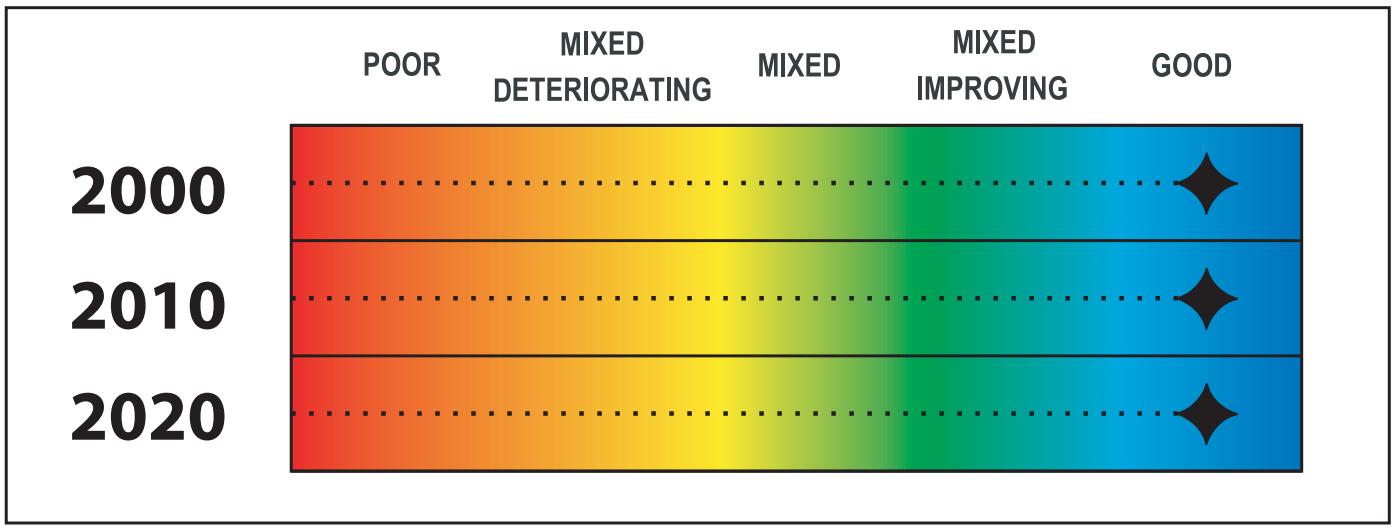
In brief, the basic concept of the phase-out proposal is to allow the Region 5 states to forgo developing TMDLs for mercury-impaired waters, including those waters with only fish consumption advisories for mercury, if they commit to perform the following actions:

- Expedite air and National Pollutant Discharge Elimination System (NPDES) permitting for mercury sources incorporating the most stringent standards (for example, Maximum Achievable Control Technology [MACT] standards or Great Lakes Initiative [GLI]). All new and existing NPDES permits will incorporate GLI standards by 2006.
- Expedite contaminated sediment remediation activities so that all sites are cleaned up by 2025. The states and Region 5 will work together to finalize a mercury source and sediment strategy by 2004.
- Implement voluntary mercury collection, reduction, and pollution prevention programs on an expedited schedule. Such programs can include mercury thermometer exchanges, source identification and reduction programs for publicly owned treatment works (POTW), and negotiation of voluntary elimination of mercury switches in automobiles. Region 5 expects that to have an approvable reduction program, a state would need to address in some way the following mercury-containing products: fluorescent lamps, thermostats, thermometers, dairy manometers, auto switches, switches used in household appliances, and electrical devices and measurement and control devices used in industry. In terms of source categories, a state would need to address households and small businesses (for instance, by providing free or low-cost mercury collection), schools, hospitals, automobile scrapping operations, dental offices, and the construction and demolition industry. The programs should be based on the objective of virtual elimination of mercury use and release. Where possible, a state should encourage discontinuation of mercury use and employment of processes that eliminate mercury releases. Where mercury use and release cannot be avoided, a state should seek to minimize releases through best management practices, improved waste management, and pollution controls.
- Develop and implement a monitoring plan to assess progress in reaching program goals. The monitoring plan should specify which parameters will be monitored and at what frequency. The plan should also indicate what benchmarks must be achieved to certify that progress is being made toward eliminating mercury impairments or fish consumption advisories for mercury in Region 5 waters.

EPA would forge individual state agreements through Memoranda of Understanding (MOU) to allow states to conduct the actions described above in lieu of developing mercury TMDLs; each LaMP would incorporate the actions. The phase-out proposal supports the Great Lakes Strategy, LaMP mercury reduction targets, and Binational Toxics Strategy mercury goals.

The phase-out proposal will be discussed at upcoming LaMP and Binational Toxics Strategy meetings and at a special stakeholder meeting.

Subgoal 2
Can we drink the water?



Status

The drinking water in the Lake Michigan basin is of good quality, although there have been sporadic outbreaks of illness related to drinking water. The waters of Lake Michigan and surrounding areas are a primary source of drinking water for 10 million people who live in the basin. Because the average adult in the United States consumes about 1.6 quarts of water each day, health effects can be serious if the drinking water supply has high levels of some contaminants. This water is obtained from a variety of suppliers, both public and private.

Challenges

(1) To understand possible vulnerabilities in water sources and prepare protection plans.

(2) To monitor for possible new contaminants.

(3) Groundwater depletion in the basin increases the number of requests to tap into the Lake Michigan source; these requests need to be tracked.

Drinking Water Contaminants

Various contaminants can adversely impact drinking water, including microorganisms (for example, bacteria, viruses, and protozoa such as cryptosporidium), chemical contaminants (including naturally occurring chemicals and anthropogenic or synthetic chemicals), and radiological contaminants (including naturally occurring inorganic and radioactive materials and metals). Some contaminants in raw (untreated) water supplies, such as aluminum, arsenic, copper, and lead, can be both naturally occurring and the result of human activities. Other contaminants, such as household chemicals, industrial products, urban storm water runoff, fertilizers, human and animal waste, nitrate (from fertilizers and sewage), and pesticides, may also end up in raw water supplies

Certain chemical contaminants pose a concern when present in drinking water because of possible health consequences associated with these substances. These contaminants may be in raw water as a result of industrial and agricultural activities or treated wastewater discharges. Some may also be present in treated water as a result of chemicals used in the drinking water treatment process (Health Canada, 1998). The impact of contaminants is diluted in a large water body like Lake Michigan but could be more serious in a groundwater source.

Microbial contamination of drinking water can pose a potential public health risk in terms of acute outbreaks of disease. The illnesses associated with contaminated drinking water are mainly of a gastrointestinal nature, although some pathogens

are capable of causing severe and life-threatening illness. In most communities, drinking water is treated to remove contaminants before it is piped to consumers, and bacterial contamination of municipal water supplies has been largely eliminated by adding chlorine or other disinfectants to drinking water in order to prevent waterborne disease. As a result, diseases such as typhoid and cholera have been virtually eliminated. Although other disinfectant treatments are available, chlorination still tends to be the treatment of choice. When used with multiple barrier systems (that is, coagulation, flocculation, sedimentation, and filtration), chlorine is effective against virtually all infective agents (Health Canada, 1998).

In general, drinking water provided by public water suppliers is likely to remain of good quality because of the multiple pollutant barrier approach being implemented across the basin. Not only are treatment systems and operating practices continually improving, increased monitoring is also providing more information about source water supplies and the need for source water protection. In the past two years, greater emphasis has been placed on assessing and protecting raw sources of drinking water. Both the source water assessments that must be completed for all public water supplies by 2003 (see text box) and recent data collected from 22 sites around the Great Lakes are providing more information about raw water supplies. Samples from the 22 sites were assessed for microbiological and chemical contaminants. The samples revealed that the health of the Great Lakes raw drinking water supply, including Lake Michigan, is good (SOLEC 2001). All of the parameters assessed in the study were found to be consistently below drinking water standards. In particular, no fecal coliform exceedances have been observed at the U.S. sites included in the study for the past ten years.

Overall, violations of chemical and microbial standards in water provided by public water systems in the basin are extremely rare. The risk of human exposure to contaminants is low (SOLEC 2001). The quality of water delivered, however, can vary due to the possibility of contaminants entering the distribution system.

Drinking Water Monitoring and Reporting

Continuing efforts must be made to inform health professionals and the public of the results of analyses of drinking water. EPA requires that public water supplies be monitored for bacteriological, inorganic, organic, and radiological contaminants. The analyses of drinking water include tests for the physical and chemical characteristics of the water as well as for contaminants from natural sources or human activities. In addition, the EPA Office of Groundwater and Drinking Water (OGWDW) web site at *www.epa.gov/OGWDW* provides detailed information on the nation's drinking water, including drinking water and health information, drinking water standards, and local drinking water

Great Blue Heron
Photo courtesy of Donald Breneman*

information. Community water suppliers deliver high-quality drinking water to millions of people every day, and a network of government agencies is in place to ensure the safety of public drinking water supplies. Our drinking water is safer today than ever before, but problems can and do occur although they are relatively rare.

Information on local water quality is available from several sources, including state public health departments and local water suppliers. To inform the public of the results of analyses of drinking water and to demonstrate a commitment to protecting human health, each community public water supplier is required to generate an annual Consumer Confidence Report that is made available to all residents receiving water from the water system. A Consumer Confidence Report provides information about the source of water used, its susceptibility to contaminants, the levels of contaminants detected in the water, the likely sources of contaminants, and potential health effects of any contaminant detected at a concentration above its maximum contaminant level (MCL). Consumer Confidence Reports can be reviewed to get an indication of the overall quality of treated surface water and groundwater and the condition of the drinking water provided. In addition, starting in 2003, the states will distribute information on the status of the source waters used by public water suppliers and the level of susceptibility of those source waters to contamination.

Next Steps

- By 2002, EPA will track and report on raw source water for Green Bay, Milwaukee, Chicago, and Muskegon.
- By 2003, source water assessments (including security assessment) will be completed and reported.
- By 2005, plans will be in place to address drinking water susceptibility to contamination.

U.S. EPA. 1997. Water on Tap: A Consumer's Guide to the Nation's Drinking Water. EPA 815-K-97-002

Health Canada. 1998. Summary: State of Knowledge Report on Environmental Contaminants and Human Health in the Great Lakes Basin. Great Lakes Health Effects Program, Ottawa, Canada

Source Water Assessments for Public Water Systems Drawing Water from Lake Michigan

Under the 1996 amendments to the Safe Drinking Water Act (SDWA), states and tribes are required to develop comprehensive Source Water Assessment Programs (SWAP) that will

1. identify the areas that supply public tap water,
2. inventory contaminants and assess water system susceptibility to contamination, and
3. inform the public of the result.

Funds to implement the assessments are available through the SDWA Drinking Water State Revolving Fund. Most states are currently conducting the assessments, and the results will be reported to the public in 2003.

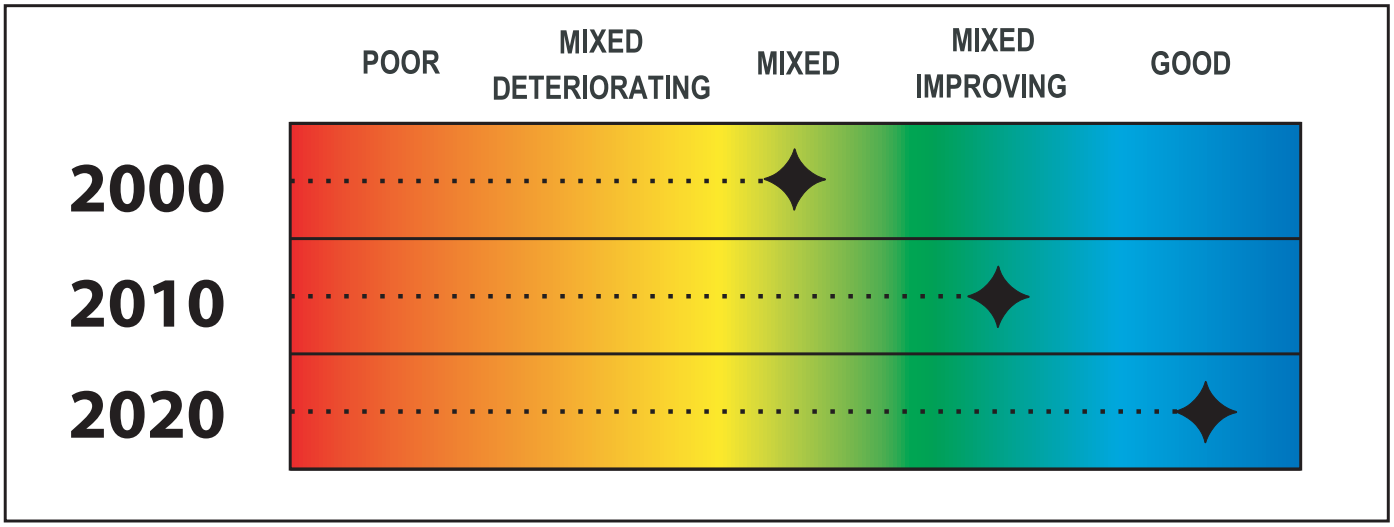
Because of the unique nature of water intakes in the Great Lakes, a special approach has been developed by the Great Lakes states to determine the source water assessment areas for Great Lakes water suppliers. A "critical assessment zone" sensitivity factors is determined by multiplying the distance of a water intake from the shore (L) by the water depth (D) in feet:

$$S=L \times D$$

Generally, S values less than 25,000 represent highly sensitive intakes, while S values greater than 125,000 indicate lower sensitivities. The shallower, nearshore intakes are more sensitive to shoreline influences than the deep, offshore intakes. This information is used by the states to determine the size of assessment areas, help prioritize assessment activities, and assist with susceptibility determinations.

Information on source water assessment approaches and assessment results will be available from each of the Lake Michigan states by 2003.

Subgoal 3
Can we swim in the water?



Status

Lake Michigan contains the world's largest collection of freshwater sand dunes and associated beaches, particularly along its eastern shore. Of a total of 3,100 coastal acres, 1,200 acres is publicly owned and available for use, while an additional 1,200 privately owned acres has significant potential for public use. It is important to note that most shoreline areas along Lake Michigan fully support swimming and secondary contact recreation. However, some areas do experience beach closures because of contamination. As a result, the current status of the goal is mixed.

Challenges

(1) Maintain and not overtax the wastewater control infrastructure.

(2) Address nonpoint sources of pathogen load to beaches and water bodies.

(3) Build a real-time beach monitoring and reporting system.

Beach Closures

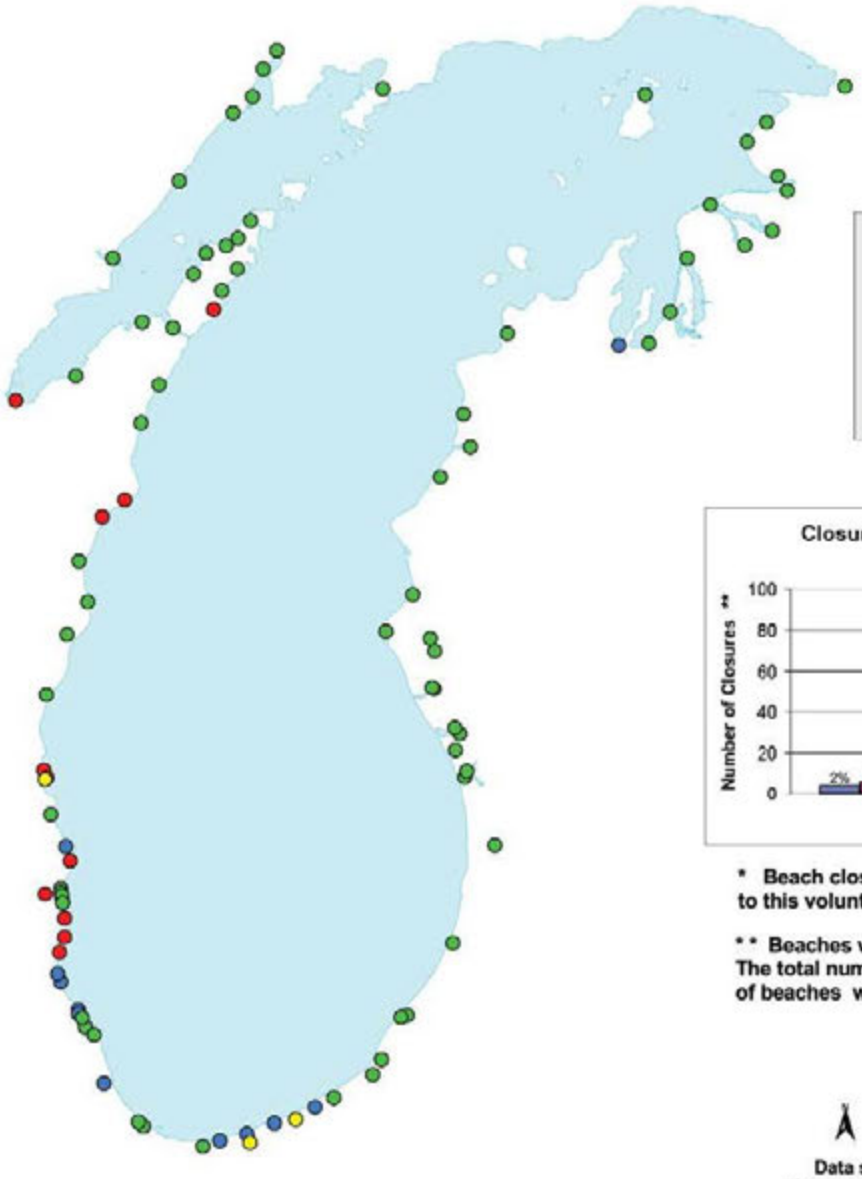
Beach closures resulting from high pathogen loads have a negative effect on the lake's significant tourist industry. Wet weather that causes overflows from aging wastewater collection systems or treatment plants, runoff from cities and farms, improperly sited or maintained septic systems, and natural sources release pathogens into tributaries and the lake. When pathogen levels exceed standards, beach managers post "No Swimming" notices in order to protect human health.

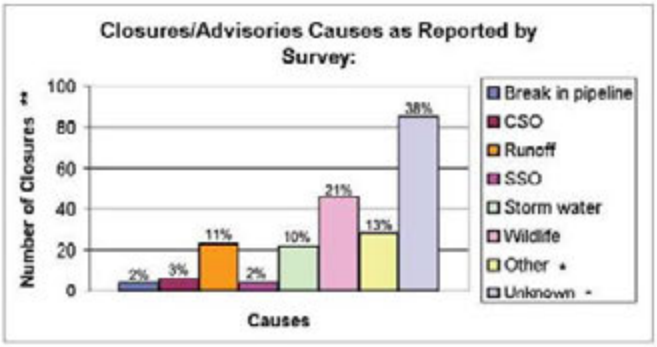
Because the Lake Michigan states currently use different standards and measurement methods to determine the need for beach closings, there are limitations on the ability to compare frequencies of exceedances of microbiological standards in order to evaluate trends in recreational water quality. Despite these limitations, the frequency of beach postings has traditionally been used as an indicator of recreational water quality. Microbial standard exceedances may be a better measure of the actual health risk associated with recreational water quality. By April 2004, all Great Lakes states will adopt bacteria criteria at least as protective as EPA's Ambient Water Quality Criteria for Bacteria – 1986. EPA's annual voluntary beach survey program provides an indication of the status of beach health. In 2000, Lake Michigan had 206 beach closings. Of the 211 beaches on the lake, 137 were monitored for pathogens. See Figure 3 for a summary of beach closure locations in 2000.

Federal Beach Bill

In October 2000, the U.S. Congress passed federal legislation amending the Clean Water Act that is referred to as the Beaches Environmental Assessment and Coastal Health Act, or the BEACH Act. The BEACH Act requires adoption of consistent bacterial standards nationwide, research on new pathogens and pathogen indicators, issuance of new or revised criteria and guidance within 5 years, and development of rapid analytical techniques for faster notification of the public regarding elevated bacteria levels. The act also authorizes EPA to award grants to eligible coastal and Great Lakes states in order to set up beach monitoring and public notification programs. In 2001, $2 million was appropriated for coastal

Lake Michigan Beaches Closures/Advisories in 2000





* Beach closures data limited; not all recipients responded to this voluntary survey.

** Beaches with one or more that one cause (175 records). The total number of closures is greather than the total number of beaches with closures (53 beaches).

10 0 10 20 30 40 Miles

Data sources: National Health Protection Survey of Beaches 2000 for swimming season.

Map create by: Martha Aviles-Quintero
ORISE Research, US EPA Region 5, 03/28/02

states to develop beach monitoring and notification programs, and an additional $10 million has been appropriated in 2002 to continue program development and implementation. Out of the 2002 appropriation, the four Lake Michigan states received over $1 million.

To provide more protection against gastrointestinal illness, EPA requires that all states adopt E. coli criteria for use as beach indicators by 2004. The BEACH Act grants will result in improved beach monitoring and public notification programs. EPA's Office of Research and Development (ORD) will be conducting epidemiological studies to examine health risks associated with swimming at several beaches across the country, including beaches on the Great Lakes.

Great Lakes Beach Conference and Follow-up Activities

In February 2001, an EPA, LaMP, and City of Chicago-sponsored Great Lakes Beach Conference was held to share information on the science and technology of beach monitoring as well as research on exposure, health effects, and water quality indicators. More than 250 environmental and public health officials, beach managers, and regulators attended the 3-day conference. A draft National Beach Guidance and Performance Criteria for Recreational Waters was produced by EPA, and the associated public notice appeared in the Federal Register; the comment period ended in October 2001. The guidance will be used to help local health departments and beach managers implement a nationally consistent water quality monitoring program for beaches. At the conclusion of the conference, EPA presented a technical workshop on the BEACH Act that was passed in October 2000. This workshop provided conference participants with the opportunity to learn about the purpose of the BEACH Act and the funding available under the act. Additional information regarding the BEACH Act is available at www.epa.gov/OST/beaches.

Several follow-up activities have occurred since the Great Lakes Beach Conference. An interactive Listserv and networking opportunities have been established. In addition, Great Lakes beach closure maps have been updated by EPA Region 5. Additional educational and outreach materials have been developed, and a Lake Michigan volunteer water quality monitoring workshop was held in March 2002. Additional opportunities for information sharing and networking will be pursued.

For more information on beach management issues, see the following web sites:

BeachNet e-mail list -
www.great-lakes.net/lists/beachnet/beachnet.info

Great Lakes Beach Conference 2001 complete conference proceedings -
www.glc.org/monitoring/beaches/GLBC/

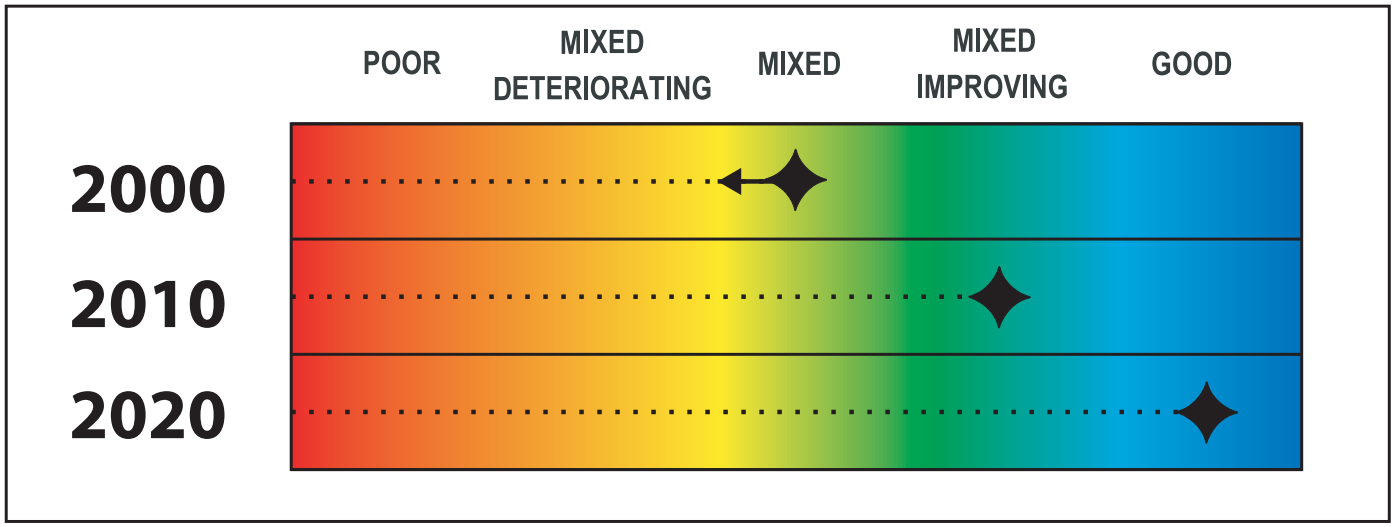
Additional beach information or applying for beach grant funds -
www.epa.gov/waterscience/beaches

Great Lakes Information Network's new human health web site -
www.great-lakes.net/humanhealth/

Next Steps

- By 2004, states will adopt criteria, standards, and monitoring programs for beach bacteria.
- By 2005, achieve a 30 percent reduction from the 1992 per capita loadings from combined sewer overflows (CSO), POTWs, and industry.
- By 2005, 95 percent of high-priority beach waters (as defined by the state) will be monitored and a public advisory system will be in place.
- By 2007, 90 percent of monitored high-priority beach waters (as defined by the state) will meet federal and state bacteria standards for more than 95 percent of the average swimming season.

Subgoal 4
Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?



Status

The Lake Michigan ecosystem continues to experience profound changes because of development, impacts of nuisance species, and pollutant loading. Overall, the status of Lake Michigan habitats, including open water, wetlands (coastal and inland), coastal shore, tributaries, lakeplains, and inland terrestrial systems, is mixed to deteriorating. Many species habitats rank as globally rare or imperiled based on their restricted distribution, the level of threat, their ecological fragility, and widespread damage or because they are part of the single largest source of fresh surface water in the world. This section assesses the status of each of the general habitat types in the Lake Michigan ecosystem and highlights significant events since the issuance of LaMP 2000. This assessment includes an overview of continuing trends in habitat loss and decreased biodiversity as well as the impacts of aquatic nuisance species.

Challenge

(1) To identify and enhance, restore, or protect critical ecosystem features and habitat through purchase or voluntary protection.

(2) To make habitat information readily available.

Open Lake System

The open lake waters of Lake Michigan consist of both inshore and offshore waters, including all waters from the offshore edge of coastal wetlands lakeward. Significant changes in the lake ecosystem

Little Traverse Bay Bands of Odawa Indians Lake Trout project

The Little Traverse Bay Bands of Odawa Indians Natural Resources Department is researching the influence of egg and fry predators on the lack of successful lake trout reproduction in the Great Lakes. Predation, particularly by exotic species, may exceed the potential of spawning reefs to successfully incubate eggs and produce measurable recruitment. During the study, the Little Traverse Bay Bands have collaborated with the Canadian Department of Fisheries and Oceans, the Michigan Department of Natural Resources, and the University of Vermont. Egg, fry, and predator abundance was measured at spawning reefs using egg seeding, fry traps, and alewife exclosures. Initial findings have documented lake trout egg deposition and survival to yolk-sac fry for the first time at specific sites in northeastern Lake Michigan. Additional field and laboratory experiments will be conducted to assess the current effect of predation on recruitment.

Rise and Fall of the Lake Trout

Lake trout (Salvelinus namaycush) is a North American salmonid that thrives in cold, fresh water. Following the retreat of the last glacier, the lake trout colonized Lake Michigan, and over the subsequent 10,000 years or so, it became the top predator in a complex ecosystem that co-evolved with the other fish species. Over that period of time different strains of lake trout evolved. Some strains thrived in the deepest waters of the lake feeding on the abundant chubs and deepwater ciscoes, while other strains thrived in shallower areas.

Starting in the mid-1800s, the human population of the region began to increase, and cities started growing around the lake. With abundant resources and convenient access to waterways, Lake Michigan quickly became a major industrial hub of the United States. Commercial fishing for lake trout also became an industry, and by the beginning of the 20th century, the lake trout population was in decline. The decline continued until the mid-1950s, when predation by sea lamprey, overfishing, and the effects of industrial pollution led to the destruction of lake trout fisheries and the disappearance forever of many of the strains of lake trout that had evolved in the lake.

Currently, federal, state and tribal management agencies around the lake are attempting to re-establish naturally reproducing populations of lake trout by planting yearlings and eggs in historical spawning areas. Assessments indicate that self-sustaining populations of lake trout have yet to be established. Research into the reasons for this failure are ongoing, but may include:

- Loss of suitable spawning habitat
- Environmental contaminants
- Predation on larval lake trout by alewife
- Thiamine deficiency from a diet of alewife
- Loss of genetically distinct strains

Photograph courtesy of the Canadian Department of Fisheries and Oceans

began in the mid-1800s when large numbers of people began to settle and develop the region. Multiple stressors continue to negatively impact the open lake ecosystem. The status of this ecosystem is changing and is heavily dependent on human management through predator fish stocking and control of exotic species such as the sea lamprey and zebra mussel.

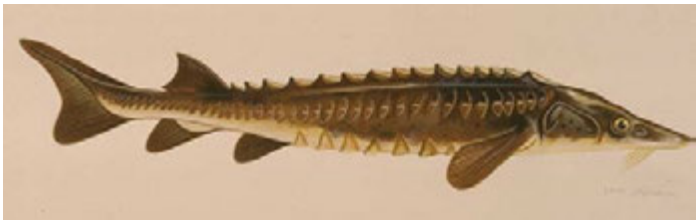
Fish communities represent the highest trophic levels within the Lake Michigan aquatic ecosystem. They are also the most visible indicators of ecosystem health and to most people, they represent one of the most important resources of the lake. Originally, Coregonids (including lake whitefish, lake herring, chubs, and ciscoes) dominated the fish communities, successfully inhabiting the many niches within the lake. Following the introduction of the sea lamprey in the 1950s, the population of top predator fish (such as lake trout and burbot) were decimated, and exotic species such as the alewife and rainbow smelt flourished. The alteration of fish communities has been the most obvious impairment to the aquatic ecosystem of Lake Michigan.

The plankton communities (microscopic plant and animals) of Lake Michigan are the foundation of the food web and therefore are one of the most critical components of the lake's ecosystem. Changes to these communities may be occurring as a result of the presence of contaminants and nutrients in the water and sediment as well as exotic species such as the spiny water flea (Bythotrephes cederstroemi) and the zebra mussel (Dreissena polymorpha).

The abundance and types of phytoplankton are highly variable within the lake, depending on the time of year, area of the lake, and availability of phosphorus and other nutrients. They are generally found throughout the open lake waters to the depths of light penetration. The increase in loading phosphorus in the lake has resulted in important man-induced change to phytoplankton communities, especially in nearshore areas. In addition, studies indicate that increased salinity and other environmental changes in Lake Michigan are enabling nonindigenous animals and algae to adapt more readily to the Great Lakes environment.

Bringing Back the Lake Sturgeon

Once abundant in the shallows of the Great Lakes, the Lake Sturgeon was overfished to the point of elimination in the Great Lakes. Total catch of lake sturgeon peaked in the mid 1880s at 4,901 metric tons (8.6 million pounds). However, by 1900 commercial catches began to decline quickly as the population of sturgeon plummeted. Between 1900 and the 1970s, sturgeon populations continued to decline. In addition to over-harvesting, habitat loss is a major factor contributing to the sturgeon's decline. In the Great Lakes, the damming of tributary waters has prevented access to historical spawning grounds and other spawning areas have been destroyed by siltation resulting from deforestation, poor agricultural practices and dredging. Pollution from nutrients and contaminants in the water has hindered reproductive success and the sturgeon's late maturity and infrequent spawning has also contributed to its decline.



Photograph courtesy of the Canadian Department of Fisheries and Oceans

Lake sturgeon populations that remain in the Great Lakes today represent only a fraction of their former number. The lake sturgeon is listed as a threatened species in 19 of the 20 states it inhabits and is recognized by the American Fisheries Society as threatened throughout North America. Lake sturgeon are now protected in most waters of the Great Lakes with closed seasons, size limits, harvest quotas and gear restrictions.

Throughout the Great Lakes, over 40 partnerships have been formed between federal and state agencies, tribal governments, Canadian agencies, academic institutions, commercial fishers, sport anglers, private organizations and individuals in order to conserve, protect and enhance lake sturgeon populations. U.S. Fish & Wildlife Service offices throughout the Great Lakes are working together with other partners to better understand the lake sturgeon's unique life history and meet rehabilitation challenges.

Zooplankton communities include many different invertebrates and comprise the bulk of the planktivorous fish diet. Because most zooplankton feed on phytoplankton, their abundance and geographic occurrence are similarly dependent upon water temperature, seasonal changes, and food availability. Zooplankton colonize open waters from the surface to the lakebed. Research conducted in the past 15 years indicates that zooplankton populations such as Daphnia, may be experiencing changes induced by Bythotrephes, an exotic species.

In addition, zebra mussels appear to be having a significant impact on benthic (bottom-dwelling) community structures and plankton abundance. Zebra mussels, which can attach themselves to any hard surface in the lake, have reached densities higher than 16,000/m2 in southern Lake Michigan. Negative impacts of their presence include increased food competition (at the expense of fish fry) for nearshore fish species (such as yellow perch), increased biomagnification of contaminants in fish eaters feeding on organisms that eat benthic organisms, and possible zebra mussel-induced mycrocystis blooms, which affect taste and odor in the water.

Coastal and Inland Wetland Systems

The coastal wetland system supports the greatest biological diversity and productivity in the Lake Michigan basin. Coastal wetlands are classified as open shoreline; unrestricted bays; shallow, sloping beach; restricted riverine; lake-connected inland; and protected or barrier beach. These wetlands are important because they collect nutrients and organic materials that are washed off the land into tributaries. These wetlands support both the aquatic food web and habitats for birds (resident and migratory), mammals, reptiles, amphibians, fish, and invertebrates, all of which depend on coastal wetlands for at least one life stage. Both lake

Status of Perch

A large decline in the number of yellow perch surviving their first year of life (young-of-the-year or YOY) has caused a reduction in the number of perch in Lake Michigan with serious effects on the sport fishing industry. The number of YOY perch captured lakewide has dropped dramatically since 1988. In addition, the number of yellow perch larvae captured at one site in Illinois has severely declined since 1994. Data from one site, however, cannot be used to decide what has happened lakewide. Therefore, WDNR along with other agencies and scientists has used a variety of assessments to analyze the status of the current yellow perch population. These assessments have focused on (1) egg deposition, (2) spawning, (3) post-larval perch, (4) YOY perch, and (5) winter-graded mesh gill net assessment Although more information is needed, these studies may indicate some recent recovery in the yellow perch population:

- The number of yellow perch egg masses found in spawning areas in the lake increased from 0.5 per 1,000 square meters (m2) searched in 1997 to 7.29 per 1,000 m2 searched in 2001.
- In 1998, a total of 4,512 yellow perch were captured during a spawning assessment, of which only 221 or 4.9 percent were females. In 2001, a total of 1,431 yellow perch were captured; 993 were males, and 438 (31 percent) were females.

For more information, see *www.dnr.state.wi.us/org/water/fhp/fish/lakemich/YELLOWPERCH.htm*

Photograph courtesy of the Canadian Department of Fisheries and Oceans

level fluctuations and longshore sediment transport are important in maintaining this highly productive system.

Coastal wetlands differ from inland wetlands in that they are shaped by lake processes such as waves, wind tides, and water level fluctuations. These processes result in constant shifting of the wetland communities, permitting hardy species able to accommodate such conditions to thrive while eliminating other species that would thrive under stable conditions. Multiple stressors continue to degrade the Lake Michigan coastal wetland system. Nonindigenous species, such as purple loosestrife, are still largely uncontrolled despite attempts to eradicate them. Changes in sediment composition and deposition have affected the habitat types, productivity, and diversity of these wetlands. The pace of shoreline modification is increasing, and there are no coordinated stewardship activities to protect or restore the remaining fragments.

The inland wetland system—wetlands away from the Lake Michigan shoreline—is a reservoir for water in the Lake Michigan drainage basin. There are many types of inland wetlands, including fens, bogs, wet meadows, and wet forests. The health of inland wetlands depends on the quantity and quality of groundwater and surface water present. Inland wetlands help to regulate the basin's volume of water as well as sediment and certain pollutant loads. They also store nutrients and serve as the nutrient exchange vehicle for the diverse species that use inland wetlands as habitat and feeding areas. Both wetland and upland species breed and feed in the Lake Michigan basin's inland wetlands.

Changes in Wetland Regulation: Impact of the Supreme Court Ruling

In January 2001, the U.S. Supreme Court narrowed federal authority to protect certain types of wetlands. The court's five-to-four decision narrowed the U.S. Army Corps of Engineers (USACE) regulating authority for wetlands not associated with waters of the United States such as a lake, stream, or river.

The court's decision came in response to a landfill battle in northern Illinois. The regional solid waste disposal authority sought to fill a wetland

Northwest Indiana Advance Identification of Wetlands Study

The Northwest Indiana Advance Identification of Wetlands study (ADID) produced maps and assessments of wetlands within the Lake Michigan Basin of Lake, Porter, and LaPorte Counties. The maps, which have a variety of corresponding biological, hydrologic, and management analysis, are available on the Indiana Geological Survey web site at http://adamite.igs.indiana.edu/arcims/lrim/start.html. This GIS site covering Lake, Porter and LaPorte Counties has interactive mapping capacity where users create customized maps. Besides wetlands, other natural features such as geology, soils, and hydrologic boundaries can be mapped with a variety of man-made features such as city boundaries, slag fill, and Superfund sites. Besides the ADID maps, the site includes the National Wetlands Inventory (US Fish and Wildlife Service) which is more comprehensive than the ADID but is outdated and provides less information.

The ADID study, completed in 2000, used rapid-assessment methodologies in the field combined with aerial photo, and topographic map, and file data analysis. Hard copy maps are available at these places: Lake County and Porter County Surveyor's Offices, Northwest Indiana Regional Planning Commission, LaPorte County Planner's Office, and the South Bend Field Office of the U.S. Army Corps of Engineers.

The wetland maps were produced under a partnership of local business, government, and environmental groups, lead by USEPA and the Northwest Indiana Regional Planning Commission. The purpose of the project was to identify and further the protection of wetlands having high quality plant and animal habitat, and wetlands that are critical to storm water storage and pollutant removal, in advance of development threats.

Wetland within Indiana Dunes National Lakeshore
Photograph by David Riecks, Illinois-Indiana Sea Grant*

for its new landfill. The wetland in question was actually created when an abandoned quarry filled with water and over time, the new wetland became a nesting spot for migratory waterfowl. The landfill proponents were able to successfully argue that USACE lacked regulatory authority to prohibit creation of the new landfill because the wetland was not linked to waters of the United States. The court ruled that the USACE must provide a nexus other than solely migratory bird stopovers.

The ruling now places the responsibility for protecting certain isolated wetlands in the hands of state and local authorities. Two examples of this change in state and local roles are found in Wisconsin and in Antrim County, Michigan (see box below).

Wetland Loss in the Lake Michigan Basin

Millions of acres of inland wetlands have been lost in the Lake Michigan basin to agriculture, industry, and urban development. Over the last two centuries, wetland losses in the four states at least partially within the Lake Michigan basin have been disproportionately greater than in many other U.S. regions. Since the 1780s, Lake Michigan basin states have lost an estimated 21.9 million acres (62.9 percent) of their wetlands out of the original 34.8 million wetland acres. This compares with an average loss of 52.8 percent nationwide. An estimated 12.9 million acres of wetlands remains in the four states, representing more than 12.3 percent of the wetlands within the lower 48 states.

Coastal Shore System

The Lake Michigan coastal shore system includes sand dunes, sand beaches, sand spits, bluffs,

bedrock and cobble beaches, alvars, and islands. These features buffer coastal wetlands and inland ecosystems from Lake Michigan waves, wind, and ice. These habitats are rich in species diversity but are greatly affected by natural processes such as weather, erosion, and lake level fluctuations.

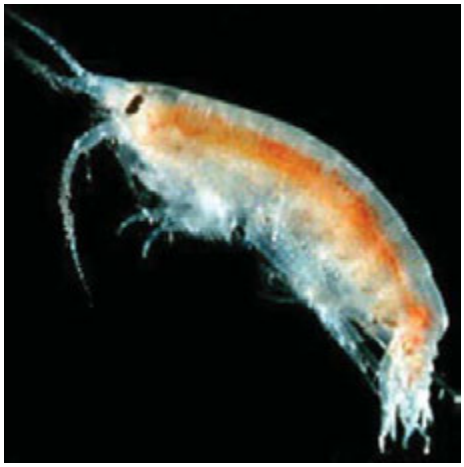
Sand Dunes with Vegetation
Photograph courtesy of the National Park Service Indiana Dunes National Lakeshore*

Sand Dunes

Massive coastal sand dunes flank the Lake Michigan shoreline from northern Indiana continuing northeasterly through Michigan. Ancient high lake levels formed the beach ridges, and as the lake receded, the prevailing onshore winds continued to blow beach sand up the slopes. Lake Michigan is now home to the largest collection of freshwater sand dunes in the world. They run along the entire shore to heights of 300 feet and widths of more than 1 mile; they are interrupted only by river valleys, cities, and roads. The Lake Michigan dunes are numerous, diverse, and irreplaceable.

The dune system is composed of successive ridges of dunes: foredunes, interdunal areas, and backdunes (usually several). Dune and swale or ridge and swale community complexes are found at several locations throughout the Lake Michigan basin. In the south, the dunes or ridges run parallel to the Lake Michigan shore and are rich in oak savanna species. The wet swales

Keystone Species in Lake Michigan Food Web Vanishing



Diporeia spp.
(NOAA, GLERL)

One of the foundations of the Lake Michigan food web is disappearing. Diporeia spp., also known as scuds, sideswimmers, beach hoppers, and sand fleas, belong to the group of invertebrates called amphipods and are about 0.5 inch long. Diporeia have inhabited Lake Michigan since the Great Lakes were formed 5,000 to 10,000 years ago, and they are environmentally sensitive, thriving only in clean, cold, well-oxygenated water. Diporeia are eaten by a variety of Great Lakes fish and provide an important energy source because they contain high amounts of fat.

Populations of Diporeia in the Great Lakes are important indicators of environmental and ecological health, and this is why it is particularly alarming to find that they have disappeared from vast areas of the bottom of Lake Michigan. While scientists have not yet determined the exact cause of the disappearance of the amphipods, they suspect it is linked to the introduction of zebra mussels in Lake Michigan in 1989, severely limiting the food available to Diporeia.

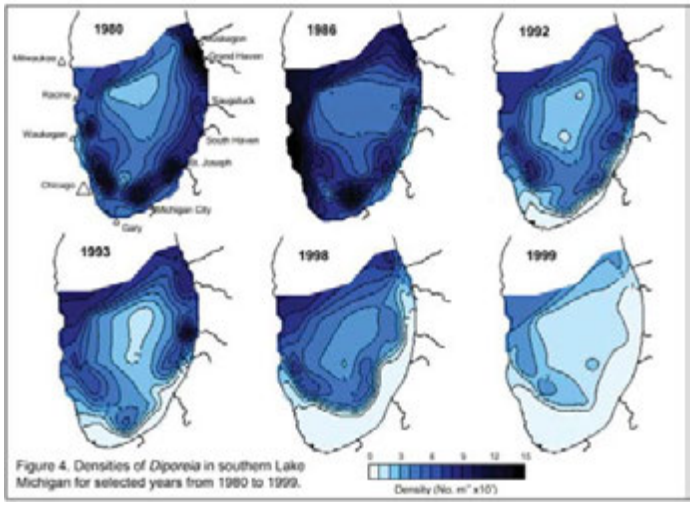


Figure 4. Densities of *Diporeia* in southern Lake Michigan for selected years from 1980 to 1999.

Lake Michigan Federation Biodiversity Recovery Report

The Lake Michigan Federation released a publication in 2001 entitled, The Lake Michigan Biodiversity Recovery Support Document compiled from research, presentations, and discussions surrounding the Urban Aquatic Habitat Summit held in November 2000. The purpose of this report was to gather relevant information for a biodiversity blueprint for Lake Michigan's shoreline and tributaries.

The nearshore Lake Michigan zone is among the most biologically productive in the region. Nearly 30 percent of the globally significant species and communities within the Great Lakes basin are associated with coastal shore systems. At the same time, the lakefront of the area studied (from the Indiana Dunes to the Illinois State Park) is under enormous pressure to produce a strong quality of life for the region.

The report's finding included:

(1) The Illinois - Indiana Lake Michigan shoreline is vastly different from its presettlement state. Most coastal wetlands and nearshore aquatic habitats have been eliminated or degraded. The effect of natural forces on sand transport and shoreline development has been greatly reduced or eliminated entirely in some areas.

(2) Fish populations have changed dramatically since settlement. Original keystone predator species have been replaced with stocked species. Native species are subject to extreme stresses as a result of exotic species invasions.

(3) Lake Michigan's fisheries represent a strong potential economic, recreational, and environmental benefit for the Illinois - Indiana area. Significant work is required to develop healthy, sustainable populations of fish species in degraded habitats, including mitigating human impacts and preventing further exotic species invasion. Federal policy tools may prove most helpful in achieving these ends.

(4) Former and working industrial sites in the Chicago area are beginning to serve as habitats for viable fish and bird populations, suggesting that conditions are favorable for urban habitat recovery.

(5) It is essential to preserve rare habitats that cannot feasibly be replaced, such as the dune and swale systems of northwestern Indiana. Stresses to these habitats should be minimized as much as possible.

(6) The Chicago shoreline serves as habitat for a variety of fish species. As the city redevelops its shoreline over the next several years, it has a unique opportunity to emphasize aquatic habitat construction as part of the lakefront park planning process.

(7) Multiple options for continued large- and small-scale habitat restoration and creation exist in the Chicago area. Primary needs include funding and research from government and academic bodies

For more information, visit *www.lakemichigan.org/habitat/bio_recovery.asp*

between these ridges support rich prairies and sometimes rare coastal plain marsh communities. In the north, the ridges are typically dominated by red and white pine and other conifers, and the swales by white cedar swamps or sedge meadows. Sand dunes around Lake Michigan are threatened by residential development, often very close to the shore, and by mining. On the eastern shore of Lake Michigan, an invasive, nonindigenous species, Baby's breath, is threatening dune ecosystems. "Blowouts," which occur most frequently in the foredune area, are created when the vegetation is disrupted and the wind quickly erodes the sand, leaving a saucer-shaped depression. The most serious blowouts occur as a result of human activity.

Sand Beaches

Sand beaches are a prominent coastal Lake Michigan feature. They may be erosional, transitory, or depositional. Shoals, sandbars, and sand spits protect lagoons and coastal marshes from wind and wave action. Artificial shoreline structures and hardening of the shoreline have interrupted the longshore sediment transport that naturally erodes and replenishes sand beaches. In many areas, tons of sand are brought in each year to artificially replenish

Lake Michigan Beach, Leland Michigan
Photograph courtesy of Michigan Travel Bureau*

beaches for recreational purposes. Beach closure problems caused by excessive levels of pathogens are discussed in Section 4.

Tributary System

Tributary streams and rivers are connected to Lake Michigan in several ways. Energy and material are transferred from lake to tributary and tributary to lake by means of fish movement upstream and downstream and by waters carrying material and nutrients downstream. Diverse plant and animal habitats are found throughout the tributary system, and many of these habitats accommodate Lake Michigan fish. The range of tributary habitats present depends on the size, slope, substrate, and geology of the drainage basin; basin land use; groundwater characteristics; the climate; and the nature of the terrestrial vegetation. The connection of the streams and rivers to the lake maximizes the biodiversity and production of fish in the lake.

The quality of many tributary rivers in the Lake Michigan basin has been significantly impaired by channelization, dredging, damming, sedimentation, bankside vegetation loss, eutrophication, increased spring flooding, and toxic contamination. Large areas of inland forests and wetlands that once served to regulate the quantity and quality of water flowing into tributaries have been lost. As a result, tributaries carry increased pollutant and sediment loads to the lakes, and the suitability of those tributaries as fish spawning habitats has been seriously impaired. Habitat degradation has been the most severe in urban areas. Pollution from agriculture, industry, and urban development has contaminated rivers and sediment as well as the fish and wildlife that depend on those rivers. Many rivers, particularly at the rivermouths, have been declared AOCs and many of their beneficial uses have been impaired.

Although the public uses many Lake Michigan basin rivers and streams, the uses are not necessarily sustainable at this time. Progress is being made in improving and protecting tributary rivers and streams, largely through the efforts of watershed groups and remedial actions at AOCs. For information on Lake Michigan tributaries, Surf Your Watershed at *www.epa.gov/surf*

Lake Michigan Dunes May Be Younger than Previously Thought

Lake Michigan sand dunes were once thought to have been formed over 5,000 years ago and to have remained relatively static ever since. New research has found that wind, waves, and human activity have reshaped the dunes since the glaciers retreated at the end of the last ice age, and the dunes continue to change today. Alan Arbogast of Michigan State University determined the age of the dunes by dating the layers of decomposed plant residue within them. His research revealed that dunes appear to grow in spurts over many years. These spurts are separated by hundreds of years of dormant growth.

Arbogast's work has helped regulators and planners understand that the dunes are active and that shifts in the sands are not entirely the result of human activities. However, the research also reveals that construction on or near the dunes may be destabilized as the dune sands continue to move, because the formation process is ongoing.

Source: Chicago Tribune, November 18, 2001

USFWS Great Lakes Coastal Program

USFWS initiated a Coastal Program in the Great Lakes region in Fiscal Year 2000 and has made tremendous strides with numerous partners on conservation and habitat restoration projects across the basin. Together with its lake partners, USFWS undertook first-year projects that focused on island habitat restoration, monitoring, invasive species control, erosion prevention along tributaries, and education. Using a nonregulatory partnership approach in the short time since its inception, the Coastal Program has played a key role in:

- Funding dozens of projects in its first 2 years that were associated with coastal habitats of Lake Superior, Lake Michigan, Lake Huron, the Detroit River, and Lake Ontario. These cooperative projects have produced measurable benefits to coastal ecosystems by conserving fish, wildlife, plants, and their habitats in coastal lands and waters.
- Restoring or protecting more than 906 acres of coastal fish and wildlife habitat
- Protecting approximately 3 miles of riparian habitat and restoring 8 miles of riparian habitat
- Removing three fish passage barriers in Great Lakes tributaries, thus reopening 8 miles of stream to allow passage of anadromous trout and salmon.

Projects in the Lake Michigan basin include the following:

Native Aquatic Species Habitat Restoration, Antrim County, Michigan
Streambank restoration and culvert replacement projects to reduce sediment loading to Antrim Creek were completed with 2 years of project funding by the Coastal Program under the direction of the Antrim Conservation District. Located in the northern part of Antrim County, Michigan, Antrim Creek is a tributary of Lake Michigan and is a major spawning ground for numerous species of native fish. A major fish-restricting culvert prevented 99 percent of fish from reaching the upper 4 miles of prime habitat. Erosion was also impacting stream quality. Unstable banks resulting from foot traffic and sandy soils delivered harmful sediment loads yearly. The sediment covered spawning habitat and eliminated invertebrates from parts of the stream. The partners have developed and are implementing a plan to improve the quality of Antrim Creek. With the Coastal Program's funding, over 3 acres of riparian land has been improved. First, the fish-restricting culvert on Old Dixie Highway was replaced with an open-bottom culvert. Secondly, over a dozen erosion sites located throughout the 5-mile span of Antrim Creek were restored. Additionally, project funds were used to remove tons of sediment covering spawning grounds. Biotechnical erosion control is the focus of the restoration. Living and nonliving materials are used to help direct the water's force in order to eliminate toe and upper bank erosion. Overall, stream improvements have increased the fish population and the spawning habitat for a variety of fish species.

Eastern Prairie Fringed Orchid Habitat Enhancement, Illinois Beach State Park, Illinois
Within this park, the North Dunes Nature Preserve contains 31 state-listed threatened and endangered species and 14 high-quality natural communities. The preserve is also a target reintroduction site for the federally listed threatened Eastern prairie fringed orchid. It contains appropriate habitat, but non-native and invasive woody species have encroached on the site, rendering it unsuitable for orchids. The project will control invasive species and make the site suitable for orchid reintroduction.

Springfield Fen Restoration, LaPorte County, Indiana
This project will complete the restoration of Springfield Fen, a 45-acre nature preserve in Indiana's Lake Michigan watershed. Invasive species that degrade habitat value will be removed from approximately 4.5 acres of the fen by means of mechanical and chemical treatment. The effectiveness of the treatments will be monitored, and the area will be used as a demonstration project.

Spread of Aquatic Nuisance Species Between the Great Lakes and Mississippi River Basin via Interconnecting Waterways - A Summary of Existing Information
Recent increases in world trade and the transport of goods have led to rapid increases in the intentional and unintentional transfer of species between continents. When a nonindigenous species enters a new ecosystem, natural enemies and diseases are absent, the species; population expansion is rapid, and the impacts on the receiving ecosystem are devastating. The interconnecting waterways between Lake Michigan and the Mississippi River basin provide convenient pathways for the exchange of such species. This project will identify potential invaders, evaluate the threats that they pose to native ecosystems, and identify potential actions that could help prevent their spread into the Great Lakes.

Watershed Assessment in the Baird Creek Watershed, Wisconsin
Baird Creek is a tributary of the Fox River. USFWS will assess erosion and sediment loadings into Baird Creek through a nonpoint pollution reduction feasibility study. This project will help the Brown County Land and Water Conservation Department to develop proper BMPs and will provide the background for future projects that will monitor BMP effectiveness over time.

Characterization of Potential Coaster Brook Trout Populations in Northern Lake Michigan Tributaries, Michigan
USFWS has recently become aware of an unconfirmed population of native coaster brook trout in a Lake Michigan tributary. USFWS will work with the Michigan Department of Natural Resources, and local conservation agencies to inventory brook trout populations in this and other potential coaster streams in northern Michigan.

Wisconsin Wetland Law

On May 9, 2001, Wisconsin Governor Scott McCallum signed the nation's first state law designed to protect wetlands from the effects of the Supreme Court ruling that left some categories of wetlands largely unprotected. The Wisconsin law is expected to become a template for other states' efforts to step up wetland preservation. The law covers at least 1 million acres of wetlands, among them sedge meadows, shallow marshes, and seasonal wetlands that are among some of the state's most productive in providing waterfowl and amphibian habitat, storing flood waters, and helping to protect water quality. The law will not impose any new regulations on landowners but allows the state to continue following the same process that was used for the past decade to decide whether a project that potentially affects wetlands can proceed.

Since the January 9, 2001, Supreme Court ruling, USACE has informed 37 Wisconsin applicants that it has no jurisdiction over wetlands that the applicants projects affected. A handful of applicants had already filled or excavated the wetlands by May 1, 2001. Those applicants who had been notified that the USACE did not have jurisdiction over their wetlands but who had not yet filled or dredged their wetlands must now await approval from WDNR and any applicable local government body before beginning any filling or dredging.

Wisconsin's law gives WDNR the authority to protect isolated wetlands in Wisconsin that the USACE has no jurisdiction over as a result of the Supreme Court's ruling. No person can fill or dredge such a wetland unless the state certifies that the project meets Wisconsin's water quality standards for wetlands.

Antrim County, Michigan, Wetland Protection Ordinance

The Antrim County Board of Commissioners adopted an Ordinance for the Protection and Regulation of Wetland Areas in the county at its regular meeting on December 13, 2001. The passage of the ordinance means that the county will have local control over the protection of wetlands as a valuable resource. Additionally, the ordinance will not only provide the authority to regulate the wetlands contiguous to lakes and streams, but it will also provide the authority to regulate other wetlands that are not connected to a water body. The preamble to the ordinance includes the following text:

> *The Board of Commissioners of the County of Antrim finds that wetland areas are indispensable and fragile natural resources. They also find that wetland areas provide many public benefits, including maintenance of water quality through nutrient cycling and sediment trapping, and flood and storm water runoff control through temporary water storage, slow release, and groundwater recharge. In addition, wetlands provide open space; passive outdoor recreation opportunities; fish and wildlife habitat for many forms of wildlife, including migratory waterfowl, and rare, threatened or endangered wildlife and plant species; and pollution treatment by serving as biological and chemical oxidation basins.*
>
> *Preservation of the remaining County wetlands in a natural condition is necessary to maintain hydrological, economic, recreational, and aesthetic natural resource values for existing and future residents of the County of Antrim. Therefore the County Board of Commissioners declares a policy of no net loss of wetlands. Furthermore, the County Board of Commissioners declares a long-term goal of net gain of wetlands to be accomplished through review of degraded or destroyed wetlands within the County and through cooperative work with landowners, using incentives and voluntary agreements to restore wetlands.*

Recognizing that much must be accomplished before the ordinance can become effective, the Board of Commissioners tasked the County Planning Commission with implementation of the ordinance. The implementation steps that must take place include provision of a 90-day public review period for the "Wetland Inventory Maps," notification of all Antrim County residents that the ordinance has been adopted, adoption of a fee schedule, and action by the Board of Commissioners to include the inventory maps as part of the ordinance. A citizens' group petitioned the Board of Commissioners, asking for a referendum. A number of legal issues concerning this proposal are currently being researched.

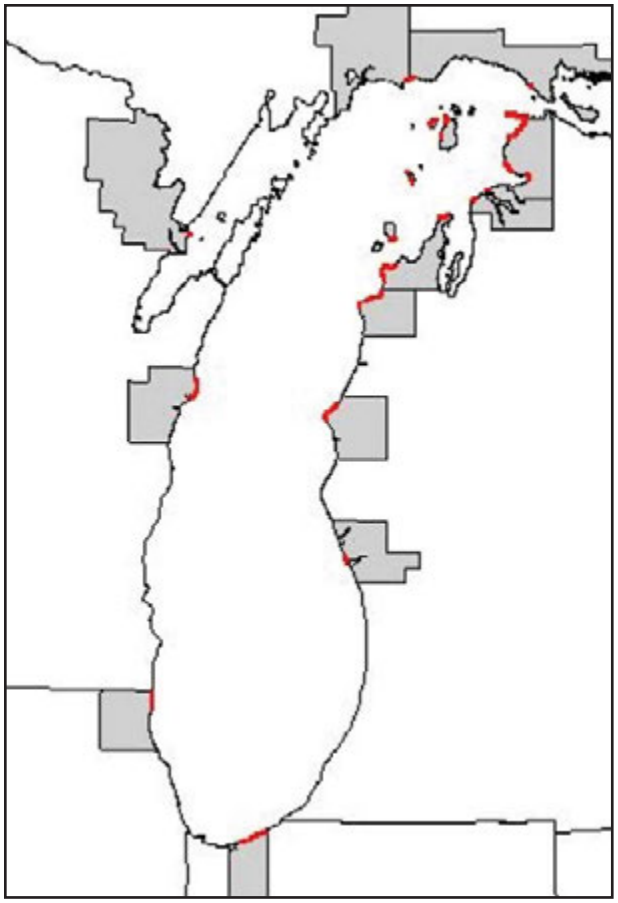
USFWS Designated Critical Habitat for Endangered Great Lakes Piping Plovers on May 7, 2001

Under the Endangered Species Act, critical habitat refers to geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management considerations or protection. A critical habitat designation does not create a preserve or refuge and only applies to situations where federal funding or a federal permit is involved. Designation of critical habitat does not affect private landowners undertaking a project on private land that does not involve federal funding or require a federal permit or authorization.

In the Lake Michigan basin, USFWS's designation affects mainland and island shoreline in Michigan, Illinois, Indiana, and Wisconsin as shown on the left. The inland boundary for critical habitat areas extends 500 meters (1,640 feet) from the normal high water line. Of the 35 Great Lakes piping plover individual habitat units, 21 were designated as critical habitat in the Lake Michigan basin.

There may be a need to temporarily restrict use of some federally managed beaches during spring and early summer to allow piping plovers to nest. However, most beaches within critical habitat do not come under federal authority and thus are not affected by the designation.

Although USFWS designated miles of shoreline as critical habitat, not all areas within the critical habitat boundaries are essential for the conservation of the species. For example, roads, lawns, paved areas, and other artificial structures will not be considered critical habitat for the species even though they may fall within critical habitat boundaries.



Approximate location of piping plover critical habitat units in the Lake Michigan basin
(Not for regulatory purposes)
See *Federal Register*
May 7, 2001; Vol. 66, No. 88, pp. 22938-22969

As a listed species under the Endangered Species Act, the piping plover is already protected wherever it occurs, and federal agencies are required to consult on any action they take that might affect the species. The critical habitat designation will help the species by ensuring that federal agencies and the public alike are aware of the plover's habitat needs and that consultation with the USFWS by federal agencies is conducted when required. Actions that occur within designated critical habitat do not require consultation if they do not affect critical habitat.

The complete description of the final critical habitat designation for the Great Lakes breeding population of the piping plover was published in the Federal Register on May 7, 2001. These descriptions and additional information on the piping plover and other endangered species are also available on the Service's website at *http://midwest.fws.gov/endangered/pipingplover*

Clean Water Act Section 305(b) and 303(d) Lists of Impaired Water Bodies in Lake Michigan States

Under Clean Water Act (CWA) Section 305(b), the states report on the status of their surface and ground waters. Specifically, the states report on the number of river miles or lake acres meeting their designated uses and the sources of water quality impairment. The State 305(b) reports are ultimately compiled together to develop a National Water Quality Inventory Report to Congress.

Under CWA Section 303(d), States are to identify impaired water bodies that either do not meet or are threatened to not meet water quality standards. The states are then required to develop a schedule for completing TMDLs for the "303(d) list" waters. The 303(d) list identifies causes of impairment and likely sources of pollutant load.

For more information on 305(b) reports
www.epa.gov/OW/305b

For more information on state 303(d) lists:
www.epa.gov/owow/tmdl

Also see Appendix A to this LaMP.

Piping Plover
Photograph courtesy of the National Park Service
Indiana Dunes National Lakeshore

Lakeplain System

The lakeplain system occupies the area of the ancestral lakebed of Lake Michigan that was formed as the last glaciers receded. This lakeplain system has served two important ecological functions: it provided a refuge during severe weather events, and it was historically important in flood water retention. The system once harbored a rich diversity of plants and animals, several of which appear on the federal endangered species list. Lakeplain prairies and savannas, two of the most imperiled ecological communities in North America, are found in the southern Lake Michigan basin.

The lakeplain system has been largely transformed since European settlement began. Many of the original plants and animals survive only in small, previously protected areas that are no longer viable or sufficient to sustain these historically diverse communities. These communities are still threatened by human development and by invasive species.

Inland Terrestial System

The inland terrestrial, or upland, system of Lake Michigan includes numerous types of forests, barrens, and prairies. These areas are a result of glaciation and climatic effects. Oak and pine barrens found in the northern part of the basin are globally significant and rare ecological communities.

One of the significant inland terrestrial features of the Lake Michigan basin is the Niagara Cuesta, a rocky outcrop of dolomite and limestone that arcs from the Door County peninsula and the Garden Peninsula to Niagara Falls. Many rare land snails, some of which were only recently discovered, inhabit the thin- layered soils and rocks of the escarpment. Increased tourism in Door County and on the Garden Peninsula has led to increased development on the escarpment, threatening these fragile habitats.

Measuring and Monitoring Lake Michigan's Ecological Changes

The U.S. EPA Region 5 is undertaking an effort to identify critical ecosystems and their status that are most sustainable in the Great Lakes basin. The

Wolf Populations Recovering in Lake Michigan Basin

Hearing the cries of wolves under a starry northern sky is a unique experience that one doesn't soon forget. Wolves once ranged throughout the Lake Michigan basin, but by the 1960s there were none left in Wisconsin and only a few in Michigan's upper peninsula. For over 100 years, the governments of Michigan and Wisconsin promoted extermination of wolves in the region by placing a bounty on the hides of wolves. Wisconsin repealed its wolf bounty in 1957, and Michigan eliminated its bounty in 1960.

The gray wolf was listed as a federal endangered species in 1967 by USFWS and was again listed in 1974 under the provisions of the 1973 Endangered Species Act. Since that time, wolf populations have slowly increased in the northern Lake Michigan basin, with wolves migrating into Wisconsin and the upper peninsula from Minnesota and Ontario, Canada.

Today, USFWS estimates that about 250 wolves exist in the upper peninsula and about 250 wolves make northern Wisconsin their home. According to the National Wildlife Federation, the northern Great Lakes region, including the Lake Michigan basin, now boasts the highest wolf population in the contiguous United States.

EPA Region 5 Critical Ecosystems Team undertook a three-year study that has produced a physical baseline built on 1994 Land Satellite imagery (Landsat) (see Figure 4). The result is a GIS-based tool that can characterize landscapes based on three ecological criteria: (1) ecological diversity, (2) sustainability, and (3) rarity of species and landcover. The combination of these criteria identify high quality ecosystems. The modeling can also pinpoint ecosystems that are not protected, in public

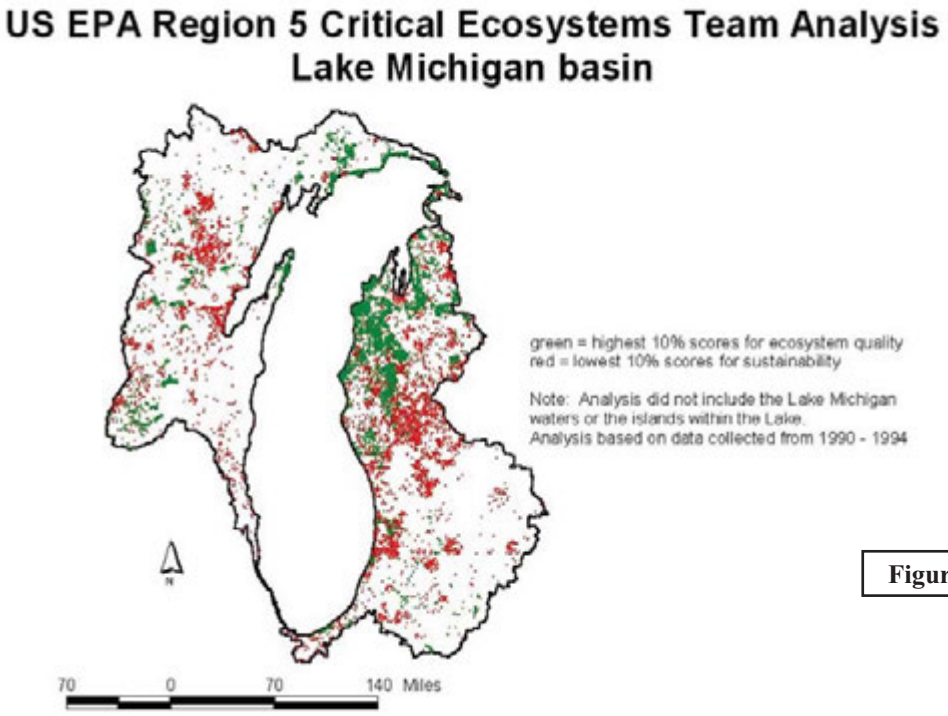


Figure 4

Preserving and Enhancing Biodiversity in Southern Lake Michigan

A consortium of organizations, through an initiative called Chicago Wilderness, has produced the "Biodiversity Recovery Plan" documenting the state of the region's ecosystems and biodiversity and the actions necessary to restore them. Implementation of the recommendations of the plan has already begun with the Northeastern Illinois Planning Commission's (NIPC) "Protecting Nature in Your Community: A Guidebook for Preserving and Enhancing Biodiversity." The guidebook is intended for local government audiences, counties, townships, municipalities, park districts, and other entities to assist them in preserving, enhancing, and restoring biodiversity in their jurisdictions.

In addition to identifying these strategies, the publication identifies economic benefits of protecting nature.

- Natural areas, such as wetlands and floodplains, can detain floodwater and thereby reduce or prevent expensive property damage.
- Natural areas provide opportunities for recreational activities, which generate income and economic activity for communities through local businesses that profit from increased recreational traffic and tourism.
- Parks, open space and natural areas may increase property values due to increased demand for these amenities close to residential areas. Increased property values translate into increased revenue for local governments.
- Open space costs less in community services than residential use.
- Nature provides numerous environmental services than residential use.
- Nature provides numerous environmental services, such as controlling erosion, improving air quality, and protecting water quality and supplies, that would be quite costly to replicate.

More information is available at the NIPC website: www.nipc.cog.il.us/ and the Chicago Wilderness website: *www.chiwild.org*

ownership or environmental management programs. Areas of highest diversity can be mapped against areas of lowest sustainability to highlight the richest ecosystems that are currently being threatened by chemical, physical or biological stressors. A low sustainability rating results from habitat fragmentation, pavement color, and other impairments.

This information can be used to help refine restoration and protection targets for the Lake Michigan basin as well as document the areas of change and trends. Once the model is peer reviewed and resources are identified to run the model with the new 2000 data, a comparison with the Lake Michigan 1994 baseline status can be made. The National Land Cover Data Base is a cooperative project including USEPA, U.S. Geological Survey (USGS) and the National Oceanographic and Atmospheric Administration (NOAA) (see Figure 4).

EPA Tool to Support Habitat Assessment and Management

Habitat and Land Use Management Tool Box

EPA Region 5 has developed an incomplete but informative list of the many web sites that provide information on the cross-cutting issues of development and environmental quality, including some possible sources of project funding. LaMP 2000 documented that human activities have altered the Lake Michigan ecosystem and created physical stressors that threaten the integrity of the ecosystem. LaMP 2000 recommended that information and tools to mitigate these physical stressors be developed and shared with landowners and with governmental units where the authority for land use decisions resides, usually at the local level.

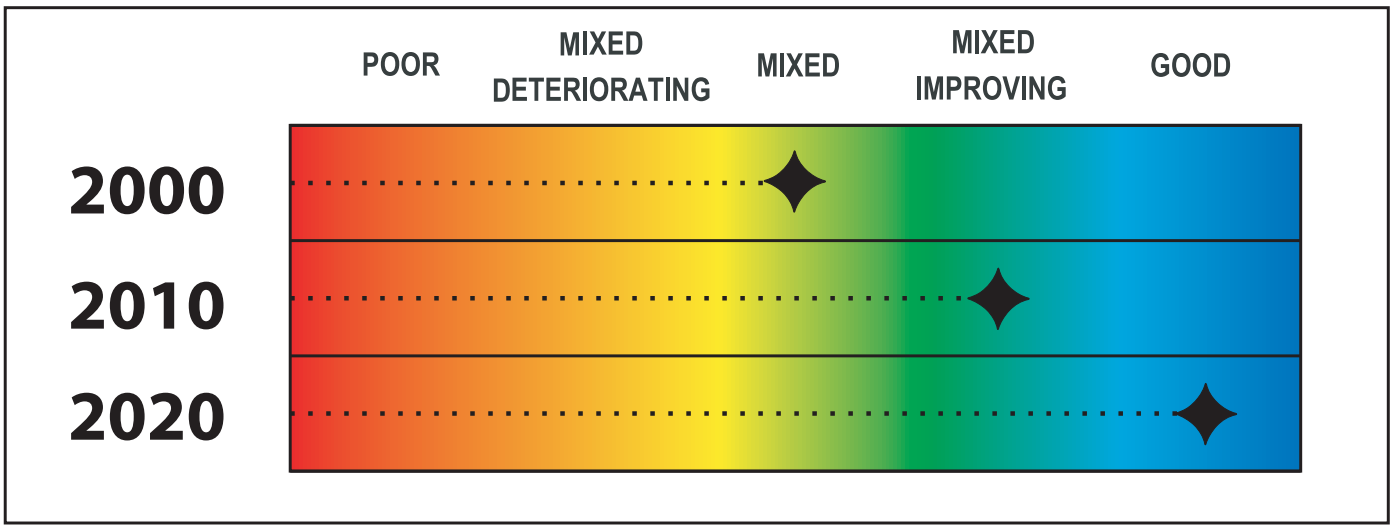
The Tool Box is intended to be a working document and will be revised as more information becomes available or as suggestions for improvement are provided. Please provide comments and suggestions to Laura Evans at EPA Region 5 (e-mail: evans.laura@epa.gov).

Next Steps

- By 2002, a process for developing biodiversity recovery manuals for major ecosystem types in the Lake Michigan basin will be implemented.
- By 2004, set targets for critical areas (fish spawning areas, dune and swale complexes, wetlands, alvars, prairies, and oak savannas) will be identified, mapped, and presented on line.
- By 2005, no net loss of wetland acreage and function will be achieved in the basin.
- By 2012, the 2004 target acreages will be enhanced, restored, or protected: 1,000 acres of spawning areas (islands under water reefs); (example acreages: 12,500 acres of system wetlands; 1,000 acres of isolated wetlands; 1,000 acres of dunes; and 37,500 acres of stream buffers - comments requested).

Beach at Empire, Michigan
Photo courtesy of the Michigan Travel Bureau

Subgoal 5
Does the public have access to abundant open space, shoreline, and natural areas, and does the public have enhanced opportunities for interaction with the Lake Michigan ecosystem?



Status

Currently, the status of the goal is mixed because of the competing needs of the public and the ecosystem. To move to mixed/improving status by 2010 and finally to good status by 2020, there is a need to find a better balance between public access and ecosystem protection. The Lake Michigan LaMP focuses on the health of the Lake Michigan ecosystem, so management actions implemented under the LaMP are to take an ecosystem approach to remediation and protection. The 1994 SOLEC Integration Paper developed by EPA and Environment Canada states that "Governments have traditionally addressed human activities on a piecemeal basis, separating decision making on environmental quality from decision making on natural resource management or on social or economic issues.... An ecosystem approach to management is a holistic approach that recognizes

Lake Michigan Access Guide for Indiana

The Indiana Department of Natural Resources (Indiana DNR) Division of Outdoor Recreation completed an inventory and assessment of recreational facilities and needs in the portions of Lake, Porter, and LaPorte Counties within the Lake Michigan watershed. The study, prompted in part by the Northwest Indiana Public Work Groups of 1995 and a resolution by the Lake Michigan Marina Development Commission, is now available as a guidebook complete with maps indicating locations of recreational sites and the activities available at the sites. The guidebook is available on line at www.state.in.us/dnr/lakemich/pdf/access.pdf

Volleyball on Beach at Grand Haven, Michigan
Photograph by Rodney E. Rouwhorst, Michigan Travel Bureau*

The National Association of State Park Directors identified factors related to recreation and open space that influence business location choices:

- Provision of parks and recreational services plays an influential role in a state's economic development efforts. When companies choose to set up business or relocate, the availability of recreation, parks, and open spaces is high on the priority list for site selection. Recreation and parks have a significant influence on people's preferred living locations.
- Companies that do not have siting limitations based on raw material or energy availability or customer proximity have great flexibility in where they locate, and they make decisions based on the quality of life for their employees. For such companies, most of which are new high- technology firms, recreation and conservation resources are fundamental to their definition of a community's quality of life.
- The National Park Service cites numerous examples of states and communities that identify quality of life as the main factor in recruiting a business. Quality of life includes convenient access to natural settings; recreational and cultural opportunities and open space; and the presence of greenways, rivers, and trails in and adjacent to communities.

For more information, see *www.naspd.org*

the interconnectedness of and addresses the linkages occurring among air, water, land, and living things."

Challenges

Public involvement in preservation and stewardship of special natural areas with public access for sport and recreational activities should be fostered by the following:

(1) Broaden the dialogue with state and local government land-use planners and decision-makers to balance environmental and recreational needs.

(2) Provide tools for local communities to understand the value of the resource and develop long-term management programs.

(3) Identify open space multi-use opportunities.

Public Interaction with the Lake Michigan Watershed

According to the Federal Interagency Ecosystem Management Task Force, an ecosystem is defined as: "… an interconnected community of living things, including humans, and the physical environment with which they interact. As such, ecosystems form the cornerstones of sustainable economies. The goal of the ecosystem approach is to restore and maintain the health, sustainability, and biological diversity of ecosystems while supporting sustainable economies and communities" (1995). Based on a collaboratively developed vision of desired future conditions, the ecosystem approach integrates ecological, economic, and social factors that affect a management unit defined by ecological—not political—boundaries. The foundation of the ecosystem approach is relating human beings and their activities to the ecosystems that contain them.

As access to Lake Michigan increases, so does the pressure for development. Growth of summer homes and year-round homes on the shoreline leads to more road construction, pollution from increased use of automobiles, and human use of areas that interrupts the natural web of basin life. In response, Smart Growth policies are being pursued by many communities, and resources such as the "Wisconsin Planning Guide for Smart Growth" and the Northeastern Illinois Planning Commission's "Environmental Considerations in Comprehensive Planning: A Manual for Local Officials" are becoming more widely available.

Outdoor Recreation Opportunities

Outdoor recreation in the Great Lakes basin is an important component of the region's economy. The region offers outstanding tourism and recreational opportunities ranging from wilderness activities in pristine national parks to swimming at beaches in major cities. A well-defined four-season climate supports many types of recreation ranging from ice fishing, skiing, and snowmobiling in the winter to

The Great Lakes Circle Tour is a series of roadways around the Great Lakes where people can enjoy activities in the basin.

golf, fishing, boating, and swimming in the summer. There are approximately 40 state parks in or near the Lake Michigan basin as well as a large number of national lakeshore parks and fish and wildlife refuges. These can be visited by following the Circle Tour route around Lake Michigan. The Great Lakes Commission, in cooperation with the Great Lakes states and provinces in the 1980s and 1990s, coordinated the creation of the Circle Tours along existing roadways. The Lake Michigan Circle Tour route is marked by signs that feature Lake Michigan and the four surrounding states. In addition, guides prepared by states and localities that highlight enjoyable areas are important tools for promoting public access as well as critical ecosystem protection.

The eight Great Lakes states have about 3.7 million registered recreational boats, or about a third of the nation's total. Michigan leads the nation in the number of boat registrations and six Great Lakes states rank in the nation's top ten in total registrations. The commercial and sport fishing industry in the Great Lakes basin is valued at more than $4 billion annually.

The Benefits of Open Space

Open space plays an important role in supporting the economy. According to the National Association of State Park Directors, use of geologically or environmentally sensitive areas as open space or for recreational purposes can reduce potential property damage costs. Hazards that can be mitigated through conservation of open space include flooding, slope instability, and structural fire damage.

Canoeing on the Grand Traverse, Michigan
Photograph by Traverse City Convention and Visitos Bureau, Courtesy of the Michigan Travel Bureau*

The combination of habitat protection and recreation is often the highest and best use of lands that are too fragile for development. The cost of not protecting such assets as slopes, aquifers, woodlots, wetlands, fens, alvars, floodways is incredibly high in the long run.

Next Steps

Over the next 2 years, the Lake Michigan LaMP will be focused on achieving the following goals:

- By 2003, the LaMP will partner with the growing coastal zone management programs in the Lake Michigan basin to ensure that public access to the lake is balanced with protection of the ecosystem
- Identify the need for additional facilities and access points (such as boat ramps canoe, and bicycle and walking trails around Lake Michigan).
- Expand the Northeastern Illinois water trail to other states around Lake Michigan.

Indiana Coastal Zone Management Program

The Coastal Zone Management Program is a national initiative, administered by the National Oceanic and Atmospheric Administration (NOAA) that focuses on balancing the economic prosperity and environmental health of the nation's coasts. Participation in the Coastal Zone Management Program will make over $900,000 available annually to achieve the goals of the Indiana Lake Michigan Coastal Program. Michigan and Wisconsin also participate in the coastal zone management program.

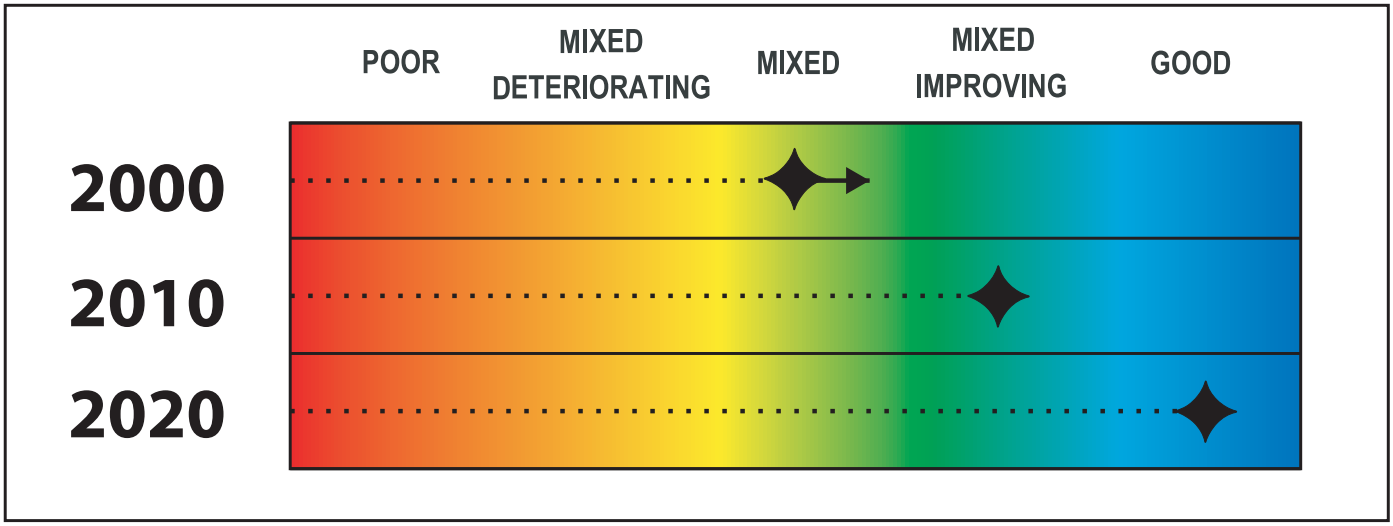
The Indiana Department of Natural Resources has completed the development process for the Lake Michigan Coastal Program, including a framework for Indiana's participation in the Coastal Zone Management Program. The Indiana Lake Michigan Coastal Program was developed to enhance the State's role in planning for and managing natural and cultural resources in the coastal region and to support partnerships between federal, state and local government agencies and organizations. The Lake Michigan Coastal Program is based on a network approach that uses existing state laws and programs. It is a new tool to implement existing programs and to provide funding for unique or under-funded projects.

The Indiana Lake Michigan Coastal Program will, through grants and partnerships with local communities, support activities that achieve the following goals in the coastal region:

- Protect and restore significant natural resources,
- Prevent the loss of life and property in coastal hazard areas;
- Improve public access for recreational purposes;
- Protect and restore important historic and cultural resources;
- Improve government coordination and policy and decision making;
- Prevent, reduce, or remediate nonpoint source pollution that affects coastal waters;
- Revitalize urban waterfronts and ports; and
- Provide for priority water dependent uses.

An extensive effort was made to continue public involvement during the development of the Lake Michigan Coastal Program. The public provided comments on both a scoping document that proposed the organization and goals of the Indiana Lake Michigan Coastal Program, released in May 2001, and a draft Environmental Impact Statement, released in September 2001. The Department of Natural Resources also held six public meetings and met with several local organizations and elected officials to hear comments on the program. A final Environmental Impact Statement will be released in 2002. There will be a final 30-day comment period on the final Environmental Impact Statement before NOAA issues its decision on Indiana's participation in the Coastal Zone Management Program.

Subgoal 6
Are land use, recreation, and economic activities sustainable and supportive of a healthy ecosystem?



Status

Land use, recreation, and economic activities are more sustainable, healthy and supportive of a healthy ecosystem, but there is significant work that needs to be done. There is more information available on critical ecosystems, significant activity in better managing water resources and determining the true value of a healthy ecosystem. There is danger, however, that the ecosystem could deteriorate in spite of these activities.

Challenge

Land use and human activities are undertaken by individuals aware of the lake ecosystem's ability to support human and environmental activities.

Sustainability

Effective, sustainable protection of the Lake Michigan ecosystem requires that the LaMP partners focus on promoting balance between the environment and society. The interdependencies inherent in

Lake Levels

Lake Michigan was measured at 2 feet below the long-term average in 2001, having dropped more than 40 inches since 1997 when it was at near record highs. The decrease in precipitation over the last five years and resulted in Lake Michigan being at its lowest point since 1966. Lake levels rose between the mid 1960s and the late 1990s.

The recent lower lake levels has caused problems for the shipping and boating industry. Cargo ships were forced to lighten their loads, and many boat ramps became inaccessible. According to the U.S. Great Lakes Shipping Association, for every inch of water that Lake Michigan loses, a cargo ship must reduce its load by 90 to 115 metric tons, leading to losses of between $22,000 and $28,000 per trip.

Early reports for 2002 indicate that the lake may rise eight inches due to increased rainfall early in the year and a decrease in evaporation during the summer/fall 2001. This fluctuation may be part of a 30 year cycle but deserves close monitoring.

Lake Level Monitoring

Current Lake Michigan levels can be monitored online through a new National Oceanographic and Atmospheric Administration website, http://glakesonline.nos.noaa.gov. The site provides immediate water level and meteorological data from water level stations. There is a 6 minute interval between data readings and plans for real time wind speed and direction data, in addition to barometric pressure and air temperature data. This augments the U.S. Army Corps of Engineers website that provides water level information *http://huron.lre.usace.army.mil/levels/hmpglv.html*

the ecosystem perspective require a balance between three fundamental elements: environmental integrity, economic vitality, and sociocultural well-being. The ability of these elements to function in balance over time is a measure of sustainability. The ecosystem perspective requires a shift of focus from resource programs to resource systems. It places human activities and communities within an ecosystem and consequently, within ecosystem management. It recognizes that human beings and their activities are part of the ecosystem and that they affect and are affected by its health.

The LaMP helps to identify the activities, partnerships, and locations where ecosystem management needs adjustment in order to attain a sustainable Lake Michigan basin. Sustainable landscapes are local ecosystems that are healthy enough to provide a range of valuable benefits and services, both now and in the future. Such benefits and services to humans include the following:

- Moderating natural events and human activities. Healthy landscapes can make communities safer and more livable by tempering the effects of natural events and human activities. For example, wetland systems can absorb and store storm waters, thereby aiding in flood control and ensuring more predictable stream flows and water levels and often providing for recharging local ground water.
- Enhancing social well-being. Healthy landscapes provide services that make communities more enjoyable and rewarding. For example, they provide opportunities for outdoor recreation. To many, they also serve as a source of civic pride and personal and spiritual well-being.
- Supporting local economies. In sustainable landscapes, people meet the needs of the present without compromising the ability of future generations to meet their needs.

Lake Michigan Potential Damages Study

The Lake Michigan Potential Damages Study (LMPDS) continues in its sixth year. Under the direction of the U.S. Army Corps of Engineers - Detroit District, in association with a number of State and Federal agencies and non-government

Great Lakes Charter Annex 2001

There has been increasing focus on the issue of water withdrawals and diversions of Great Lakes resulting in the Great Lakes Governors and Premiers signing the Great Lakes Charter Annex in June 2001. The Annex is an amendment to the Great Lakes Charter of 1985 which outlined a voluntary process for managing withdrawals of water from the Great Lakes. It sets guidelines for new Great Lakes water withdrawals. It establishes a series of principles for a new standard used to review new water withdrawals that would require new water withdrawals to result in an improvement to the Great Lakes. This standard is the first that would directly link water use to restoration and improvement of the ecosystem. The Governors and Premiers pledged to complete the final agreement by 2004. More information on the Annex is available at www.cglg.org/projects/water/index.html.

Lake Michigan Diversion to Chicago and the Mississippi River System

During the late 1990s, the diversion of water from Lake Michigan to the Chicago River exceeded the U.S. Supreme Court consent decree limit (2.1 billion gallons per day) by nearly 15% because of leakage at the Chicago River control works. Following a Memorandum of Agreement among the Great Lakes states, Illinois agreed to reduce its annual diversion over 14 years to pay off its water debt caused by the leakage. Repairs to the Chicago River locks and construction of new control works were completed in 2000. Because of this and lower lake levels, Illinois exceeded its goal in reducing the water debt between 2000 and 2002. The State of Illinois constructed a new lakefront control wall to prevent unintended leakage from Lake Michigan into the Chicago River as one measure to bring the Chicago diversion into compliance with a Supreme Court Consent Decree.

DuSable Harbor, Chicago, Illinois
The new lakefront control works under construction at the mouth of the Chicago River in 1999. The new wall significantly decreased leakage and allowed the creation of a new marina for pleasure boats.
Photography by Daniel Injerd, Illinois Department of Natural Resources

Historic Agreement to Manage Fisheries in 1836 Treaty Waters

On August 7, 2000, after months of negotiations, State of Michigan and federal government officials joined representatives of five Michigan Indian tribes to sign a historic 20-year settlement for treaty fishing rights in the Great Lakes. The agreement facilitates the lake trout rehabilitation effort in Lake Michigan by placing harvest limits on commercial and recreational lake trout fisheries, eliminating "deferred" rehabilitation zones, and recommending increases in stocking in areas containing high-quality spawning habitat. These actions should allow the growth of sizeable spawning stocks, thereby improving the chances for successful reproduction. It is important to note, however, that there are many forces unrelated to mortality caused by commercial or recreational fishing that are impeding lake trout rehabilitation (for example, exotic species, loss of genetic diversity and water quality).

The five tribes include the Bay Mills Indian Community, the Grand Traverse Band of Ottawa and Chippewa Indians, the Little River Band of Ottawa Indians, the Little Traverse Bay Bands of Odawa Indians, and the Sault Ste. Marie Tribe of Chippewa Indians.

organizations. The ultimate goal of the Study is to conduct a long-term assessment of potential shoreline damages over the next 50 years due to fluctuating lake levels along the Lake Michigan shoreline. A number of tasks were completed since 2000. These include:

Miller Woods, Indiana Dunes National Lakeshore, Lake Michigan
Photograph by B. Daum, National Park Service, Indiana Dunes Lakeshore*

- GIS mapping of shore protection and boating structures in drowned rivermouth areas of Lake Michigan's eastern shore;
- An assessment of water level changes on the recreational boating and charter fishing industry;
- An update and assessment of land use and shoreline management practices;
- Land use trend analyses, land use / land cover change analysis and trend predictions in five prototype counties;
- Completion of the Flood and Erosion Prediction System (FEPS) and its application to five prototype counties;
- An assessment of the impacts to shore protection and harbor structures as a result of changes in water levels;
- Further development of geospatial databases for the Lake Michigan shoreline.

Further information can be found on the Lake Michigan Potential Damages study at *http://huron.lre.usace.army.mil/coastal/LMPDS*

Land Conservation

The urbanized land area in the United States has quadrupled since 1954. To compound the problem, populations in coastal areas, which contain some of the most sensitive ecosystems, have been increasing even faster than in the rest of the country. From 1982 to 1996, the population in the Chicago-Northwest Indiana area grew by 10.9

Can the Value of Lake Michigan be Quantified?

Economic Valuation Study for the Great Lakes

The Northeast-Midwest Institute published a guidebook that is intended to make Great Lakes decision makers more familiar with the techniques available to measure environmental benefits using economic tools. It is intended not as an end point, but as a means to begin a discussion on how to better make decisions that affect the Great Lakes.

The economic tools identified provide more insight into the tradeoffs that decision makers must evaluate. These tools help address such issues as:

- Converting Great Lakes Benefits of the Future to Present-Day Value
- Managing Irreplaceable Amenities and Irreversible Outcomes
- Accounting for Natural Resource Capital
- Risk and Uncertainty
- Sorting Through Benefits from Multiple Projects
- Accounting for Secondary Impacts
- Distribution of Benefits Across Society
- Distribution of Benefits Across Generations
- Placing a Value on Human Life and Health

Economic Valuation Study for Lake Michigan

The Lake Michigan Federation released a study in July 2001 that estimates the economic value that the public places on southern Lake Michigan Natural Resources as between $3 billion and $5 billion dollars. The *Natural Capital of the Southern Lake Michigan Coastal Zone: First Steps Toward Economic Valuations* surveyed residents of Northeast Illinois and Northwest Indiana to determine how much they would be willing to pay each year through volunteer activities, donations to conservation groups and taxes to maintain 13 species of birds and six species of fish.

Economic Value of Cleaning Contaminated Sediments

The University of Wisconsin Sea Grant Institute completed a study that estimates the economic benefits of cleaning up contaminated sediments in Great Lakes Areas of Concern. It uses the Lower Fox River/Green Bay as an example to provide a critical view at potential methods for identifying economic benefits of sediment remediation. The study is based upon the question "Do we expect that the benefits of sediment cleanup will be larger than the cost of a particular alternative on a per household basis?" rather than simply asking "What are the benefits of remediation?"

The researchers used contingent valuation analysis that estimated that citizens of the Fox-Wolf water shed are willing to pay $100 to $300 per household to clean the Area of Concern. The estimates include a $222 per household per year benefit from a 100 percent cleanup.

Erosion Along Developed Indiana Shoreline of Lake Michigan
Photograph Courtesy of National Park Service, Indiana Dunes National Lakeshore*

percent but consumed 44.2 percent of the land. (Urban Roadway Congestion: Annual Report 1998) Wetlands, which naturally help control runoff from urban areas by storing flood and surface water and slowly releasing and filtering it, have been destroyed in the Lake Michigan basin to a greater degree than elsewhere in the country.

EPA's Office of Environmental Information states that "the construction of impervious surfaces such as roads and rooftops leads to the degradation of water quality by increasing runoff volume, altering regular stream flow and watershed hydrology, reducing groundwater recharge, and increasing stream sedimentation and water acidity." A 1-acre parking lot produces a runoff volume 16 times as large as that produced by an undeveloped meadow. Many impervious construction materials have higher surface temperatures that may cause ambient air temperatures to rise. When combined with a decrease in natural vegetation, areas are subject to what is called the urban heat island phenomenon, which may increase utility bills, cause health problems associated with heat stress, and accelerate formation of harmful smog. Clearly the effect of urban development on our communities and environment is a cross-cutting issue.

Communities around the basin are continuing to support conservation activities. For example, the Milwaukee Metropolitan Sewer District (MMSD) Commission approved a plan in September 2001 to

work with local community groups, municipalities and others to purchase easements or acquire outright properties identified as critical for guarding against future flooding in the Menomonee River, Oak Creek and Root River watersheds. The Commission approved a contract with The Conservation Fund, a national non-profit conservation organization to act on MMSD's behalf in acquiring easements and property, and administering the program.

The Conservation Fund analyzed undeveloped land in the three watersheds and identified 41 sites, totaling 7,065 acres that contained the necessary soil conditions to provide future flood-reduction benefits. In all, the group estimated the sites could provide 4.7 billion gallons of storage. The sites range in size from 30 acres to 674 acres.

Oil and Gas Drilling in the Great Lakes

With the energy "crisis" in California in 2001 came renewed interest in tapping oil and natural gas reserves. In the Great Lakes basin, much of these resources lie under the lakes themselves. Drilling under the lakes raises concerns because a spill would lead to harm to the world's single largest source of freshwater.

Due to this concern, an amendment to the Energy and Water Development Appropriations Act of 2002 prohibits all federal and state governments from issuing leases or permits for new oil and gas directional or offshore drilling in or under the Great Lakes for two years. Michigan's legislature passed legislation that would ban all direct and directional drilling in its portion of the Great Lakes basin. Furthermore, a proposed natural gas pipeline for bottomlands of Lake Michigan from Wisconsin to Indiana was withdrawn in 2001.

Currently in the Lake Michigan basin, only Illinois has never issued an oil or gas mineral lease for Lake Michigan bottomlands. Indiana has permitted limited exploratory drilling, but no oil or gas has been produced. Wisconsin allows drilling for oil and gas in certain circumstances and Michigan has allowed drilling that begins on land with the pipes "slanting" under the lake .

Upland Michigan Land Use Report

The Michigan Economic and Environmental Roundtable and Public Sector Consultants, Inc. released the final report of the Michigan Land Resource Project in December 2001 – a study that projects the future of agriculture, forestry, tourism, and mining in Michigan if present land use trends continue. Using a land transformation model developed by researchers at Michigan State University, the Michigan Land Resource Project projects the future of Michigan in a mapping format for the years 2020 and 2040. It also features detailed economic forecasts for the land-based industries of agriculture, forestry, tourism, and mining in the state. The economic forecasts were prepared by researchers associated with Michigan State University, the University of Michigan, and Michigan Technological University.

The Michigan Land Resource Project was funded by grants from the W. K. Kellogg Foundation and the Frey Foundation. The complete report is available on-line at www.publicsectorconsultants.com.

Among the major findings of the report:

- Michigan will lose 25 percent of its orchard land in the next 40 years.
- The state' destination resorts, particularly those in the northern lower peninsula, are threatened by encroaching development along the travel corridors that lead to them.
- In order to keep forestry harvesting costs down, access to large parcels is necessary. As the land becomes more fragmented, the price for harvesting Michigan's timber will increase.
- Michigan will lose 1.9 million acres of farmland in the next 40 years.
- Land available for hunting will dramatically decrease, while "edge" species such as white-tailed deer will continue to increase in numbers.
- "Built" land will increase by 4.1 million acres across the state, more than tripling the existing amount of "built" land.
- Transportation costs associated with moving construction materials farther distances will dip into the profit of mining operations.

A Wisconsin Planning Guide for Smart Growth

The Wisconsin Department of Natural Resources (WDNR), in cooperation with the University of Wisconsin-Extension, released an 84-page "how-to" manual titled Planning for Natural Resources: A Guide to Including Natural Resources in Local Comprehensive Planning. The natural resources guide is meant to provide useful insights to a broad group of users including local government officials, land use planning consultants, and private citizens interested in preserving wild areas and the natural resources of the state.

WDNR also created a new Internet web site devoted to land use issues and comprehensive planning. The site not only provides a direct link to the department's own guide to including natural resources in local land use planning, but links to guides and articles written and produced by other state agencies and organizations on the same topic. The entire DNR comprehensive planning guide www.dnr.state.wi.us/org/es/science/landuse is available to read or download from the DNR Web site.

As part of legislation passed by the state legislature in 1999, virtually every community in Wisconsin is required to prepare or be part of a comprehensive land use plan. This is commonly referred to as Smart Growth and all Wisconsin communities must have a comprehensive plan in place by 2010. Each Smart Growth plan is required to include a compilation of objectives, policies, goals, maps and programs to address the conservation, promotion and effective management of the community's natural resources. According to the legislation, each community's plan must specifically address several key elements, including transportation, housing, agriculture, and natural resources.

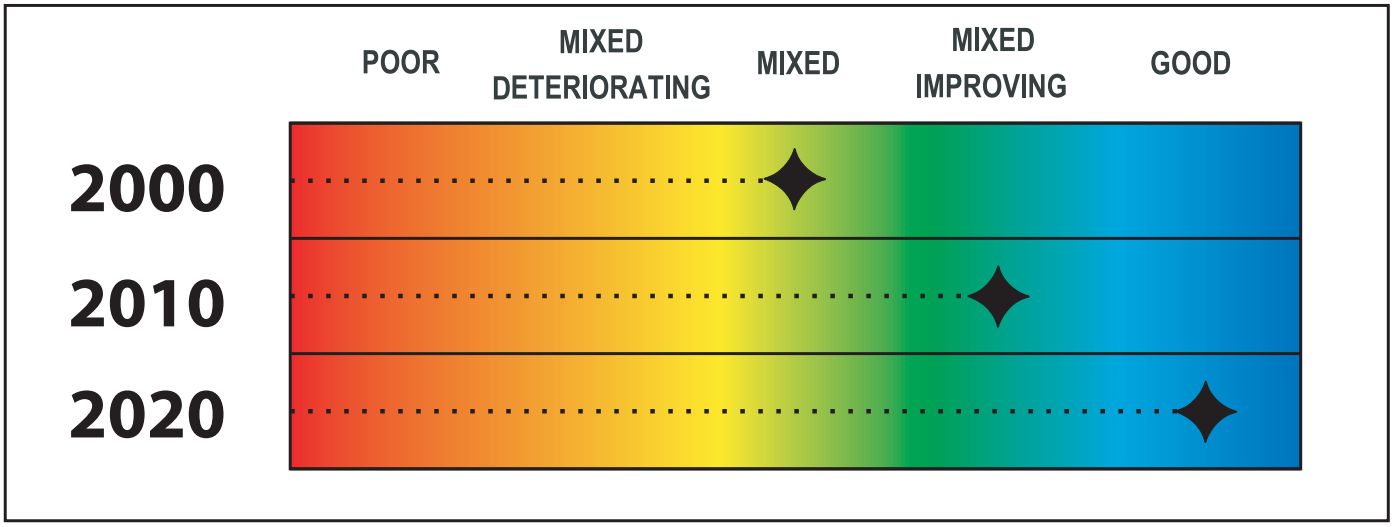
Next Steps

Over the next 2 years, the LaMP is targeting the following for completion:

- Publication and distribution of a Habitat and Land Use Management Tool Box that provides web-based information sources on environmentally sensitive habitat and land use management policies and programs.
- Establishment of a Lake Michigan Watershed Academy to provide training to local planners and policy makers on balancing environmental concerns with economic and social activities in a watershed context.
- Convening of a Brownfield to Greenfield Conference to highlight the need for redevelopment of facilities that have mild to medium contamination rather than developing greenspace.
- Convene Planning Commissions to partner on identifying societal indicators and gathering data.
- On-line habitat atlas will be operational.

Indiana Dunes
Photograph courtesy of National Park Service, Indiana Dunes National Lakeshore*

Subgoal 7
Are sediments, air, land, and water sources or pathways of contamination that affect the integrity of the ecosystem?



Status

Sediments, air, land, and water continue to be sources or pathways of contamination that affect the integrity of the Lake Michigan ecosystem. While regulatory and remediation programs reduce pollutant sources, ongoing releases and the region's legacy of contamination continue to serve as sources of pollutants. As a result, the status of this goal is mixed. There has been significant activity that will assist in changing the status to mixed/improving over the next decade. In particular, the findings of the Lake Michigan Mass Balance Study will allow decision-makers to better understand pollution pathways so that they can develop more effective policies to deal with pollution issues and pathways.

The following section presents recent findings regarding pollution pathways and predictions of future levels of PCBs in lake trout fish

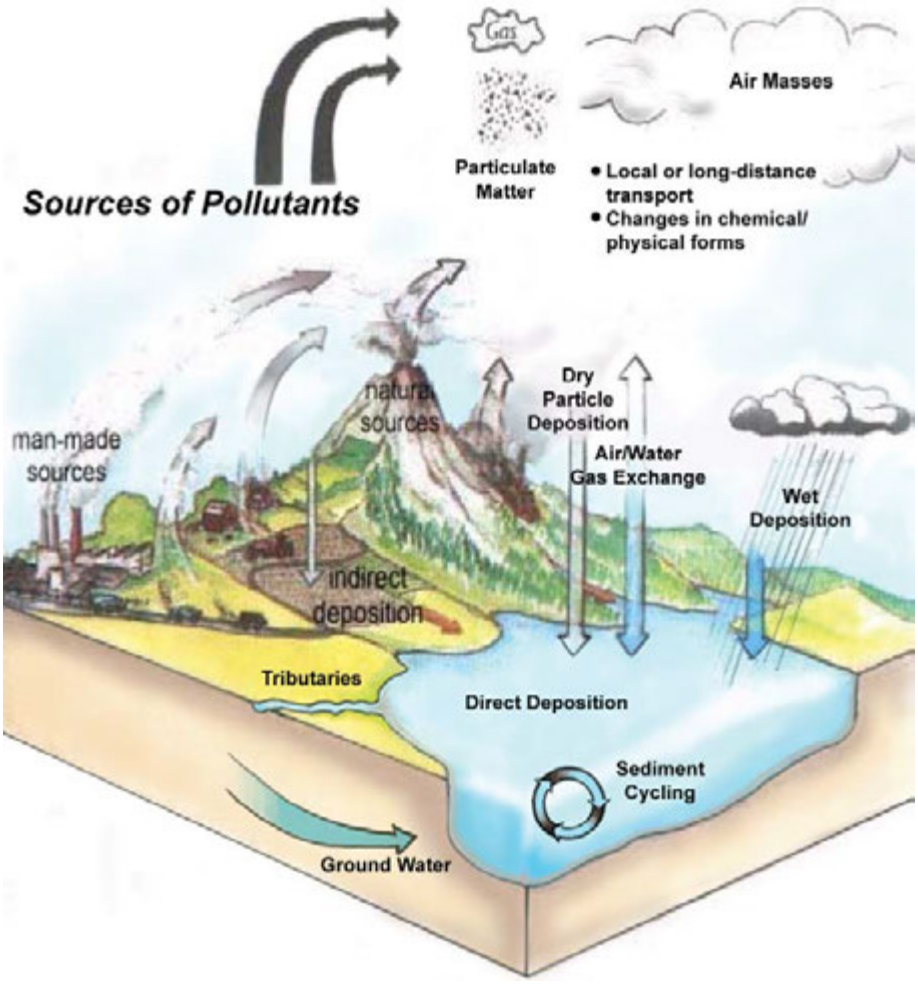


Figure 5 Pollutants enter Lake Michigan through several pathways
Source: EPA (http://www.epa.gov/owow/oceans/airdep)
Augmented by Joseph F. Abboreno, Tetra Tech EM, Inc.

Lake Michigan Mass Balance Study Findings

- Present concentrations of PCBs in Lake Michigan water and biota are dominated by historical loadings as represented by the large reservoir of PCBs present in bottom sediments. As sediments are resuspended, PCBs are released to the water column where they are subsequently volatilized to the atmosphere.
- Once the sediment reservoir of PCBs is depleted, the most important remaining sources will become atmospheric absorption, tributary loadings, and atmospheric deposition (wet and dry). Gaseous exchange is an important mechanism and together with vapor phase concentrations, govern the movement of PCBs into and out of Lake Michigan via the air.
- Chicago is an important contributor of atmospheric inputs to the lake. Levels of PCBs tend to be higher in the Chicago area than at offshore and rural sites. High concentrations of PCBs occur over the lake when the winds are from the southwest (Chicago-Gary region) and during warm months.
- Approximately 70 percent of the atrazine loading to the lake comes from tributaries, with the remaining 30 percent of the load coming primarily from precipitation.
- Trans-nonachlor concentrations in Lake Michigan rivers are relatively low in all cases. However, the concentrations in rivers draining agricultural watersheds are usually higher. The Kalamazoo, Milwaukee, and Sheboygan Rivers, and Indiana Harbor have slightly lower trans-nonachlor levels than other Lake Michigan tributaries, but are still of similar magnitude (Figure 6).
- Mercury is transported into Lake Michigan from a variety of sources, including tributary rivers (Figure 7). Transport of mercury from some tributaries to Lake Michigan increases with summer and fall storm events, particularly in more freely flowing rivers with mercury-contaminated sediments.

Additional information on the study is available at *http://www.epa.gov/glnpo/monitor.html.*

References and figures see Appendix C.

tissue and atrazine in the waters of Lake Michigan. The section concludes with an overview of specific pathways that continue to serve as sources of pollutant load to Lake Michigan.

Challenges

(1) To gather data on sources and pathways of contaminants in Lake Michigan.

(2) To develop a better understanding of the natural dynamics that affect pollutant distribution in the Lake Michigan ecosystem.

(3) To reduce pollutant loads with effective control and pollution control measures

(4) To develop coordinated monitoring in 2004 or 2005 and to develop a 10-year trend analysis based on the 1994 mass balance project for the lake.

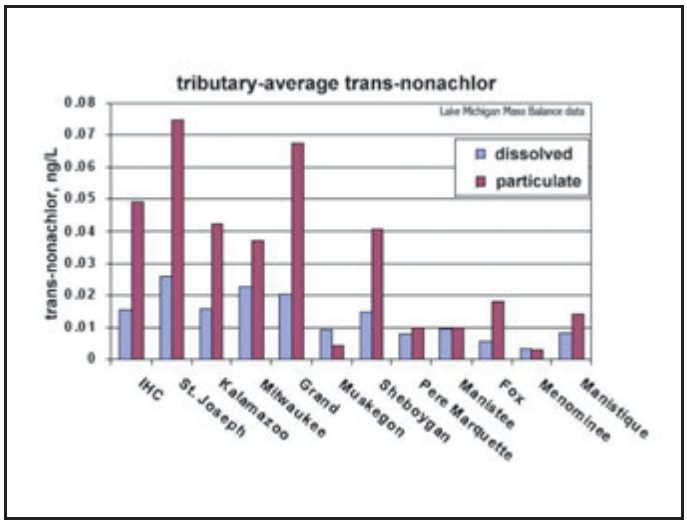


Figure 6: Average Tributary trans-nonachlor Concentrations
Source: EPA GLNPO

Lake Michigan Mass Balance Project

The Lake Michigan Mass Balance (LMMB) Project is an enhanced monitoring and modeling project that is working to develop a scientific base of information to inform LaMP policy decisions and better understand the science of pollutants within an ecosystem. The LMMB Project's specific objectives are:

(1) To identify relative loading rates of four categories of pollutants (PCBs, mercury, transnonachlor, and atrazine) entering Lake

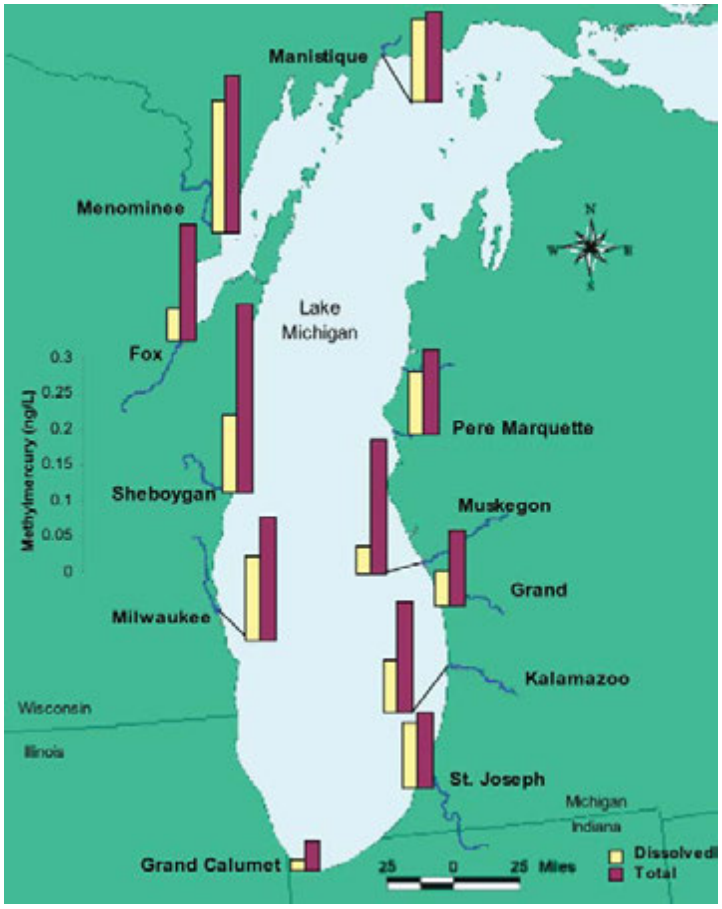


Figure 7: Lake Michigan Mass Balance Findings: Methylmercury in Lake Michgan Tributaries (mg/L)

Michigan from major media (air, tributaries, and sediments);

(2) To establish baseline loading estimates in 1994-1995 against which to gauge future progress;

(3) To develop the predictive ability to determine the environmental benefits of specific load reduction scenarios for toxic substances and the time required to realize those benefits through the use of models; and

(4) To improve our understanding of key environmental processes governing the movement of pollutants through the lake (cycling) and fish and plant life (bioavailability) within relatively closed ecosystems.

The LMMB Project focused on constructing mass balance models for a limited group of pollutants. Polychlorinated biphenyls (PCBs), trans-nonachlor, atrazine, and mercury were selected for inclusion in the LMMB Project because these pollutants currently or potentially pose a risk to aquatic and terrestrial organisms (including humans) in the Lake Michigan ecosystem. These pollutants were also selected to cover a wide range of chemical and physical properties and represent other classes of compounds which pose current or potential problems. Once a mass budget for selected pollutants is established and a mass balance model calibrated, additional contaminants can be modeled with limited data.

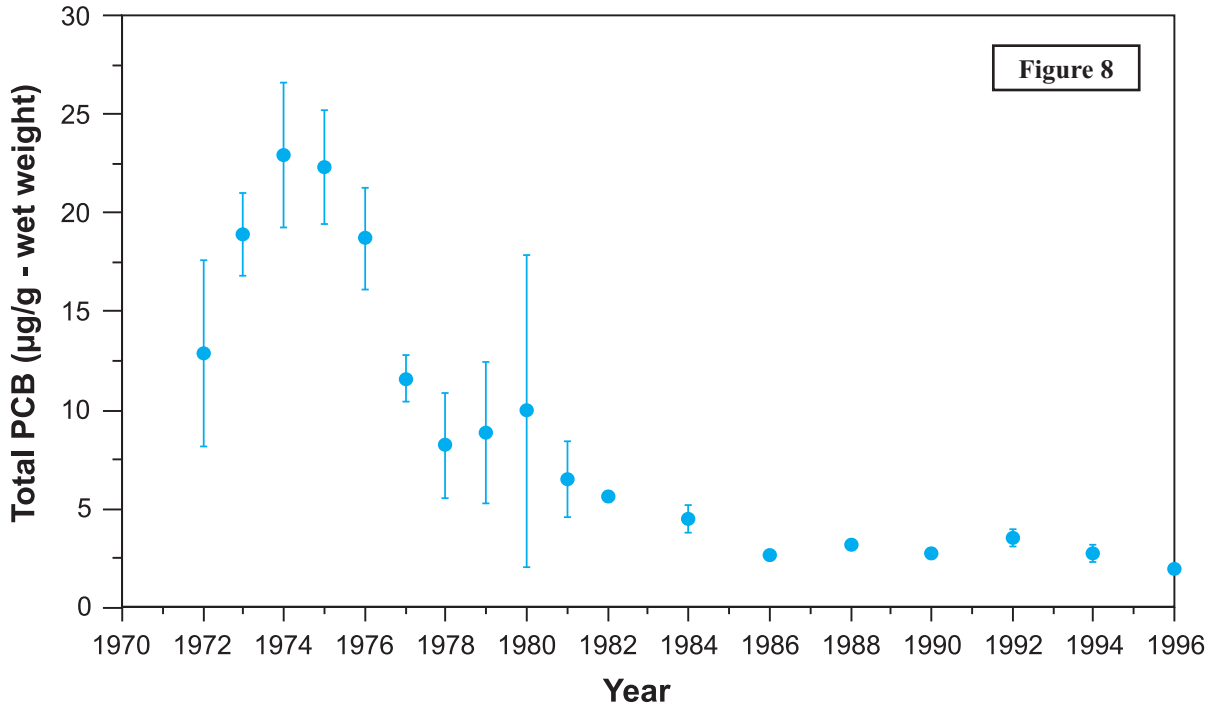
The LMMB Project used a mass balance approach to evaluate the sources, transport, and fate of contaminants in the Lake Michigan ecosystem. The mass balance approach is based on the law of conservation of mass, which states that the mass of a chemical contained in the lake is equal to the amount entering the system, less the amount leaving and chemically changed in the system. In the Lake Michigan system, pollutant inputs may come from atmospheric deposition, tributary loads, or sediments. Pollutants may leave the system through burial in bottom sediments, volatilization to the atmosphere, or discharge through the Straits of Mackinac. Pollutants within the system may be transformed through degradation or stored in ecosystem compartments such as the sediments, water column, or biota, including humans.

Data reports and preliminary modeling results are now being released by LMMB researchers. Although a suite of models is still being developed, modified, calibrated, and applied, preliminary model results have been used to conduct these initial assessments. The initial model results have focused on PCBs and atrazine. Mercury and trans-nonachlor model results will be published in the next 2 years. A few highlights of these results are summarized below.

PCB Prognosis for Lake Michigan: Modeling Future PCB Levels in Lake Trout

PCB concentrations in fish over the past 30 years show a downward trend from peak levels in the 1970s (Figure 8). However, the most recent data indicate that concentrations may be achieving equilibrium above desired levels in lake trout. Similar trends may be occurring in other species. The LMMB Project was undertaken, in part, to

Total PCB Concentrations in Lake Michigan Lake Trout
Error bars = 95% confidence limits



PCB Loads (kg/year) to Lake Michigan from Major Monitored Tributaries, 1994-1995

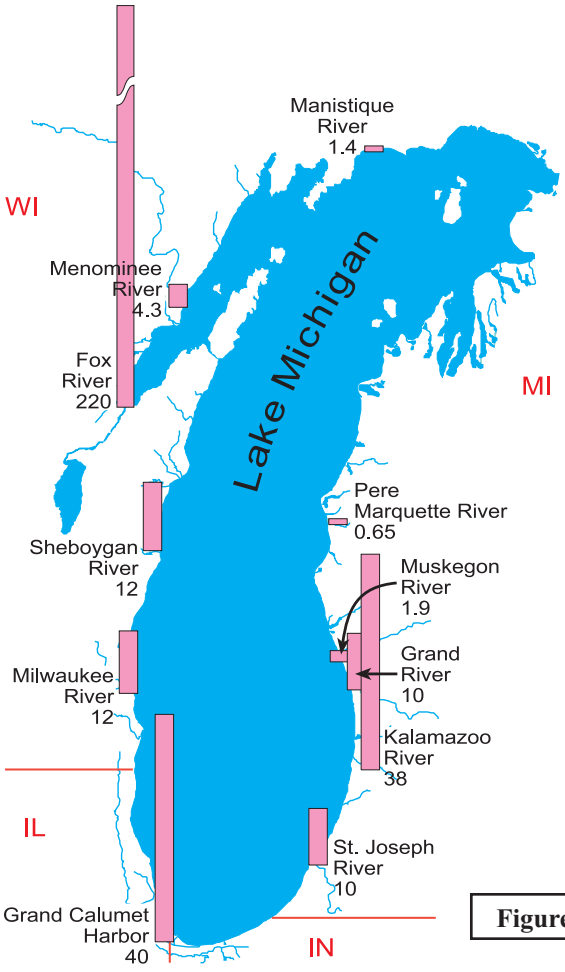


Figure 9

investigate this problem in detail and to develop mathematical models that could be used to project future concentrations in water, sediment, and biota, with and without further remedial and/or regulatory efforts.

These interim results provide several insights into the sources, fate, and effects of PCBs in Lake Michigan and the continuing need for reduction.

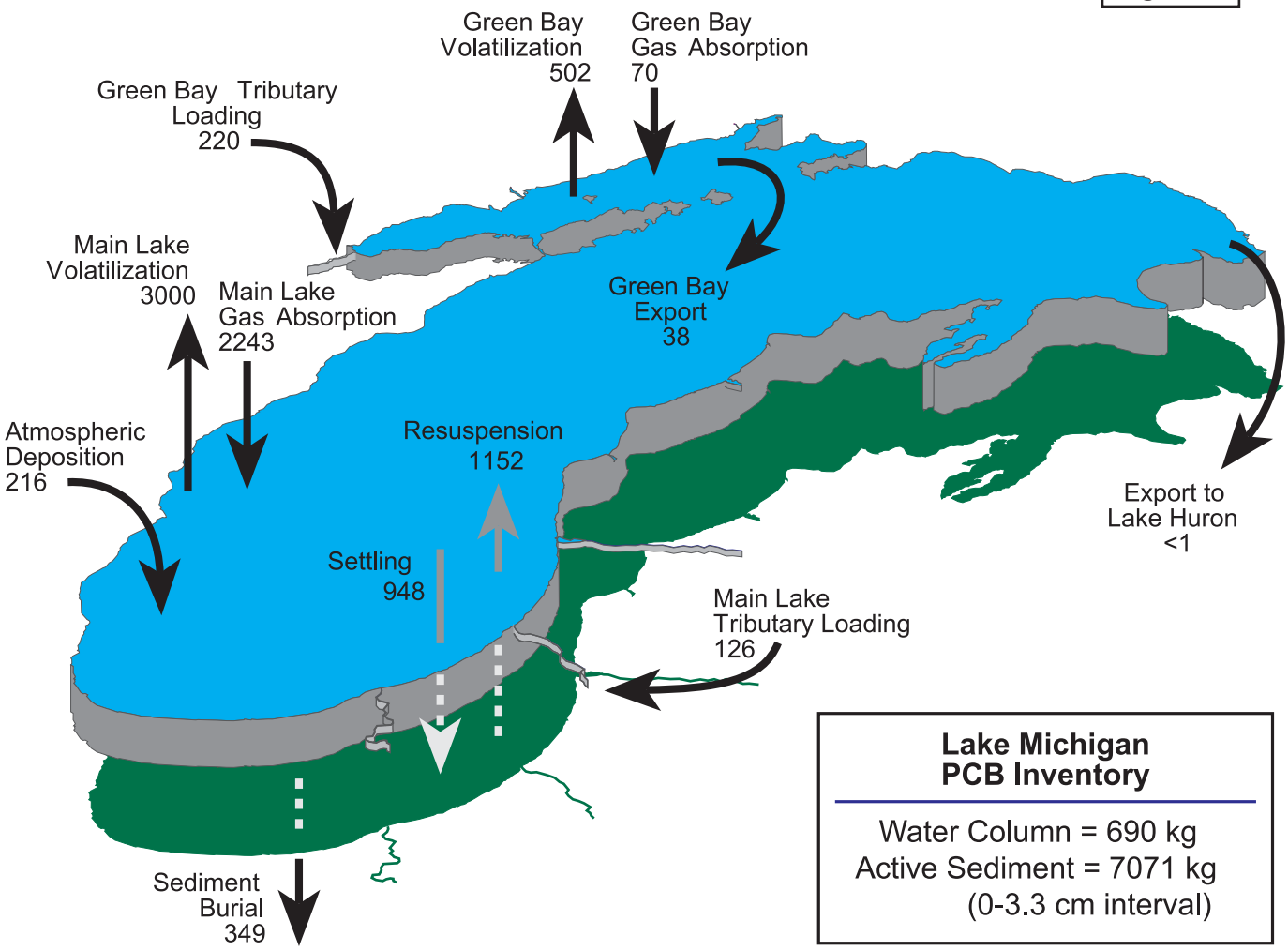
Figure 9 shows a summary of PCB loads from tributaries in 1994-1995. The relative importance of sources and losses of PCBs in the entire system is provided in Figure 10.

Table 2 outlines three scenarios evaluated using the MICHTOX model. The scenarios evaluate a range of management alternatives from taking no action to reduce PCB loads to eliminating 50 percent of loads to eliminating all PCB loads from tributaries, atmospheric deposition, and the vapor phase. The scenarios were evaluated to determine whether they would achieve reductions in fish tissue PCB levels.

Under Scenario A, PCBs should continue to decline over time even with no further controls (Figure 11) Under this scenario, PCBs should decline naturally over time, but once the sediment reservoir is depleted, further reductions will depend on the

1994-1995 Average Lake Michigan PCB Fluxes (kg/year)

Figure 10



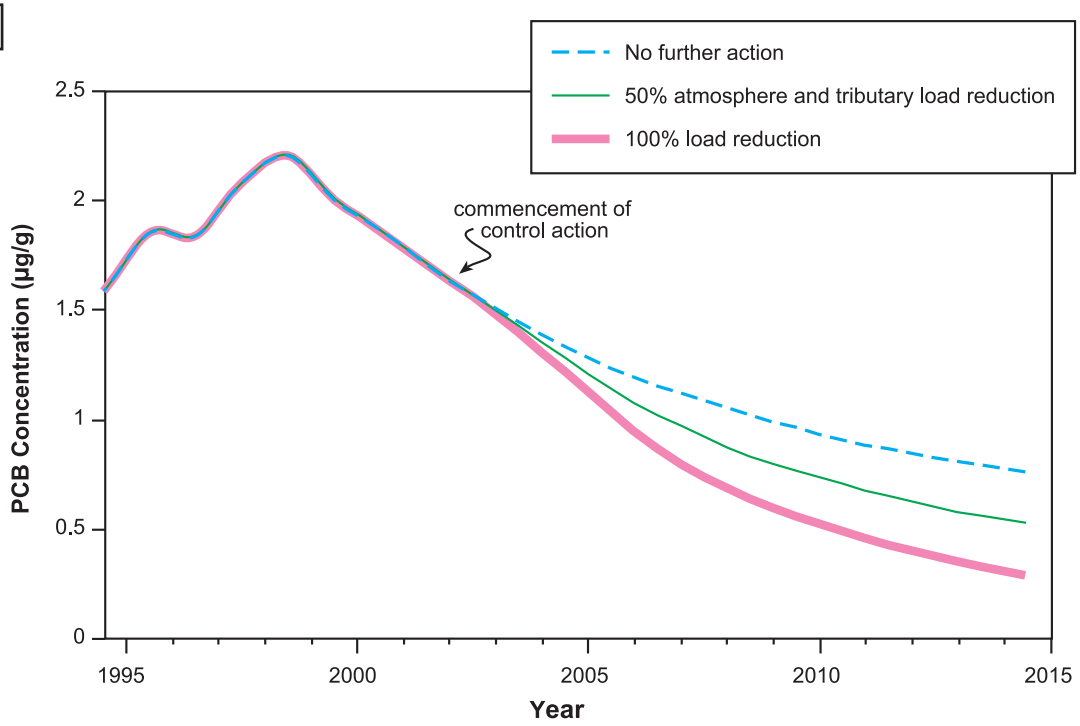
control of the tributary and atmospheric sources. Under Scenario B, in order to further reduce fish consumption advisories by 2020, a 50 percent reduction of PCB loads needs to occur. Under Scenario C (hypothetical virtual elimination or 100 percent reduction of PCB loads), fish tissue levels would be approaching advisory levels by approximately 2020. However, this virtual elimination scenario is hypothetical, because PCBs presently found in the environment make virtual elimination unfeasible.

Table 2. PCB Load Reduction Scenarios

Scenario	Description	Tributary Loads	Atmospheric Deposition	Vapor Phase Concentration
A	No Change	Constant	Constant	Constant
B	50% Reduction	50% Reduction	50% Reduction	50% Reduction
C	Virtual Elimination	100% Reduction	100% Reduction	100% Reduction

Toxic Chemical Management Alternative Comparison of Forecast Simulations for Age 7 Lake Trout in Southern Lake Michigan

Figure 11



Atrazine Prognosis in the Open Waters of Lake Michigan

Unlike PCBs and mercury, the herbicide atrazine does not bioaccumulate in organisms but does remain in the water column. The two single-most important atrazine loads to Lake Michigan include tributaries and wet deposition (rain and snow). Historical loading estimates of atrazine from both tributaries and wet deposition to Lake Michigan are depicted in Figure 12. Decreases in loadings from the tributaries is evident starting in 1985. A decreasing trend of loadings from the atmosphere in the form of wet deposition is not as evident.

Atmospheric loadings to the lake are higher in the southern portions than in the northern areas. The higher loadings in the south are likely due to the close proximity of this area to corn growing regions in the southern basin. Most of the atrazine loadings

Integrated Atmospheric Deposition Network (IADN)

IADN has been operating since 1990 through a partnership between Environment Canada and the U.S. EPA's Great Lakes National Program Office. IADN consists of a system of 5 master monitoring stations (one located on each of five Great Lakes) and several satellite stations (see figure). IADN measures concentrations of PCBs, PAHs, organochloride pesticides, and trace metals in the air and precipitation around the Great Lakes. One of the goals of IADN is to calculate atmospheric loadings of these pollutants to the Lakes and examine trends in atmospheric concentrations at the different stations over time. The latest IADN loadings report, using more recent data, is consistent with the LMMB findings. The IADN findings include:

- PCB levels and loadings are generally decreasing at IADN master stations; however, available data for Chicago suggests that PCB concentrations are holding steady over time.
- Loadings of banned pesticides to the Great Lakes are generally decreasing over time. Loadings of in-use pesticides are generally twice as high as banned pesticides.
- Regional loadings of DDT and DDD have been consistently positive (into the Great Lakes) over time. This finding indicates that the Great Lakes basin is still acting as a sink for chemicals that have been banned from use in the United States and Canada for over 20 years.

For more information on IADN, please refer to *http://www.msc.ec.gc.ca/IADN*

Atrazine Reassessment

Atrazine is regulated as a pesticide and EPA has set a maximum contaminant level (MCL) for drinking water. The MCL is most important for groundwater sources as Lake Michigan provides a large dilution factor. EPA's Office of Pesticide Programs (OPP) has released the preliminary ecological risk assessment for atrazine, a pesticide undergoing re-registration and tolerance reassessment. The atrazine risk assessment and related documents are available at: http://www.epa.gov/pesticides/reregistration/status.htm.

Concurrently, EPA's Office of Water has released the Draft Aquatic Life Criteria Document for Atrazine, which provides recommendations to states and tribes for their use in establishing water quality standards as regulations. The associated Federal Register notices are available on EPA's web site at http://www.epa.gov/fedrgstr. The comment periods for these documents ended in 2001.

EPA's preliminary ecological risk assessment for atrazine indicates that risk quotients exceeded levels of concern for chronic effects on mammals, birds, fish, aquatic invertebrates, and non-target plants at maximum and in some cases at typical use rates. A refined risk assessment for atrazine focusing on the aquatic environment and using the extensive ecosystem exposure monitoring data as well as additional ecotoxicological data found in the open literature, resulted in concerns for adverse toxicological effects on freshwater and estuarine plants and their communities as well as indirect adverse effects on aquatic invertebrate and fish populations at monitored atrazine levels in surface waters. For more information on the preliminary ecological risk assessment, see http://www.epa.gov/oppsrrd1/reregistration/atrazine/atrazine_eco_assessment.pdf.

from the atmosphere to the lake are associated with wet deposition.

In water, atrazine is primarily in the dissolved state and, therefore, any processes that involve sediment or suspended particle interactions are probably of minor significance (Rygwelski et al. 1999).

Tributaries are the most significant source of atrazine to the lake. Figure 13 illustrates atrazine loadings from the eleven rivers monitored under the LMMB Project. Estimates of these tributary loads were made in 1994 and 1995 using two methods: (1) monitoring estimates by USGS and (2) estimates based on the amounts of atrazine applied in these river basins and the amounts historically exported from these types of watersheds. As depicted in Figure 13, both methods for calculating loads indicate that the tributary carrying the largest load

Historical Tributary and Wet Deposition Atrazine Loadings to Lake Michigan

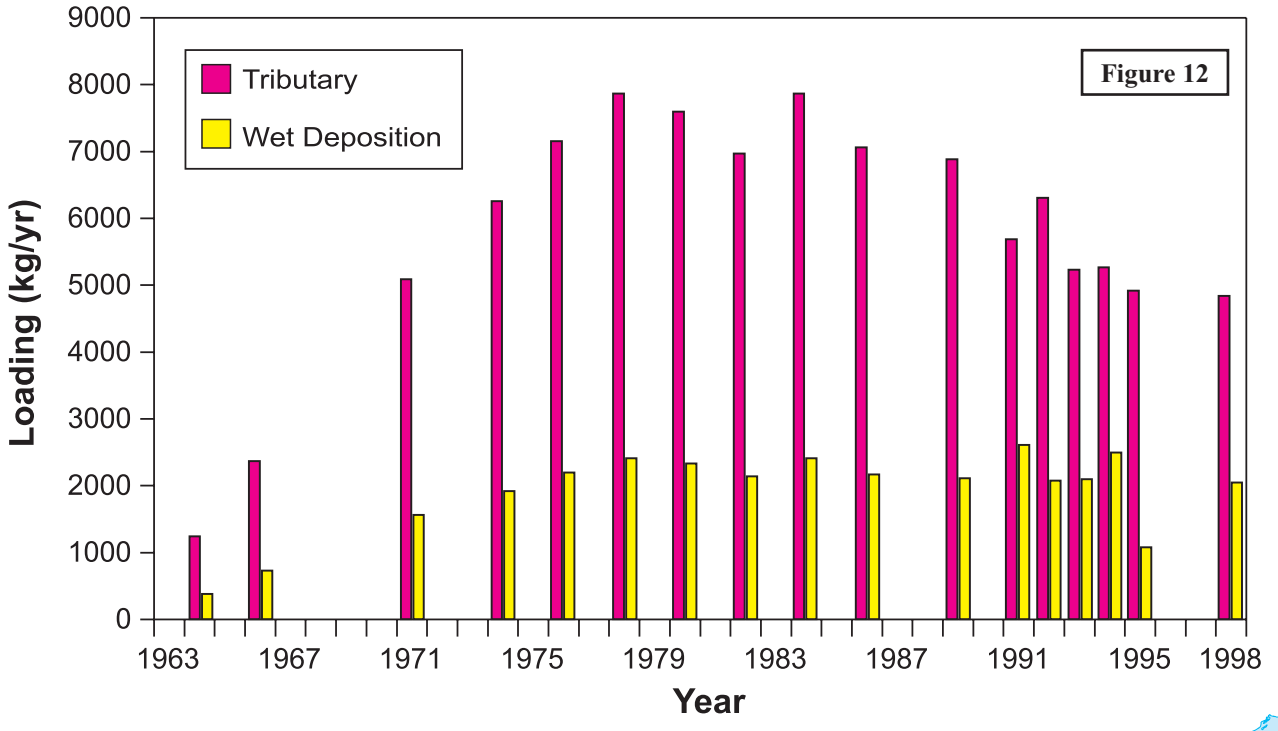
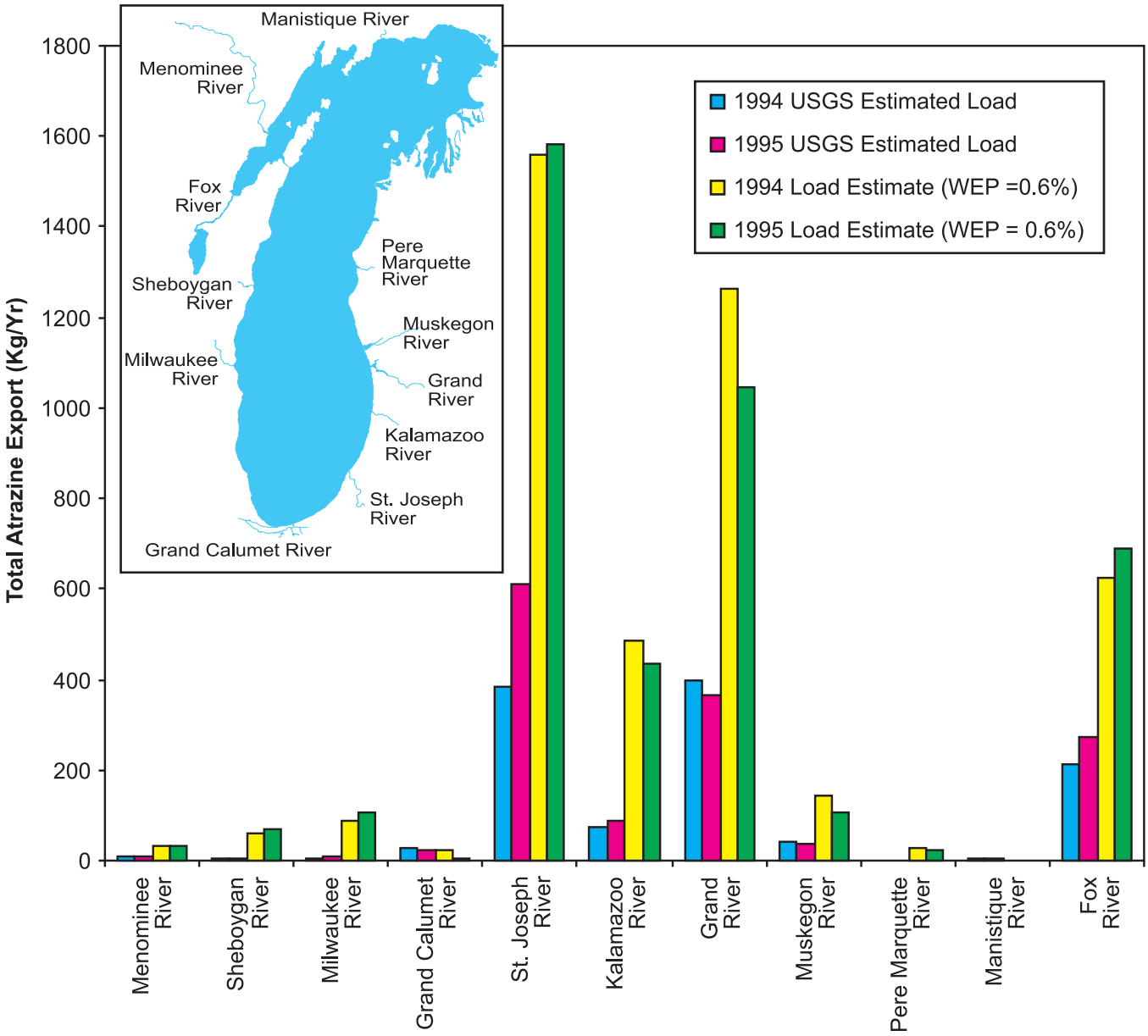


Figure 13

Atrazine Loadings from Tributaries to Lake Michigan



of atrazine to the lake in 1994 and 1995 was the St. Joseph River followed by the Grand River.

In order to understand the impact of the atrazine loadings to Lake Michigan, a mass balance model was developed for the lake. From these model results, one can note that of the fluxes out of the system, gross export out of the Straits of Mackinac is largest at 1,550 kg/year (Figure 14). Net absorption less volatilization is estimated to be a flux of 438 kg/year into the lake; however, if the vapor phase concentration were assumed to be zero throughout the model simulation, this number would be negative indicating that there would be a net flux out of the lake through volatilization.

The results from the modeling exercises indicate that atrazine in Lake Michigan water is decaying only at an estimated rate of 0.8 percent per year. This translates into a half-life of approximately 87 years due to loss through decay. The literature suggests that atrazine decay is enhanced in shallow, warm freshwater systems that have high suspended solids, high dissolved organic carbon, low pH, and high concentrations of nitrate ions (Rygwelski et al. 1999). The cold, deep, high pH, oligotrophic

Toxic Air Emissions Inventory

On January 16, 2002 the Great Lakes Commission released the 1998 Inventory of Toxic Air Emissions, presenting a multijurisdictional inventory of point, area, and mobile (onroad and nonroad) sources for 82 toxic contaminants released in the Great Lakes Basin. (Emissions data were available for 78 of the 82 targeted contaminants.) This is an ongoing project in which the air quality departments in each of the Great Lakes states and the province of Ontario perform the inventory work, which is coordinated by the Great Lakes Commission. The emissions inventory is just that: an inventory of recorded emissions of the targeted contaminants. The results are not a trend analysis of emissions. Differences between years are mainly due to an expansion of area sources for some states and improvements of emission estimation methods, emission factors, and activity data. The 1999 inventory will include all 188 hazardous air pollutants identified in Section 112(b) of the Clean Air Act for point, area, and mobile sources.

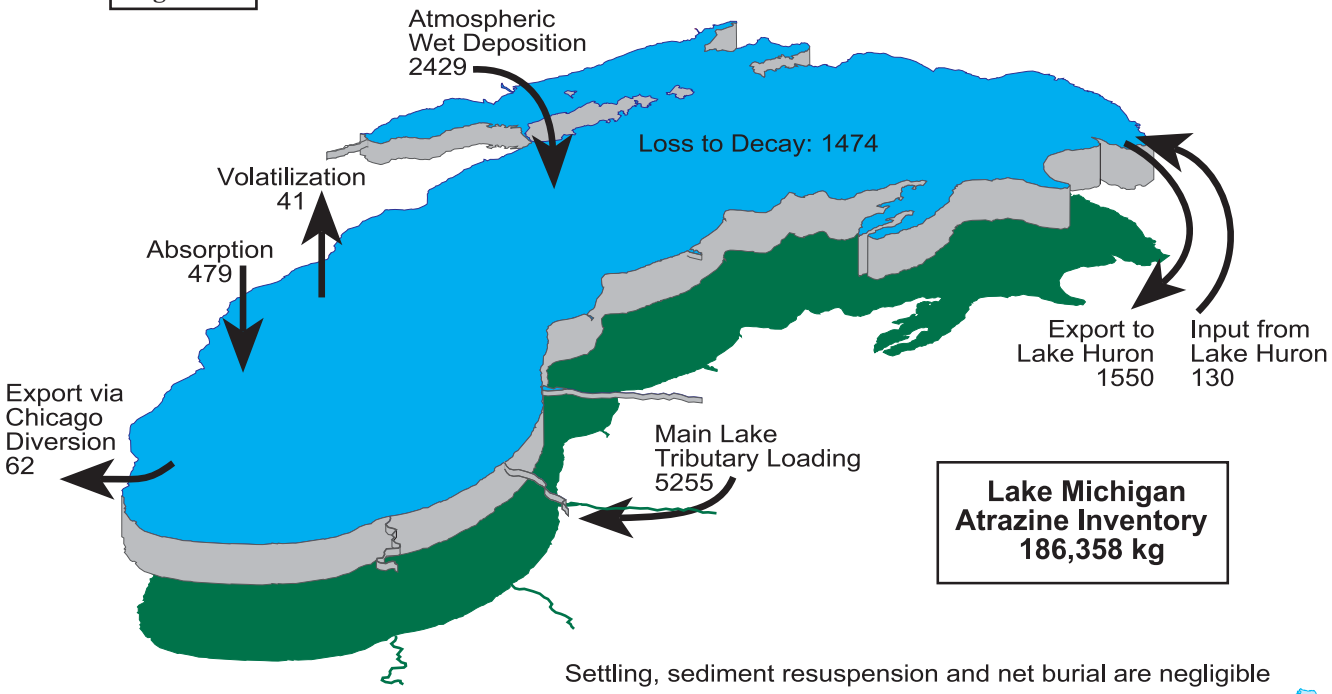
The 1998 emissions inventory includes emissions from 672 distinct source categories and 1,532 distinct processes. Point sources emitted all 78 pollutants, while area, onroad, and nonroad mobile sources emitted subsets of these pollutants. Toluene was estimated to have the highest overall emissions (631,177,350 lbs.) and parathion emissions were estimated to be the lowest (0.58 lbs.). Additional inventory results and information, as well as state-by-state emissions data may be found at *www.glc.org/air/air3.html*

waters of Lake Michigan do not appear to support considerable decay of atrazine.

Long-term simulations under various loading scenarios are depicted in Figure 15. The no action scenario fixes current loadings at rates estimated for 1998 and holds them constant. The resultant lakewide concentration increases to approximately 67 ng/L. To maintain the lake concentration at levels observed in 1994 (no further degradation scenario), a tributary load reduction of approximately 57 percent would be needed. A 100 percent tributary load reduction results in an ultimate concentration of approximately 24 ng/L. The modeled scenario yielding the most rapid decline in lake-wide concentrations is achieved if all external loads were shut off including tributary loads, wet deposition, and load input from the vapor phase.

1994 Average Lake Michigan Atrazine Fluxes (kg/year)

Figure 14



Climate Change and Clear Skies Initiative

On February 14, 2002, President Bush announced two new initiatives aimed at reducing toxic air emissions: the Clear Skies Initiative and the Global Climate Change Policy.

The goal of the Global Climate Change Policy is to cut greenhouse gas intensity (defined as the ratio of greenhouse gas emissions to economic output) by 18 percent over 10 years. This plan includes a 5-year, $4.6 billion commitment to tax credits for renewable energy sources and cogeneration.

Other key domestic components of the policy include (1) voluntary challenges to businesses to reduce greenhouse gas emissions; (2) transportation programs to promote development of fuel-efficient motor vehicles, research options for producing cleaner fuels, and programs to improve energy efficiency; and (3) a 10-year commitment to enhance natural storage of carbon by plant material by implementing and improving the conservation title of the Farm Bill.

The policy also has international components, including increased funding for "Debt-for-Nature" programs, funding of climate observation systems in developing countries, expanded technology transfer and capacity building in developing countries, and international research cooperative agreements (for example, with Japan, Italy, and Central America). For more information, see *http://www.whitehouse.gov/news/releases/2002/02/print/20020214-5.html*

LMMB Project Summary

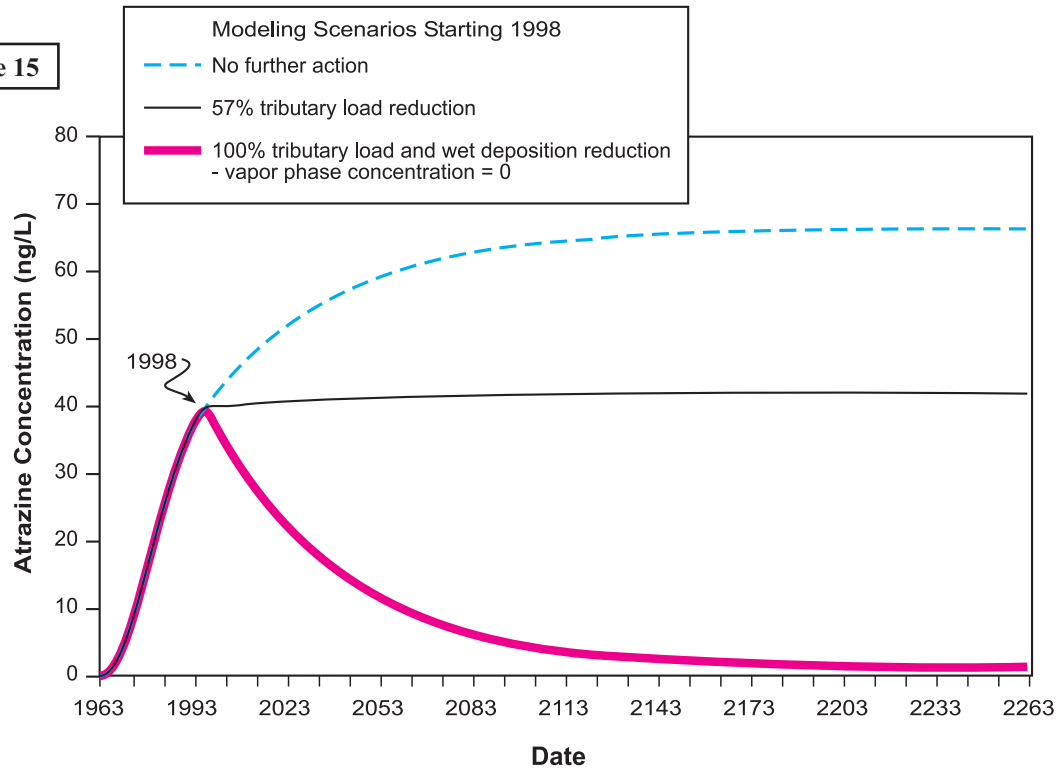
Preliminary model results are currently available for PCBs and atrazine only. Model results for mercury and trans-nonachlor will be released in the next 2 years. The PCB model results indicate that a 50 percent reduction in PCB loads to Lake Michigan will be needed to reduce lake trout fish tissue concentrations to below the fish consumption advisory level of 0.5 g/g by 2020. In order to maintain atrazine levels at 40 ng/L in the open waters of the lake, the atrazine model predicts that a 57 percent reduction in tributary loading levels will be needed.

Federal Conservation Programs

Innovative programs such as USDA's Environment Quality Incentive Program (EQIP) provide a "systems approach" for addressing agricultural nonpoint source pollution to Lake Michigan. This approach allows for sustainable production of food and fiber products while maintaining environmental quality and a strong natural resource base. In addition, EPA has several standing programs (for example, Section 319 nonpoint source pollution control) to address soil erosion and sedimentation within the basin.

Lakewide Atrazine Concentration Forecasts (Lake Michigan 41 Segment Model)

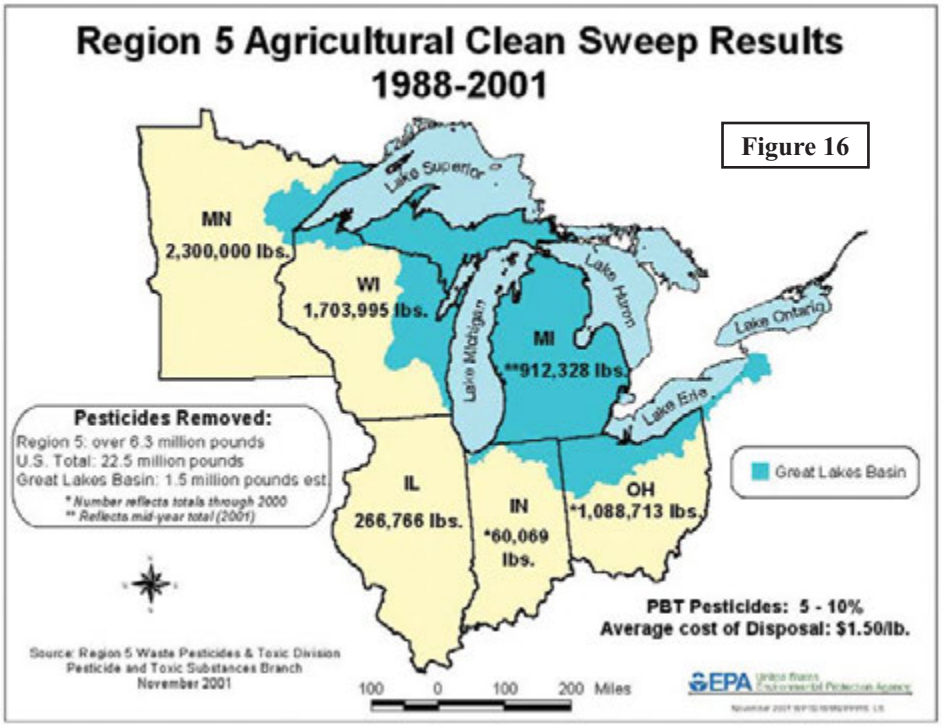
Figure 15



Other Pathways of Pollutant Load to Lake Michigan

While the LMMB study focused on four pollutants to develop a better understanding of pollutant fate and transport within the Lake Michigan ecosystem, many other pollutants are entering the ecosystem through a variety of pathways. The following discussion addresses recent investigations of four of these pathways:

- Atmospheric deposition,
- Nonpoint source runoff, including combined sewer overflows (CSO)
- Sediment
- Groundwater



Atmospheric Deposition

The role of air pollution as an important contributor to water pollution has long been recognized and has been the subject of growing scientific study and concern in recent years. Over the past three decades, scientists have collected a large and convincing body of evidence showing that toxic chemicals released into the air can travel great distances before they are deposited on land or water. Most notably, PCBs and some persistent pollutants (including several pesticides that have not been used in significant amounts in the United States since the 1970s) have been widely distributed in the environment and are now part of the global atmospheric background. Section 112 of the Clean Air Act required congressional reports of the effect of air deposition on the "Great Waters" of the United States, including the Great Lakes.

Loadings of pesticides whose use has been canceled or restricted in the United States to Lake Michigan are primarily from atmospheric sources that may be impossible to regulate or control. Although there are no current commercial sources of banned pesticides in the United States, loadings continue from use of remaining consumer stocks, evaporation from soils, resuspension of contaminated sediments, and atmospheric transport from other countries that continue to apply these substances. Further pesticide reductions can only be achieved through cleanup of contaminated sites, collection and disposal of existing stockpiles ("clean sweeps"), and use reduction in other countries.

Between 1988 and 2001, EPA Region 5 estimates that agricultural clean sweeps have removed 1.9

The Great Lakes Air Deposition Strategy

In January 2002,EPA published its Great Lakes Air Deposition (GLAD) Strategy: Priorities for U.S. EPA's National Geographic Initiative Grants. The strategy is intended to assist EPA Region 5 and the Great Lakes states in allocating Great Lakes National Geographic Initiative funds over the next 5 years by identifying high-priority activities. There are four high priority areas: (1) air deposition and source characterization monitoring, (2) emission inventory development and emission inventory development and emission factor development, (3) atmospheric and multimedia modeling, and (4) assessments of effects on aquatic life and wildlife. Additional information on the GLAD Strategy and proposal requirements is available at *http://www.epa.gov/region5/air/glakes/glad.htm*

Conservation and Buffer Strips Along Waterways

Federal legislation has established several programs to provide financial incentives or actual payments to agricultural landowners who choose to take land out of production. Using prescribed land cover for 10 to 15 years is a means of reducing agricultural runoff and the resultant erosion, sedimentation, water quality degradation, and habitat destruction in streams and lakes. Among these programs are the Conservation Reserve Program (CRP), the Conservation Reserve Enhancement Program (CREP), and the Continuous CRP (CCRP), which are managed through the Department of Agriculture's Natural Resource Conservation Service (www.nrcs.usda.gov). The U.S. Fish and Wildlife Service operates a private land management program to provide cost-sharing incentives to individual landowners for habitat improvement projects. There are similar programs at the state and local levels offering grants, tax offsets, or conservation easements. These programs are accomplished through local, voluntary partnerships between individuals and government and make use of financial incentives, which limits the number of participants because of resource constraints.

While long-range atmospheric transport is an important pollutant source for Lake Michigan, recent studies also point to the influences of local sources, particularly from urban areas. For example, air sampling over Lake Michigan when the wind is blowing from the southwest shows contributions of PCBs, PAHs, and mercury from the Chicago area to the lake. The relative importance of each pollutant source to the overall loadings is variable depending on the season and local weather conditions.

million pounds of pesticides from the Great Lakes basin (Figure 16)Figure 16

Nonpoint Source Pollution

EPA identifies polluted runoff as the most important remaining source of water pollution and provides for a coordinated effort to reduce polluted runoff from a variety of sources. Previous technology-based controls, such as secondary treatment of sewage, effluent limitation guidelines for industrial sources, and management practices for some nonpoint sources, have dramatically reduced water pollution and laid the foundation for further progress. However, nonpoint source loads continue to turn rivers and streams into pollutant pathways to the lake. Total maximim daily load (TMDL) studies will be needed for these tributaries to identify the management measures needed to bring them back into compliance with water quality standards. Over the next several years, states will be developing many TMDLs for pollutants entering into water bodies from both point and nonpoint sources. TMDLs will help manage water quality on a watershed scale.

Major sources of nonpoint pollution include urban stormwater runoff, discharges from animal feeding operations, cropland runoff, and episodic combined sewer overflows.

Stormwater is water from rain or snow that runs off city streets, parking lots, construction sites, and residential yards. It can carry sediment, oil, grease toxicants, pesticides, pathogens, and other pollutants into nearby storm drains. Once this polluted runoff enters the storm sewer system, it is discharged, usually untreated, into local streams and waterways. It can contaminate drinking and recreational waters and remains a major source of beach closures.

In late 1999, EPA promulgated rules to reduce stormwater runoff from construction sites between 1 and 5 acres and municipal storm sewer systems in urbanized areas serving populations of less than 100,000 through the issuance of permits. These controls must be in place by 2003.

This new stormwater rule builds on the existing program to control stormwater runoff from municipalities with populations greater than 100,000 and 11 industrial categories, including construction disturbing over 5 acres. Under the expanded program, sediment discharges from approximately 97.5 percent of the acreage under development across the country will be controlled through permits.

The Lake Michigan basin has a high concentration of agricultural enterprises where animals are kept and raised in confined environments. Polluted runoff from animal feeding operations is a leading source of water pollution in some watersheds. Potential impacts include the absence or low levels of dissolved oxygen in surface water, harmful algae blooms, fish kills, and contamination of drinking water from nitrates and pathogens and beach closures.

For the vast majority of animal feeding operations (AFO), voluntary efforts will be the principal

approach to assist owners and operators in developing and implementing site-specific management plans. Impacts from higher risk, confined animal feeding operations (CAFO), such as sites with the equivalent of 1,000 beef cows, are addressed through National Pollutant Discharge Elimination System (NPDES) permits under the authority of the Clean Water Act. About 5 percent of all animal feeding operations are expected to need permits.

Control of Combined Sewer Overflows

Combined sewer overflows (CSO) continue to be a major source of pollution in the Lake Michigan basin. Combined sanitary and storm sewers were commonly built throughout the Lake Michigan watershed as an economical means of managing urban wastewater. These systems are heavily concentrated in the northeast and Great Lakes regions. Under normal conditions, these combined systems are able to transport sanitary wastes and limited amounts of stormwater to a wastewater treatment plant for disposal. However, during heavy precipitation events, the combined sewer can become overloaded and discharge the untreated overflow containing sanitary and stormwater directly into surface waters. Because the overflows contain pathogens, toxic pollutants, solids, and debris, CSOs can create serious public health and environmental problems. CSOs are considered point sources under the Clean Water Act and are therefore subject to regulation.

Dredging Lake Michigan*
Photograph courtesy of USEPA

Sediment sampling aboard EPA research vessel, "Mud Puppy" in Indiana Harbor Canal
Photograph courtesy of EPA, ARCS program*

On January 29, 2002, EPA delivered a Report to Congress on Implementation and Enforcement of the Combined Sewer Overflow Control Policy. This report provides an overview of the progress made in controlling CSOs across the United States. It also provides state-by-state summaries of CSO control programs. Additional information on the report and state CSO programs as well as the state-by-state summaries can be found at http://cfpub.epa.gov/npdes

Sediments: Both a Contaminant and a Pathway

Land disturbed by natural or man-made processes produce sediments that impair tributary mouths and spawning areas. Better understanding of sediment movement in the lake is the goal of the Episodic Events: Great Lakes Experiment (EEGLE) at www.glerl.noaa.gov/eegle/.

Sedimentation in the tributary mouths and nearshore areas of Lake Michigan has been an ongoing problem. See Appendix B for a summary of sediment contamination and cleanups at the Lake

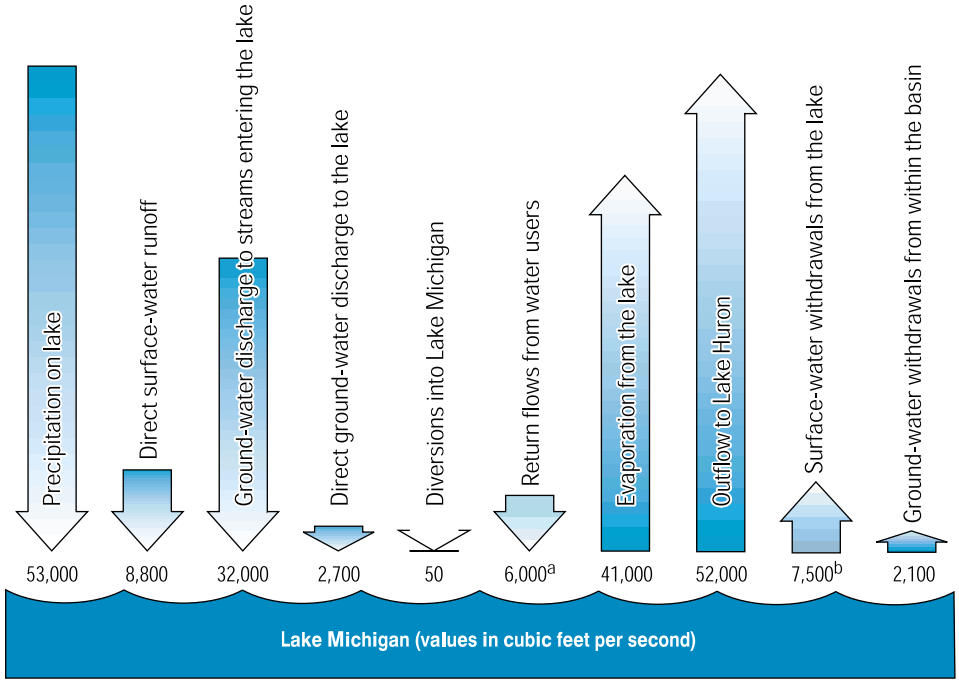
Michigan AOCs. Substances found in Lake Michigan sediment reflect the land uses in the upper portions of the watershed. Runoff from agricultural lands washes soil particles as silt that can smother aquatic habitat. The soil particles may also carry agricultural chemicals and nutrients into water bodies. Urban runoff also contributes sediments contaminated with pesticides, nutrients, oils, and other pollutants. Other substances deposited into the lake and its tributaries, such as PCBs, may bind preferentially with sediment particles. These substances accumulate or persist in the tributary mouths and nearshore areas because unlike smaller rivers that are constantly flushed with water, the lake is a sink. A drop of water entering Lake Michigan will take an average of 100 years to either evaporate or be washed into Lake Huron. The retention time for a particle of sediment is even longer.

Remediating Lake Michigan's legacy of contaminated sediment continues to be a high priority, and some progress has been made toward remediating the most highly contaminated sites on the lake in the past two years. As discussed under subgoal 1 "Can we all eat any fish?," two examples are moving forward on the Fox River in Wisconsin and Grand Calumet River in Indiana. The removal of 700,000 cubic yards of contaminated sediment from the east branch of the Grand Calumet River is targeted to begin in 2002. The cleanup is a result of a $30 million settlement between the Federal government, the State of Indiana, and USX. The sediments targeted have been highly contaminated with PCBs, heavy metals, benzene, PAHs, and cyanide. Approximately 4.65 million cubic yards of contaminated sediment will eventually be removed from the Indiana Harbor Ship Canal.

Sediment dredging is also moving forward in other areas of Lake Michigan. The U.S. Army Corps of Engineers is moving forward with a Comprehensive Dredge Material Management Plan for Waukegan Harbor, Illinois. The plan calls for dredging 250,000 cubic yards of polluted material and disposing the material in a confined disposal facility.

Finally, progress is being made to reduce future siltation and sediment contamination problems. The Lake Michigan Forum has formed an Agriculture Pollution Prevention Task Force to address specific pollution prevention projects for sediments and pesticides in the Lake Michigan basin. In winter 1999, the Forum held a workshop on sediment issues

Figure 17



[a] Return flow is reduced by 3,200 ft^3/s that is diverted out of the basin at Chicago, Ill.

[b] Withdrawals for power plant cooling not included

Citation: USGS

in the basin based on input received from the task force. The Buffer Initiative is also an important step forward in controlling this pathway. (see p. 77)

Groundwater Pathways in Lake Michigan

Groundwater enters the Great Lakes as either direct or indirect discharge. Direct groundwater discharge is flow directly into a lake through the lake bottom. Indirect groundwater discharge is flow into a lake by way of a tributary stream.

Groundwater discharge is a significant determinant of the biologic viability of tributary streams and coastal wetlands. In undisturbed areas, groundwater discharge throughout the year provides a stable inflow of water with consistent dissolved oxygen concentration, temperature and water chemistry. Where land uses significantly reduce groundwater flow to a stream, reaches of the stream or wetlands may lose their biologic viability. Likewise, where land uses add contaminants to a stream or wetland, they also may become impaired.

Lake Michigan is the only Great Lake for which there is enough information to estimate direct groundwater discharge. Figure 17 represents the relative contribution of groundwater and surface water to Lake Michigan.

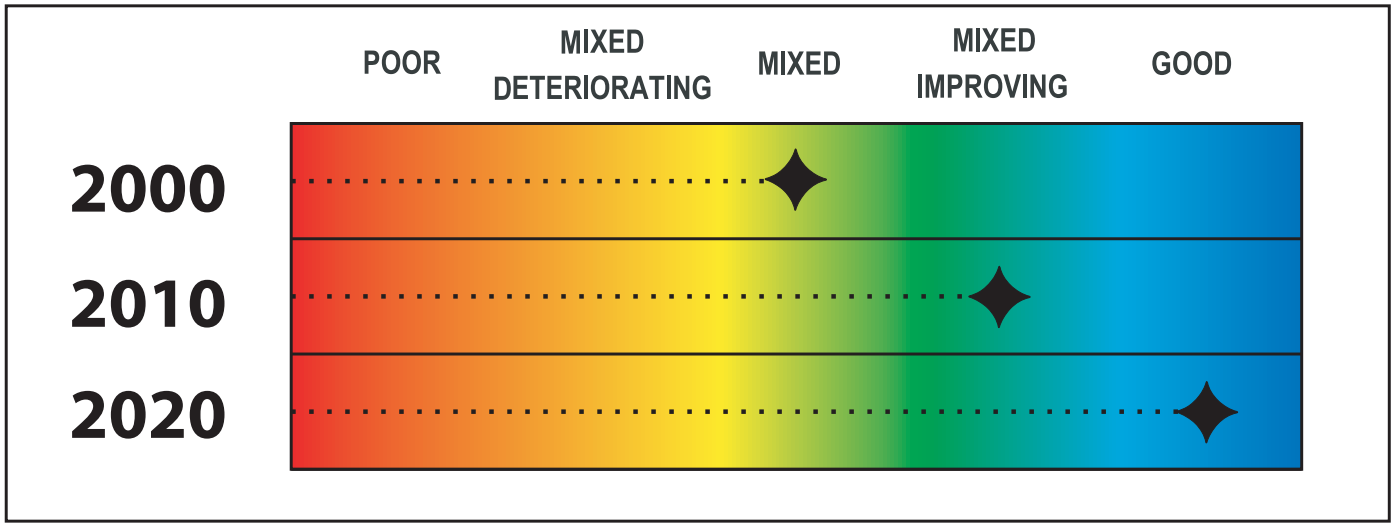
Until recently, the impact of groundwater on surface water quality has largely been ignored. Nonetheless, groundwater can have a significant effect on the quality of water in stream tributaries to the Great Lakes and on coastal wetlands by transporting natural and man-made pollutants to them. In agricultural and urban areas of the Great Lakes basin, contaminants on the land surface become dissolved in groundwater and eventually flows into streams, wetlands, and the Great Lakes. This widespread, diffuse flow of contaminants by way of groundwater is a type of nonpoint source contamination. Pesticides and nutrients, such as nitrate and phosphorus, are the principal nonpoint source form of pollution that reaches the Great Lakes by way of indirect groundwater discharge to tributary streams and coastal wetlands. The growing understanding of the importance of this pathway has led many States to begin setting ground water quality standards and regulating the substances that can be discharged to groundwater.

Next Steps

- A mercury source reduction and sediment remediation strategy will be finalized.
- Contaminated sediment sites will be reviewed and their status will be updated.
- EPA will compile a report on nutrient contributions from the agricultural sector and on point sources during wet weather.
- Fall 2003 State of Lake Michigan Conference will present updated mass balance results.
- By 2004 and 2005, develop coordinated monitoring to provide a 10-year trend for the lake
- By 2010, remediation of 50 percent of AOC sites
- By 2020, remediation of 70 percent of AOC sites
- By 2025, remediation of 100 percent of AOC sites

Luddington Lighthouse
Photograph by Carole Y. Sineheart, the Michigan Sea Grant Extension*

Subgoal 8
Are exotic species controlled and managed?



Status

The record of exotic species prevention and control in Lake Michigan is mixed. While there are success stories for the control of sea lamprey and the potential to prevent future introductions, zebra mussels and other new species continue to proliferate and are competing for food and habitat with native species. In the last 2 years, a new exotic, the spiney water flea, was introduced to Lake Michigan. Furthermore, there is a danger that other new exotics, the bighead and silver carp from Asia, accidentally released into the Mississippi River, could enter Lake Michigan during the next few years through the Illinois River system.

These trends highlight the need for more effective action in preventing the unintentional introduction of new species and controlling the nuisance species already established. In summer 2001, the Great Lakes Governors and Premiers signed an Action Plan for Preventing and Controlling Nonindigenous Aquatic Nuisance Species. This agreement builds on actions such as installation of barriers for exotic species, performance of demonstration projects, and passage of new legislation to address the problem. These actions will help to more the status of this goal to mixed/improving by 2010 and to good by 2020.

Challenge

- To eliminate further ANS introductions by 2010.

The History of Exotics in the Great Lakes

One of the greatest threats to the restoration and viability of native aquatic species in Lake Michigan is aquatic nuisance species (ANS), or invasive exotic species. Sea lampreys entered the Great Lakes following construction of the Welland Canal in the 1950s, which provided oceangoing vessels with access to all the Great Lakes. More recent arrivals such as the zebra mussel, round goby, and ruffe entered the lake through ballast water releases. Governments have been using various integrated measures to control exotic species, including use of barriers to prevent movement of the exotics into tributary rivers and streams. Specially formulated chemicals are used to target and kill young exotics, but these chemicals sometimes also kill native invertebrates and fish.

LaMP 2000 recognized that ANS have caused irreparable harm to the ecosystem of Lake Michigan. Prevention of unintentional introductions of such species, not only in the Lake Michigan basin but throughout the Great Lakes, is therefore one of the most important actions for achievement of subgoal 4 - “All habitats are healthy, naturally diverse and sufficient to sustain viable biological communities.”

Sea Lampreys attaching themselves to native fish*
Photography courtesy of USEPA

Chapter 6 of LaMP 2000 lists the following actions that can restore, enhance, and sustain the health, biodiversity, and productivity of the ecosystem:

- Ballast water management and pollution prevention
- Development of ballast water discharge standards
- Legislation
- Technological efforts
- Research

There has been significant activity in all of these areas in the past 2 years.

Ballast Water Management and Pollution Prevention

There has been a movement to develop clear, concise biological standards or guidelines for treatment of ballast water working toward zero discharge of ANS. These focus on best practical technologies and devise a short-term plan for dealing with the No-Ballast-On-Board (NOBOB) issue (where ballast remains in the ship containing ANS). This will require newly built ships to incorporate pollution prevention technology to address the ballast water problem as well as retrofitting existing ships.

Development of Ballast Water Discharge Standards

The International Maritime Organization's (IMO) Marine Environment Protection Committee is developing draft regulations for ballast water management to prevent the release of harmful aquatic organisms present in ballast water. The proposed instrument is a new international convention addressing control and management of ships' ballast water and sediments in the water. A diplomatic conference is planned for late 2003 to adopt the new regulations. For more information, visit *http://www.imo.org/index*

The U.S. Coast Guard (USCG) is required by the National Invasive Species Act (NISA) to issue regulations and guidelines for ballast water management practices to prevent introduction of ANS to U.S. waters. In May 2001, the USCG submitted a document titled Potential Approaches to Setting Ballast Water Treatment Standards for public comment. For more information on USCG's progress, visit *http://www.uscg.mil/hq/g-m/mso*

Legislation

In August 2001, Governor Engler signed the Michigan Ballast Water Reporting Program into law. This program requires MDEQ to determine (1) whether all oceangoing vessels operating on the Great Lakes are complying with the ballast water management practices promoted by the Shipping Federation of Canada and (2) whether all nonoceangoing vessels operating on the Great Lakes are complying with the ballast water management practices promoted by the Lake Carriers' Association and the Canadian Shipowners' Association. To help make this determination, MDEQ has distributed a reporting form to all vessel owners and operators. All vessels complying with the applicable ballast water management practices will be so identified on the Michigan Ballast Water Management web site at *http://www.michigan.gov/deq/1, 1607, 7-135-3307_3667_8278—,00.html*

As of March 1, 2002, any owner or operator of a vessel that is not identified on the web site and any persons in Michigan with contracts for the transport of cargo with the operator of a vessel that is not identified on the web site will not be eligible for grants, loans, or awards administered by MDEQ. The reporting program also requires MDEQ to evaluate ballast water treatment methods in order to prevent future introduction of ANS and to determine a deadline for use of such treatment

Chicago Sanitary and Ship Canal Dispersal Barrier Study

USACE completed installation of a demonstration dispersal barrier in the Chicago Sanitary and Ship Canal. USACE is using the project to investigate environmentally sound methods for preventing and reducing dispersal of nonindigenous ANS between Lake Michigan and the Mississippi River basin.

The canal forms a unique, manmade link between two major watersheds and provides ANS with a pathway between the two basins. A multi-agency panel agreed to install an electronic dispersal barrier that does not interfere with navigation or the Lake Michigan diversion volume.

The effectiveness of the barrier will be monitored for up to 2 years. A contract for monitoring of the project was awarded in November 2001, and a contract for operation and maintenance of the barrier was awarded in March 2002. Operation and monitoring will continue through fiscal years 2002 and 2003. The total project cost will be $2.2 million over the lifetime of the project.

The Upper Mississippi and Illinois River systems and lock locations
Courtesy of U.S. Army Corps of Engineers

methods, should it be determined that they are available for use.

On the national level, the National Invasive Species Act (NISA) is scheduled to be reauthorized in 2002. As the reauthorization process begins, the opportunity exists to strengthen the NISA by addressing programmatic and policy gaps, including gaps associated with ballast water requirements.

The Department of Transportation has published the Saint Lawrence Seaway Development Corporation - Seaway Regulations and Rules: Ballast Water, Final Rule (33 CFR Part 401). Under agreement with the St. Lawrence Seaway Management Corporation of Canada, the Saint Lawrence Seaway Development Corporation amended the joint regulations to make compliance with the ballast water management practices a mandatory prerequisite for clearance of a commercial vessel for transit of the Seaway system in support of assuring the continued control of the introduction of aquatic nuisance species (ANS) in the Great Lakes Seaway System.

The St. Lawrence Seaway Handbook will now include the following:

Ballast Water Management Practices

Effective with the 2002 navigation season:

[a]. every vessel entering the Seaway after operating beyond the exclusive economic zone must agree to comply with the "Code of Best Practices for Ballast Water Management " of the Shipping Federation of Canada dated September 28. 2000, while operating anywhere within the Great Lakes and the Seaway: and

[b]. every other vessel entering the Seaway that operates within the Great Lakes and the Seaway must agree to comply with the "Voluntary Management Practices to Reduce the Transfer of Aquatic Nuisance Species Within the Great Lakes by U.S. and Canadian Domestic Shipping" of the Lake Carriers' Association and the Canadian Shipowners Association dated January 26, 2001, while operating anywhere within the Great Lakes and the Seaway.

Technological Efforts

The Great Lakes Ballast Technology Project was established in 1996 to accelerate development of practical and effective ballast treatment technology for ships. The project, which is led by the Northeast-Midwest Institute and the Lake Carriers' Association, is supported by grants from the Great Lakes Protection Fund and several state and federal agencies. The centerpieces and ongoing emphasis

of the project are its high-flow field trials of commercially available ballast treatment equipment. Treatment technologies tested on working ships include high-volume filtration, cyclonic separation, and ultraviolet radiation. For more information, visit the Northeast-Midwest Institute's web site at *http://www.nemw.org/biopollute.htm*

Research

Under the Michigan Ballast Water Reporting legislation, the Michigan Department of Environmental Quality is in the process of determining whether ballast water treatment methods could be used by vessels to prevent future aquatic nuisance species introductions. If treatment methods are identified as available for use, the MDEQ will determine a time period for vessel use of the treatment method. After the time period determined by MDEQ, all vessels must then verify the use of the treatment method. The MDEQ is currently evaluating treatment methods through an on-board ship evaluation process.

Various research projects involving nonindigenous species are being conducted throughout the Great Lakes by governmental and academic entities. Information on the results of research into ANS impacts and prevention can be found at the following web sites:

- *http://www.sgnis.org*
- *http://www.glerl.noaa.gov/res/Programs/nsmain.html*

Other Actions

The ANS Task Force is an intergovernmental organization dedicated to preventing and controlling dispersal of ANS and charged with implementing the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990. The various NANPCA mandates were later expanded with the passage of NISA in 1996. For a list of actions taken by the ANS Task Force to prevent the introduction and spread of ANS, visit the web site at http://www.anstaskforce.gov/.

The Great Lakes Panel on Aquatic Nuisance Species is an intergovernmental, multi-stakeholder organization whose charge is to identify Great Lakes priorities regarding ANS; assist and make recommendations to the ANS Task Force; coordinate exotic species program activities in the region; advise public and private interests on ANS control efforts; and submit an annual report to the task force describing ANS prevention, research, and control activities in the Great Lakes basin. For the most recent list of actions taken by the Great Lakes Panel, visit the web site at *http://www.glc.org/ans/anspanel.html*

The Great Lakes Governors' Ballast Water Initiative was created at the request of Governor Engler and unanimous approval of the Great Lakes Governors, the Council of Great Lakes Governors has convened a Task Force to explore, outline, and advise the Great Lakes Governors and Premiers on the range of options that exist to stop further introduction of exotic species into the Great Lakes. The Task Force is charged to formally recognize the importance the Governors and Premiers place on the threat nonindigenous aquatic nuisance species present to the Great Lakes; to showcase and prioritize state/provincial initiatives to date; to emphasize the importance of a consistent and coordinated effort and legislation throughout the region, and to ultimately provide options as to how the Governors and Premiers can best arrest the introduction and spread of ANS within the region's ecosystem and economy. The structure of the Task Force follows the threefold organization of Michigan's dialogue with the shipping industry: management practices, biocides, and technologies. It is the desire and intention of the Task Force to build upon the efforts already initiated on ANS in the Great Lakes region.

The Hazard Analysis and Critical Control Point process was originally developed to prevent contamination and spoiling of food during preparation and processing. However, through an initiative of the Sea Grant program, the process is being applied to collection and distribution of bait fish and the aquaculture industry, which is often a pathway for ANS. For a description of these initiatives, refer to an article at *http://www.seagrant.umn.edu/seiche/jan.01/art04.html*

Since 1993, the USCG has had mandatory ballast water regulations in place, and it has

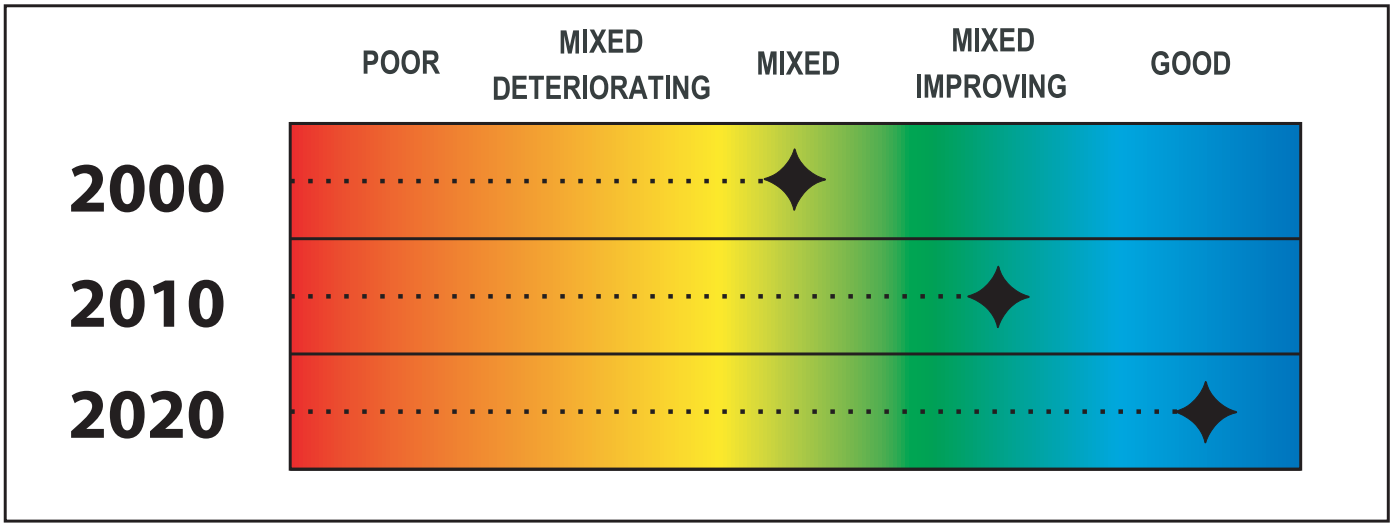
recently solicited public comments on approaches to setting standards for ballast water treatment and implementing and enforcing those standards. EPA released a draft report in September 2001 outlining options for addressing ballast water and ANS. Great Lakes Strategy 2001 identifies invasive species as a major threat to the Great Lakes and proposes numerous options, both regulatory and voluntary, for eliminating further ANS introductions by 2010. Finally, several states have introduced legislation to address ANS in ballast water, but thus far Michigan is the only state to adopt any form of ballast water legislation.

Next Steps

- Track and provide information on ANS developments as an important part of the LaMP education and outreach efforts.
- By 2003, a multi-agency "SWAT" Team will be developed to respond to newly discovered invasive species with the latest control technology.
- By 2010, vessels entering the Great Lakes will discharge ballast water free of invasive species.

Sand Sculptures on the Beach
Photo courtesy of the Wisconsin Division of Tourism, Milwaukee Dept. of City Development*

Subgoal 9
Are ecosystem stewardship activities common and undertaken by public and private organizations in communities around the basin?



Status

Each government, institution, organization, and individual within the Lake Michigan basin has a potential role in ecosystem stewardship; however, no single government, institution, organization, or individual has the ability to implement stewardship activities and achieve sustainability in the basin unilaterally. The current status of stewardship is mixed but will improve as more Lake Michigan partnerships are formed.

Challenge

To create a framework for participating organizations to contribute their expertise and resources in a manner that allows all partners to participate in decision-making on an even basis.

The Importance of Partnerships

The past decade of ecosystem management in the basin has seen a profound shift from a top-down, command and control, government-dominated approach to a bottom-up, partnership-based, inclusive approach. This evolution is the manifestation of a number of developments, including changes in federal, state, and local relationships; local community empowerment; increased focus on local partners; and watershed-based institution building. If a sustainable Lake Michigan ecosystem is to be achieved, it falls to us to rearrange ourselves, our interest groups, and our governments into a new institutional framework—a framework that consists of existing organizations and governments "rafted" together as full partners in the pursuit of the LaMP goals.

Cook County, Illinois Clean Sweep

In 1997, EPA, Illinois EPA, Cook County, the City of Chicago, industry, and other stakeholders created the Cook County PCB and Mercury Clean Sweep Partnership. The partnership, which concluded in December 2000, provided incentives and disposal opportunities for small businesses and local governments in Cook County to properly dispose of their PCB- and mercury-containing materials and equipment. The targeted businesses and government entities were chosen because they were not served by household hazardous waste collection events or national enforcement activities. The result was the collection from voluntary participants of 135 high-intensity discharge mercury bulbs, 57 8-foot boxes and 231 4-foot boxes of fluorescent bulbs, 15 gallons of lab-packed mercury waste for stabilization, 134 gallons of lab-packed mercury for restoring, 640 PCB-containing ballasts, one 55-gallon drum of hexane/ PCB oil, one large PCB-containing transformer, and one small and one large PCB-containing capacitor.

Lake Michigan's Watershed Academy

The concept of a Lake Michigan Watershed Academy is to provide a "packaging and delivery system" that brings together the tools, data, and expertise of many federal, state, local, and tribal agencies as well as NGOs and environmental organizations to explore opportunities for new partnerships, thereby impacting the quality of the land use plans in the Lake Michigan watershed.

Many of the stressors on Lake Michigan are driven or prevented by land use decisions made at the local governmental level and/or private property. Lake Michigan LaMP 2000 highlighted the need to promote a series of dialogues with local decision-makers about the status of these decisions that would provide training leading to plans, possible activities, and partnerships that could benefit both the local and lake-wide ecosystems.

Many training materials and tools have been developed including EPA's Watershed Academy Web-Based Training (www.epa.gov/OWOW/watershed/wacademy), Drinking Water Academy, American Water Works Association Source Water Training, Land Trust Alliance training materials, other existing videos and state and local training materials such as Michigan's Department of Environmental Quality's "Developing a Watershed Management Plan for Water Quality."

More Information

The Lake Michigan LaMP has also developed a "Habitat and Land Use Management Tool Box" that is a collection of hundreds of useful web sites for detailed followup. In Fall 2002, the LaMP in cooperation with the Great Lakes Commission will also preview the Lake Michigan On-Line Habitat Atlas. Planning is underway to hold the first Watershed Academy training in 2003.

For more information, contact: Judy Beck (beck.judy@epa.gov)

Effective place-based partnerships are the result of the rafting of "full partners." Full partnership implies moving beyond the stakeholder model, wherein citizen committees (stakeholder groups) are briefed about agency plans and projects, to a model based on full collaboration in the definition of basin-wide goals and the sharing of resources to achieve these goals.

The Lake Michigan Forum

The Lake Michigan Forum provides input on the LaMP to EPA from representative stakeholders of the Lake Michigan basin. In recognition of the LaMP statement that every basin resident is a "Lake Michigan Manager," the forum seeks opportunities to foster ecosystem stewardship through multi-organizational initiatives and partnerships, looking for LaMP implementation opportunities beyond what can be achieved by government efforts.

As the nongovernmental component of the Lake Michigan LaMP, the Forum has a number of responsibilities, including

- Representing the diverse interests and geography of the Lake Michigan basin and creating a communication link between the forum members' constituents and the LaMP process
- Providing input to and review of LaMP updates and assisting in their completion and implementation
- Identifying targets of opportunities for demonstration projects relating to LaMP goals and recommendations
- Promoting the LaMP to the public and building a constituency for its implementation
- Serving as a forum for regional and watershed approaches to accomplish LaMP goals;
- Serving as a forum for identifying, discussing, and conveying critical/priority issues
- Serving as a conduit for public concerns and input to the LaMP process

The forum's membership consists of representatives of local governments, industry, environmental groups, sport fishing interests, academia, agriculture, Native American tribes, sewerage districts, and AOCs.

The forum holds public meetings quarterly at different locations around the Lake Michigan basin

Lake Michigan Basin Stewardship Trust Concept

The Forum is currently developing a "Stewardship Trust" concept for use in helping to support community/watershed-based stewardship initiatives. The Trust would operate similar to community trusts that house and manage several donor-directed and restricted use funds. Fundraising, foundations, and state and federal enforcement action settlements are all possible sources of funds.

For more information, visit *www.lkmichiganforum.org*

and, in partnership with EPA and Grand Valley State University, sponsors an education and outreach tour. For more information, visit the forum web site at *www.lkmichiganforum.org*

The W.G. Jackson
Photography courtesy of Grand Valley State University

The "Making Lake Michigan Great" Tour

Each summer since 1998, the ship W.G. Jackson has made its way around Lake Michigan on the Making Lake Michigan Great Tour, spreading the word about the Lake Michigan LaMP. The tour provides hands-on experience in water issues for the public aboard a research vessel operated by the Robert B. Annis Water Resources Institute of Grand Valley State University in Allendale, Michigan. The event includes cruises for students and the public, open houses, and community activities. Since it began, thousands of people have participated in the tour at 26 ports of call around Lake Michigan.

State of Lake Michigan Conference

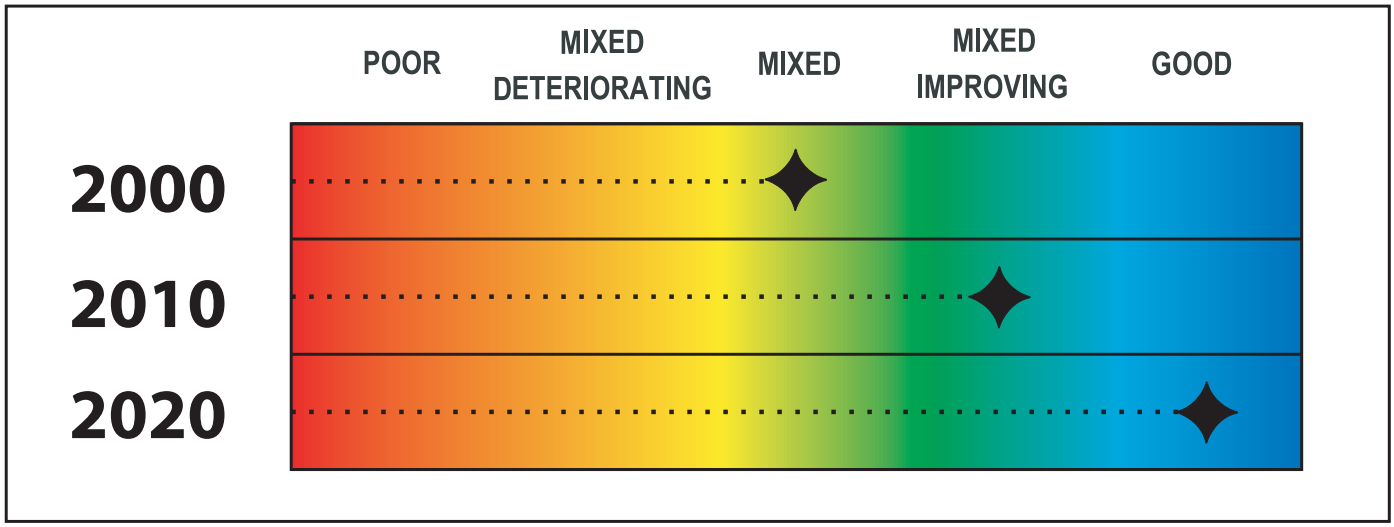
In November 2001, EPA, Lake Michigan Forum, and Grand Valley State University hosted the State of Lake Michigan conference in Muskegon, Michigan. The conference brought together over 300 attendees and presenters to discuss the status of the lake. A copy of the conference proceedings is available on CD. Contact Janice Carrollo at carrollo.janice@epa.gov

Students getting hands-on experience aboard the W.G. Jackson
Photography courtesy of Grand Valley State University

Next Steps

- Establish the Lake Michigan Watershed Academy
- Publish additional education and outreach materials
- Publish the habitat and land use management tool box
- On-line habitat atlas will be operational
- Hold FY 2003 State of Lake Michigan Conference

Subgoal 10
Is collaborative ecosystem management the basis for decision-making in the Lake Michigan basin?



Status

The LaMP provides a lake-level framework serving both as a reference document and a proposal for a process to remediate past errors and achieve a sustainable Lake Michigan basin ecosystem. To this end, every effort has been made to ensure that the Lake Michigan LaMP and updates contain clear, comprehensive goals, specific objectives, a strategic plan, and a system of indicators and monitoring to judge the environmental status and effectiveness of current actions.

Collaboration among a variety of stakeholders to improve the Lake Michigan ecosystem has increased since LaMP 2000. This section documents several of these collaborative activities, including:

- The Great Lakes Strategy (www.epa.gov/glnpo/gls/index/html)
- Activities of the Binational Executive Committee
- Great Lakes Binational Toxics Strategy (www.epa.gov/glnpo/p2/busintro.html)
- The Great Lakes Human Health Network
- Activities of the Great Lakes Fishery Commission (www.glfc.gov)
- A shared goals project involving EPA Region 5 and state water quality programs
- A buffer protection strategy
- The 2002 Wingspread Accord

Other collaborative activities, such as a proposed mercury phase-out, are discussed in other sections of this document.

Challenge

- To develop clear goals and objectives that facilitate coordinated actions among agencies and stakeholders.

Empire Bluff at Sleeping Bear Dunes National Lakeshore, Empire, Michigan
Photography courtesy of Michigan Travel Bureau*

Great Lakes Strategy

Great Lakes Strategy 2002 was created by the U.S. Policy Committee – a forum of senior-level representatives of federal, state, and tribal agencies responsible for environmental and natural resource management of the Great Lakes – to help coordinate and streamline the efforts of the many governmental partners involved in protecting the Great Lakes. The strategy focuses on multi-lake and basinwide environmental issues and establishes common goals that the governmental partners work toward. It supports efforts already underway, including LaMPs and RAPs for AOCs, by addressing issues that are beyond the scope of these programs and helping to integrate them into an overall, basinwide context. The strategy also advances the implementation of the United States' responsibilities under the 1987 GLWQA.

The strategy is a concise, policy level statement of basinwide priorities and activities that address the current state of the Great Lakes basin ecosystem and key environmental goals for the future so that a unified approach to implementation can be carried out by a diverse set of federal, state, and tribal agencies. The long-term vision of the strategy can be simply expressed as follows:

- All Great Lakes beaches are open for swimming all the time.
- All Great Lakes fish are safe to eat all the time.
- The Great Lakes are maintained and enhanced as a safe source of drinking water.
- The Great Lakes basin is a healthy natural environment for wildlife and people.

The Binational Executive Committee

The Binational Executive Committee (BEC) is charged with coordinating the implementation of the binational aspects of the 1987 GLWQA. The BEC is co-chaired by Environment Canada and U.S. EPA, and includes members of the Great Lakes states, the Province of Ontario, and other federal departments and agencies in Canada and the United States. The BEC addresses binational, basinwide issues of concern and provides strategic direction to the LaMPs, RAPs, and other Great Lakes programs such as the Binational Toxics Strategy, and the State of the Lakes Ecosystem Conference.

Great Lakes Binational Toxics Strategy

The Canada-United States strategy for the virtual elimination of persistent toxic substances in the Great Lakes basin, known as the Great Lakes Binational Toxics Strategy (GLBTS), provides a framework for actions to reduce or eliminate persistent toxic substances, especially those which bioaccumulate. The strategy was jointly developed by Canada and the United States in 1996 and 1997, and it was signed by the two governments on April 7, 1997 .

The GLBTS establishes reduction challenges for an initial list of persistent toxic substances targeted for virtual elimination: aldrin/dieldrin, benzo(a)pyrene, chlordane, DDT, hexachlorobenzene, alkyl-lead, mercury and compounds, mirex, octachlorostyrene, PCBs, dioxinss and furans, and toxaphene. These substances have been associated with widespread, long-term, adverse effects on wildlife in the Great Lakes and through their bioaccumulation, pose threats to human health. The strategy marked the first time that specific reduction targets were set jointly by the two countries.

Recognizing that virtual elimination is a long-term process, the GLBTS provides the framework for actions to achieve reductions for specific toxic substances in the 1997 to 2006 timeframe. Flexibility is provided in the GLBTS to allow for revision of challenges, timeframes, and the list of targeted substances. The development of baseline measurements for tracking and measuring progress toward reductions is a key element. A "Technical Support Document" appended to the GLBTS provides action items that will be undertaken to pursue reductions (*www.epa.gov/glnpo/p2/bnsintro.html*).

Great Lakes Human Health Network

A Great Lakes-wide human health network is being formed to maximize resources and efficiencies of scale. The U.S. EPA's GLNPO will provide staff resources for a year (2002-2003) as a pilot program. 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.

The Great Lakes Fishery Commission

The Great Lakes Fishery Commission (GLFC) is a critical partner in achieving a balanced and healthy fish community in Lake Michigan, 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 Michigan. 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.

EPA Region 5 Shared Water Program Goals

The EPA Region 5 Office of Water is collaborating with state and tribal partners to protect and enhance water quality throughout the area. On December 11, 2001, IEPA, IDEM, the Minnesota Pollution Control Agency, WDNR, EPA Region 5, and the EPA Great Lakes National Program Office (GLNPO) all signed a Joint Commitment to Achieve Shared Water Goals. The shared water goals are as follows:

- Goal 1: All waters in Region 5 will support healthy aquatic biological communities.
- Goal 2: All waters in Region 5 will support fish populations with safe levels of contaminants.
- Goal 3: Designated swimming waters in Region 5 will be swimmable.
- Goal 4: All people in Region 5 served by public water supplies will have water that is consistently safe to drink.
- Goal 5: The quantity and quality of critical aquatic habitat in Region 5, including wetlands, will be maintained or improved.

A Great Lakes Tributary Riparian Buffer Protection Strategy

A team evaluating a Great Lakes Tributary Riparian Buffer Protection Strategy is assessing options for an integrated, interagency, tributary protection strategy and developing associated recommendations for the U.S. Policy Committee. The recommendations should include identification of indicators or performance measures that would be used as targets and subsequently monitored to assess the effectiveness of the strategy.

Systemic protection efforts for riparian areas would provide multiple ecological benefits for the Great Lakes basin ecosystem. Terrestrial habitat protection, travel and migration corridor preservation, stream bank stabilization, hydrologic flux moderation, reductions in pollutant loads and impacts, and streambed stabilization are all potential benefits of comprehensive riparian

An impaired stream before bank restoration and installation of stream buffers
Photography courtesy of the Brown County Land Conservation Department, Green Bay, Wisconsin

buffer restoration and protection efforts. The implementation challenge that must be overcome to realize these benefits is multiple agency and program coordination and integration. Many jurisdictions have incentive programs for landowners in the riparian zones. A major question is how jurisdictional differences can be effectively blended into a comprehensive effort by eliminating data gaps, duplication of effort, and conflicts. An equally important question is to what degree this integration can occur without compromising the initial legislative intent of the many program authorities.

The Farm Service Agency (FSA) administers the current program with technical assistance from the Natural Resources Conservation Service (NRCS). Under the program, agricultural lands are converted into protected buffer strips or filter strips as a means of reducing water runoff, reducing sedimentation, improving water quality, and providing food and habitat for wildlife. This program offers cash incentives for enrollment, annual payments during enrollment based on local land rental rates, maintenance payments, and bonus cost sharing for restoration practices. There is a national goal to enroll 2 million miles of protected riparian buffers.

The 2002 Wingspread Regional Accord

The Chicago Area Transportation Study , the Northwest Indiana Regional Planning Commission, the Northeast Illinois Planning Commission, and the Southeastern Wisconsin Regional Planning Commission signed the Wingspread Regional Accord in 2002. The Accord acknowledges that the southern Lake Michigan tri-state region is characterized by socio-economic and environmental interdependence, as evidenced through shared water resources and ecosystems, interconnected transportation systems, and connected employment and residential patterns.

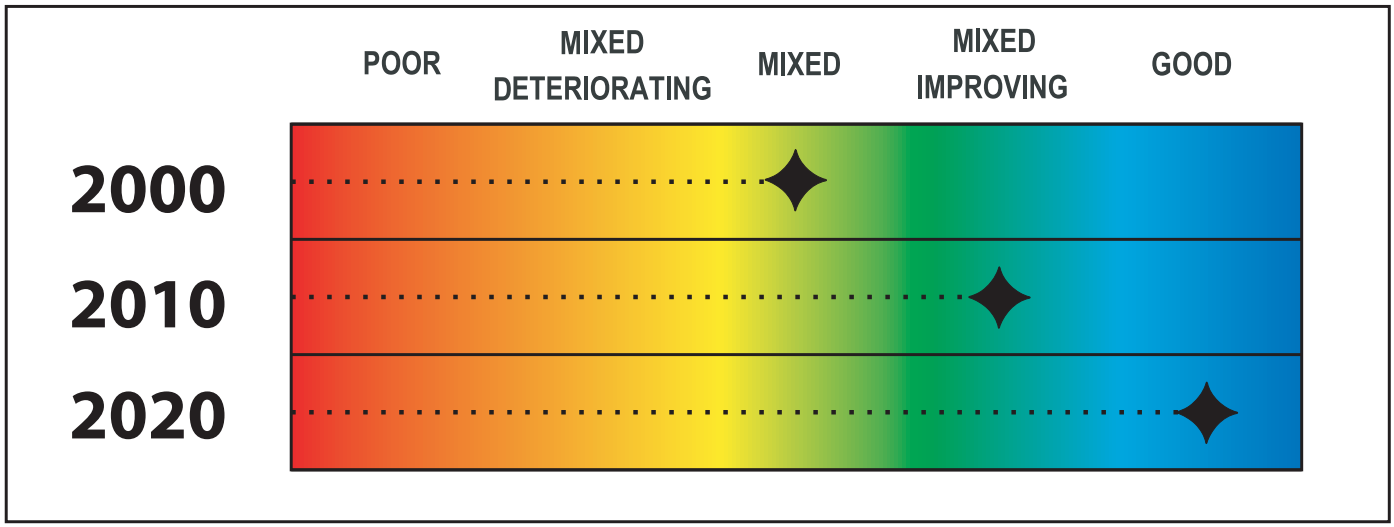
Next Steps

Over the next 2 years, the LaMP will support the following activities to increase collaborative activities:

- Convene a bi-state St Joseph Watershed conference on June 10 and 11, 2002
- Establish the Lake Michigan Watershed Academy
- Hold a 2003 State of Lake Michigan conference
- Take comments on proposed changes to Lake Michigan pollutant and stressor lists

Stream banks restored and stream buffers installed to prevent farm animals from impairing the stream
Photography courtesy of the Brown County Land Conservation Department, Green Bay, Wisconsin

Subgoal 11
Do we have enough information, data, understanding, and indicators to inform the decision-making process?



Status

Some information sources are available to support Lake Michigan decision-makers, but more data and indicators are needed to address complex management issues. Numerous monitoring programs and activities are currently underway in the Lake Michigan basin at the federal, state, county, municipal, and watershed levels. These programs monitor water quality, sediments, fish, air quality, and habitat. They involve collecting chemical, microbiological, fish and wildlife, physical characteristic, land use, and other environmental data. The Lake Michigan LaMP has also begun identifying indicators to guide these monitoring efforts. If the environmental indicators identified by the Lake Michigan LaMP are to support future management decisions, they must be adopted by monitoring programs basinwide and used to guide sampling and assessment parameters and media. Over the last 2 years, efforts have been undertaken to gather data on wetlands, beaches, stream buffers, and other items that will ensure that the goal status changes from mixed to mixed/improving by 2010 and to good by 2020. The following section describes these data collection efforts.

Great Black Backed Gull
Photography courtesy of the National Park Service, Indiana Dunes National Lakeshore*

Challenge

To expand Lake Michigan basin monitoring collaboration and coordination by promoting data comparability and joint planning and to deliver efficient and timely reporting on the status of the Lake Michigan ecosystem.

Environmental Indicators

The Lake Michigan LaMP promotes use of environmental indicators to track progress in achieving the LaMP goals. For a list of potential indicators, see Chapter 3 of LaMP 2000. The concept of environmental indicators is not new. State and federal agencies have used indicators to track trends in environmental health, particularly fish population trends and to help guide management decisions. Effective use of the LaMP indicators

Air Deposition Monitoring Recommendations

Recommended actions from the Delta Institute and the Lake Michigan Forum include:

- creation of an adequate monitoring network and comprehensive emission inventories; enhancement of regional modeling efforts;
- examination of the implications of urban air toxics initiatives;
- application of environmental management systems;
- extension of pollution prevention techniques to agricultural practices;
- consideration of a total maximum daily load (TMDL) calculation for Lake Michigan;
- targeted emission reductions from federal facilities; and
- integration of reduction targets into energy policies.

Recommended actions from the IAQAB include:

- completion of the Lake Michigan Mass Balance Study for pathways other than atmospheric deposition;
- extension of that Mass Balance to other contaminants;
- improvement of emission inventories, particularly for point and areal dioxins sources within 100 km of the Lake Michigan basin and for dominant areal, and largely unquantified sources of PCBs and other banned contaminants;
- development of a predictive, first estimate model for areal urban emissions of banned contaminants ;
- use of models to estimate emissions of residual banned pesticides from agricultural practices;
- and the continuation and extension of enhanced ambient measurement schemes to better estimate areal and regional loading and support model verification.

will link actual environmental responses directly to programs and activities.

The LaMP indicators are environmental, social, and economic measures used to assess the achievement of LaMP goals and objectives. These indicators will demonstrate improvements in and protection of the Lake Michigan ecosystem and will function as an early warning system to identify pressures on the ecosystem. The indicators will measure conditions such as ecosystem integrity, aquatic health, human health, and the quality of life.

State of the Lakes Ecosystem Conferences

Additional work has been completed on the indicators over the past 2 years through the State of the Lakes Ecosystem Conference (SOLEC) process. The SOLEC is hosted biennially by U.S. EPA GLNPO and Environment Canada. The last SOLEC was held in October 2000 in Hamilton, Ontario. The next conference will be held in Cleveland, Ohio, in October 2002. The conferences are intended to provide a forum for exchange of information on the ecological condition of the Great Lakes and surrounding lands. A major goal is to bring together a large audience of government (at all levels), corporate, and not-for-profit managers to discuss problems that affect the lakes. The conferences have led to information gathering by a wide variety of agencies and organizations. In the year following each conference, a State of the Great Lakes Report is prepared by the governments based on the conference itself and on extensive public comments following the conference.

Lake Michigan Monitoring Coordinating Council

The Lake Michigan Monitoring Coordinating Council was established to enhance coordination, communication, and data management among agencies and other organizations that conduct or benefit from monitoring efforts in the Lake Michigan basin in the interest of supporting the Lake Michigan LaMP.

The Council has 31 members representing federal, state, tribal, and local governments, nonprofit watershed groups, and other environmental organizations, educational entities, and the regulated community. The Council meets twice each year in locations throughout the watershed. Council meetings, biennial conferences, and feedback from constituents shape the Council's work plan and activities. The Council will develop goals, each with an active working group, whose broad membership will expand the core Council membership.

In 1999, four short-term working groups were created to develop information to move the Council forward: Data Inventory and Analysis; Monitoring Objectives; Watershed Pilots; and Outreach and

Great Lakes Wetlands Consortium

On November 29, 2000, EPA's GLNPO awarded a cooperative agreement to the Great Lakes Commission for the first large-scale, binational, collaborative effort to assess the ecological health of Great Lakes coastal wetlands. A consortium brought together by the Great Lakes Commission will (1) design and validate indicators to assess the ecological integrity of Great Lakes coastal wetlands; (2) design an implementable, long-term program to monitor Great Lakes coastal wetlands; and (3) create and put coastal wetland data in a binational database accessible to all scientists, decision-makers, and the public. GLNPO has contributed $400,000 to the effort, and the other consortium members are contributing over $200,000. The consortium currently includes Great Lakes wetland scientists and resource managers from the U.S. and CAnadian federal governments, states and provinces, nonprofit organizations, and academia. Similar funding levels are expected fir each of the next 2 years. The award is premised on the recognized need to assess the health of Great Lakes coastal wetlands, which are an integral part of the Great Lakes basin ecosystem. Coastal wetlands have critically important ecological values and functions, yet little basinwide data is available for assessing their ecological health. For this reason, a suite of 13 Great Lakes coastal wetland indicators was presented at SOLEC 1998. An assessment of five of these indicators was presented at SOLEC 2000 in Hamilton, Ontario. The consortium's work will expand the monitoring and reporting capabilities of the United States and Canada under the GLWQA. For additional information, contact Karen Rodriguez of GLNPO at 312-353-2690 or rodriguez.karen@epa.gov.

Map courtesy of the Great Lakes Commission


Wetlands within Illinois Beach State Park
Photograph by David Riecks, Illinois-Indiana Sea Grant*

Collaboration. The progress of those short-term working groups set the stage for the development of a new Council operating framework in 2001.

The new Council framework has been developed to increase coordination between appropriate monitoring entities, allow the development of a strategic plan for monitoring, and add value to the individual efforts of the Council's member organizations. The new Council framework takes advantage of the logical interactions between the various resource-based monitoring entities and other affected stakeholder groups.

The working groups formed under this new framework will build on the efforts to coordinate monitoring within individual resources by groups such as the Lakewide Management Plan Committees, the Wisconsin Groundwater Coordinating Council, and the Great Lakes Fisheries Commission. Each of these resource-based working groups will coordinate existing monitoring networks around several common considerations: monitoring objectives; spatial, temporal and parameter network design; methods comparability; quality assurance and control planning; database sharing; and data analysis approaches.

Lake Michigan Monitoring Assessment

The Great Lakes Commission, in partnership with EPA and the Lake Michigan Monitoring Coordinating Council, issued a report on Lake Michigan monitoring in October 2000. The report provides a comprehensive review of monitoring programs at the federal, state, and local levels for targeted watersheds; an analysis of gaps,

Lake Michigan Monitoring Assessment Recommendations

- Continue to update the monitoring inventory, and expand data collection to include all tributaries.
- Establish better lines of communication with state DNRs, USFWS, the U.S. Forestry Service, and the U.S. Department of Agriculture.
- Better integrate habitat and wildlife monitoring with traditional water quality monitoring.
- Improve information on the geographic locations of monitoring sites.
- Initiate planning for a coordinated sampling event for 10 years following the initial LMMB Study, and share data and modeling results with the public in a timely fashion through numerous outlets.
- Include academic research and data collection efforts in future updates to the monitoring inventory.
- Further examine the monitoring coverage of specific LaMP critical pollutants and emerging pollutants.
- Take better advantage of relatively untapped volunteer monitoring resources.
- Take better advantage of local agencies such as health departments, conservation districts, and planning agencies.
- Establish a better framework for bottom-up monitoring program linkages.
- Standardize data collection and reporting.
- Encourage federal, state, tribal, and local agencies to report monitoring coverage and results to a meta-database with universal access.
- Develop an on-line database of monitoring information that is geographically based and content-searchable.
- Develop and coordinate implementation of comparable methods to collect indicator data in a coordinated network.

Additional information is available at *http://www.glc.org/monitoring/lakemich*

Tributary Lakesheds represented in the Lake Michigan Monitoring Report
Map courtesy of the Great Lakes commission

inconsistencies, and unmet needs; an assessment of the adequacy of existing efforts to support critical ecosystem indicators; and recommendations for addressing major monitoring needs, particularly those considered most important for lakewide management decision-making. The study focused on monitoring in Grand Traverse Bay, White Lake, Muskegon Lake, the Grand River, the Kalamazoo River, the St. Joseph River, the Grand Calumet River, Waukegan Harbor, the Milwaukee River and Estuary, the Sheboygan River, the Fox-Wolf River Basin, Door County, the Menominee River, the Manistique River, and the open waters of Lake Michigan.

The report outlines a series of recommendations (see text box) for improving monitoring in Lake Michigan. These recommendations are having a broader impact as organizations and governments in the United States and Canada are beginning work on better coordinating the Great Lakes systemwide monitoring strategy.

BEACH Monitoring

EPA initiated the Beaches Environmental Assessment, Closure, and Health (BEACH) program to strengthen individual beach programs and water quality standards, better inform the public, and promote scientific research to further protect the health of people who use beaches. EPA is improving laboratory testing methods for detecting contaminants at beaches and is assisting local governments in monitoring beach water quality. The

Great Lakes Commission is pilot-testing a program for communicating the results of the National Beach Survey, assessing the consistency of beach closures with restriction advisories, and creating maps that connect with the national BEACH effort.

Integrated Atmospheric Deposition Network

U.S. EPA is a participant in the Integrated Atmospheric Deposition Network (IADN), established in July 1988, by the Atmospheric Deposition Monitoring Task Force of the International Joint Commission. The objective of IADN is to acquire sufficient, quality-assured data to estimate the loading to the Great Lakes Basin of selected toxic substances. The relative importance of the atmospheric pathway can then be ascertained and appropriate control strategies developed.

Coordination of Monitoring

The Great Lakes Water Quality Agreement requires that LaMPs "include a description of surveillance and monitoring to track the effectiveness of remedial measures and the eventual elimination of the contribution to impairments of beneficial uses..."

Monitoring collaboration and coordination need to be maximized in order to promote data comparability, enhance data utility, extend resources and deliver efficient and timely reporting on environmental change and progress as measured by Lakewide Management Plans (LaMPs) and State of the Lakes Ecosystem Conference (SOLEC) indicators.

Responsibility for monitoring in the Great Lakes is divided among a vast number of program and agencies throughout the basin. While these monitoring efforts meet individual program needs and mandate, the lack of consistency in protocols and methodology limits the usefulness of the resultant data for sharing, comparing and opportunities coordination might provide. The Binational executive Committee(BEC) sponsors two frameworks for developing indicators and reporting on the status of the Great Lakes ecosystem: LaMPs and The State of the Lakes Ecosystem Conference (SOLEC)..

BEC requested agencies to investigate the opportunities to enhance monitoring coordination and prepare a status report for the BEC Spring 2002 meeting and a set of options for the Fall 2002 meeting. A series of workshops are being conducted to develop a draft proposal.

Volunteer Monitoring

Volunteer monitoring is integral to the effort to assess the health of our nation's waters. Government agencies have limited funds for monitoring and have found that volunteer programs can provide high quality, reliable data to supplement their own monitoring programs.

The U. S. Environmental Protection Agency's Oceans and Coastal Protection Division, in partnership with The Ocean Conservancy and Lake Michigan LaMP , coordinated a free, two-day workshop March 19,20,2002 at the Illinois Beach Resort and Conference Center in Zion, Illinois.

The 54 attendees were:

- Leaders of local volunteer water quality monitoring programs
- Teachers conducting student water quality monitoring programs
- Local, state, regional, and federal agencies working with water quality issues

Workshop participants reviewed valuable techniques for establishing or improving monitoring operations, ensuring the quality of data collected, enhancing training efforts, and improving program management. In addition, the workshop promoted coordination and networking among volunteer monitors and government agencies operating in the Great Lakes basin.

The Marsh Monitoring Program (MMP) gave a presentation on their network of volunteer opportunities to help conserve Great Lakes amphibians and birds and their threatened wetland habitats through a binational, long-term monitoring program, Initated in 1994 by Bird Studies Canada and Environment Canada, the MMPhas been developed and expaned through the additional support of the US EPA Great Lakes National Program Office and Great Lakes Protection Fund as well as committed individuals and private

foundations. The MMP reports are respected and utilized by those attempting to track conditions in the Great Lakes. Additional Lake Michigan basin volunteers are needed- contact :www.bsc.eoc.org or call1-888-448-2473.

Air Deposition Monitoring

During the 1999-2001 priority work cycle, the International Air Quality Advisory Board (IAQAB) and the Great Lakes Science Advisory Board (SAB) held two workshops, in cooperation with the Delta Institute and the Lake Michigan Forum, focusing on the capability of atmospheric models to support the development of policies, including source control strategies, by confirming deposition trends and identifying significant sources of persistent contaminants.

At the workshops, presentations from leading researchers and modelers were followed by discussion of the policy implication of their work. Participants included representatives of municipal, state and provincial governments, the U.S. and Canadian governments, universities, consultants, industry and environmental group. A Task Force has been formed in response to the many recommendations.

Next Steps

- Monitoring research and development will be presented for the critical pollutant Watch List.
- A LMMB Study report will be prepared for each contaminant studied added to the LaMP 2000 online.
- Progress will be made in prioritizing indicators for the lake and monitoring them.
- The coordinated monitoring plan for the lake will be finalized.
- LMMB Study findings will be documented and model runs will be completed.

3.0 Conclusions and Recommendations

LaMP 2002 builds on LaMP 2000 and the Lake Michigan Mass Balance Study preliminary model runs to propose pollutant reduction targets. LaMP 2002 applies adaptive management approaches to the list of LaMP pollutants and stressors and proposes list changes based on the review that proposes adding certain stressors to the level of pollutants of concern. 1994 is established as the base line for measuring activity results and a monitoring dialogue will provide better coordinated efforts in data collection and dissemination.

LaMP 2002 provides an update on the activities that have been completed over the past two years to improve the Lake Michigan ecosystem. Overall, progress has been under all of the LaMP subgoals:

- More information regarding fish advisories is being disseminated to the public, while plans to control sources of contaminants in fish such as PCBs in sediments are moving forward.
- Drinking water quality in the lake remains good, although the potential for isolated contamination events still needs to be assessed and controlled through source water protection.
- Beach closures are a growing concern, but new resources available under the Federal Beach Bill and information and networking resources, such as those provided through the Great Lakes Beach Conference, are helping communities manage this problem.
- Lake Michigan habitat continues to be threatened by fragmentation, urban sprawl, wetlands loss, and changes in biological community structure. A number of new programs are collecting data and refining indicators .
- Open space preservation is increasing in importance. State coastal zone management programs will need to work to ensure that public access to the lake is balanced with protection of the ecosystem.
- Sustainable management of the Lake Michigan ecosystem faces new challenges with regard to declining lake levels, water diversions, and other concerns.
- The Lake Michigan Mass Balance Study revealed the importance of the air deposition pathway as a source of pollutant loading to the lake as sediment sites are remediated. PCB levels in Lake Michigan fish continue to decline, but additional controls on PCB sources will be needed to attain reduced fish consumption advisory levels targeted for 2020. Atrazine loadings through tributaries will also need to be reduced to simply maintain atrazine levels at current levels in the open waters of the lake.
- Aquatic nuisance species continue to enter the lake, although new agreements and pilot control programs including the ballast water reporting program in Michigan, may help pave the way to new management practices.
- New ecosystem stewardship activities are being undertaken throughout the basin, including establishment of a Lake Michigan Watershed Academy in 2002.
- Opportunities for collaborative decision making and information sharing are available through the Great Lakes Strategy, the Binational Executive Committee, the Great Lakes Binational Toxics Strategy, and others.
- More information is also becoming available to support collaborative data collection and reporting through the Lake Michigan Monitoring Coordinating Council, SOLEC, IADN, and the Great Lakes Wetland Consortium.

While much progress has been made, more work is needed to achieve the management recommendations outlined by the Lake Michigan Technical Coordinating Committee in LaMP 2000. These recommendations are reiterated below.

1. Ballast Water Control. The Great Lakes are not only impacted by aquatic nuisance species causing irreversible damage, but also serve as a pathway to other connected ecosystems. Standards or guidelines should be developed for ballast water treatment, working toward zero discharge.
2. Clean Up Legacy Sites. The Lake Michigan Mass Balance Study has confirmed that

contaminated sediment sites in the lake remain an ongoing source of contamination into the food web, causing fish consumption advisories and delaying dredging of navigable waterways, thereby affecting the local economies. In order to move swiftly to clean up contaminated legacy sites, both on land and in the water, we will convene federal and state Superfund, RCRA Corrective Action, Drinking Water, and Surface Water programs for planning discussions focused on the Lake Michigan ecosystem. The goal is to complete most of the plans by 2005 and cleanup actions by 2010. A few of the major sediment sites may require additional time.

3. Protect Source Water. As the drinking water source for 10 million people, it is important to determine if the current level of protection is sufficient. This can be done utilizing the state source water assessments that delineate source water areas and assess significant potential contaminant sources. Consideration should also be given to the issue of exporting the water.

4. Protect Habitat. Determine a priority for preservation sites within the recently mapped bio-rich clusters as well as the sites identified in the North American Waterfowl Management Plan, including connected corridors between clusters. Wetland areas, particularly those connecting to the lake that are important to many species, and restoration of coastal brownfields to greenfields, should be highlighted. Natural areas not only provide habitat, but also serve to filter sediments and runoff, as well as store flood waters and recharge ground water. This information should be provided online.

5. Collaborate on Fish Projects. Develop joint projects with the Great Lakes Fishery Commission that implement both the LaMP and the Joint Strategic Plan for Management of Great Lakes Fisheries. Collaborate on the development of fish spawning maps to aid protection activities and provide adjacent land use planners with protection tools and data.

6. Match Decision Makers with Issues. The appropriate level of government and other nontraditional groupings should be convened and engaged to accomplish LaMP goals. The following should be promoted within these groups: 1) national dialogue for control of aquatic nuisance species and atmospheric deposition of toxics; 2) academic and agency dialogue to promote data sharing, to define research needs, and to develop lake-related courses; and 3) local dialogue to provide protection tools and a lakewide perspective to land use planners.

7. Control Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs). The mixed discharge of storm water and domestic waste causes beach closings and is also a pathway for pathogens to enter the lake. Tools, training, and data should be provided to local governments to promote full compliance with CSO, SSO, and storm water regulations, and sewer system maintenance with awareness of land use planning on a watershed basis.

8. Develop an Agriculture Pollution Prevention Strategy. The strategy should include and coordinate among states, Natural Resource Conservation Service (NRCS), and the Lake Michigan Forum's Agriculture Task Force, promoting nonpoint source pollution prevention. Such activities may include using planted stream buffer strips, and pollution prevention strategies for pesticides, confined animal feed operations, and nutrient controls. Food web disruptions in Lake Michigan relate to sedimentation and continuing nutrient pollution.

9. Implement Area of Concern (AOC) Remedial Action Plans (RAPs). AOC RAPs are in various stages of completion. Many RAP and watershed groups, as well as local communities, have included the watershed in their planning and have developed a list of priorities (found in Addendum 6-B of the LaMP). These groups need support that includes tools, technical assistance and training, and some level of funding to leverage scarce resources.

10. Fill Data Gaps. Promote research with the following goals: 1) define in-basin and out-of-basin air pollution; 2) develop technology to control aquatic nuisance species in ballast water; 3) understand pesticides, pathways, and longevity in open water; 4) reuse contaminated sediments; 5) understand endocrine disrupters and their effects, sources, and possible controls; 6) identify fish spawning site locations; and 7) review and refine the Lake Michigan pollutants list.
11. Clean Sweep Strategy. Years after some pesticides were canceled and restricted (such as DDT/DDE, dieldrin, chlordane) they are still recovered in clean sweep operations, indicating the effectiveness of the tool. However, there is no specific funding source for these activities. Therefore, there is a need to develop a strategy to ensure long-term consistent funding or ownership of annual pesticide, household hazardous waste, and small business PCB/mercury Clean Sweep programs for each state.
12. Measure and Report. Continue development of the Lake Michigan Monitoring Coordinating Council and jointly develop a Monitoring Plan for Lake Michigan that includes expanding the United States Geological Service (USGS) National Water Quality Assessment Program (NAQWA) monitoring to Lake Michigan's eastern shore and drainage. Develop a strategy for duplicating the coordinated monitoring (simultaneous air, water, land, open water, and tributary mouths) of the Lake Michigan Mass Balance Project (LMMB, 1994) in 2004 to have data for a 10-year analysis. Establish a beach community monitoring network and a volunteer basin monitoring network.
13. Provide on-Line Information, Public Involvement Activities. Promote sharing of public information and public involvement by providing the following: 1) on-line data site that includes public health information; 2) an on-line habitat atlas of the basin showing ecologically-rich areas; and 3) a running summary of comments and responses. Continue the Forum's public meetings, workshops, and boat tour in partnership with organizations such as Grand Valley State University, which also sponsors the State of Lake Michigan Conference.
14. TMDL Strategy. Total Maximum Daily Loads (TMDLs) must be developed when waters do not meet state-adopted water quality standards, even after the implementation of technology-based controls. TMDLs are calculated to return waters to their designated uses. States develop TMDLs for their tributaries, but a strategy for cooperative TMDL work for Lake Michigan that includes a public involvement process is needed.
15. Stewardship Actions. The majority of the land that drains into the lake is privately owned and managed. America's cities and towns account for 80 percent of energy use. Of that 80 percent, land use planning and urban design affect about 70 percent, or 56 percent of the nation's total energy use. Energy production and transportation are major sources of air pollution. The message from these statistics is that every basin resident is a "Lake Michigan Manager." We need to strengthen partnerships with other education and outreach efforts to promote the activities necessary to accomplish the following: 1) promote recycling efforts, energy and water conservation, and trash barrel burning awareness; 2) place special emphasis on preventing the spread of aquatic nuisance species by boat owners for the next two years; 3) communicate the importance of private efforts in habitat preservation on both public and privately owned land; and 4) develop an Areas of Stewardship program for local communities and watersheds.

Glossary

Aquatic Nuisance Species (ANS)
Water-borne plants or animals that pose a threat to humans, agriculture, fisheries, and/or wildlife resources.

Area of Concern (AOC)
Areas of the Great Lakes identified by the International Joint Commission as having serious water pollution problems requiring remedial action and the development of a Remedial Action Plan. AOCs are defined in the Great Lakes Water Quality Agreement as: "a geographic area that fails to meet the general or specific objectives of the Great Lakes Water Quality Agreement, or where such failure has caused or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life." Initially, there were 43 AOCs in the Great Lakes Basin.

Area of Stewardship
An Area of Stewardship watershed focus is an area, most often a watershed, for which a level of ecosystem integrity has been established as a goal and where an integrated, multi-organizational initiative or partnership is actively working to achieve that goal. The Lake Michigan Watershed Academy is being established to promote the concept of stewardship. Examples of such areas include the Chicago Wilderness, the Kalamazoo Multi-Jurisdictional Watershed Agreement, and the work in Grand Traverse Bay, Michigan and Door County, Wisconsin.

Basin
The land area that drains into a lake or river. This area is defined and bounded by topographic high points around the waterbody.

Beneficial Use
The role that the government decides a waterbody will fulfill. Examples of these uses include healthy fish and wildlife populations, fish consumption, aesthetic value, safe drinking water sources, and healthy phytoplankton and zooplankton communities. Restoring beneficial uses is the primary goal of the Remedial Action Plans for the Areas of Concern and of the Great Lakes Water Quality Agreement.

Beneficial Use Impairment
A negative change in the health of a waterbody making it unusable for a beneficial use that has been assigned to it. Examples of the 14 use impairments designated in the Great Lakes Water Quality Agreement include: restrictions on fish and wildlife consumption, beach closings, degradation to aesthetics, loss of fish and wildlife habitat, and restrictions on drinking water consumption. Local use impairments occur in Areas of Concern or other areas affecting the lake. Regional use impairments occur in an Area of Concern cluster or multi-jurisdictional watershed. Open water or lakewide impairment is a condition of pervasive impairment.

Binational Executive Committee (BEC)
The Binational Executive Committee (BEC) is a high-level forum composed of senior-level representatives of the USPC and Canadian counterpart agencies who are accountable for delivering major programs and activities to fulfill the terms of the GLWQA. The BEC derives its mandate from the provisions of the GLWQA which relate broadly to notification, consultation, coordination, and joint activity. In particular, Article X specifies the commitments of the Parties to consultation and review: "The Parties (U.S. and Canada), in cooperation with State and Provincial Governments, shall meet twice a year to coordinate their respective work plans with regard to the implementation of this Agreement and to evaluate progress made."

Biological Integrity
The ability of an ecosystem to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to the best natural habitats within a region.

Boundary Waters Treaty
The international treaty between the United States and Great Britain signed on January 11, 1909, regarding the waters joining the United States and Canada and relating to questions arising between the two nations. It gave rise to the International Joint Commission.

Designated Uses
The role that a waterbody is slated to fulfill, such as a drinking water source. Uses are specified in water quality standards for each waterbody or segment, whether or not the current water quality is high enough to allow the designated use. Other typical uses of a waterbody include propagation of fish and wildlife, recreation, agriculture, industry, and navigation.

Ecosystem
A biological community and its environment working together as a functional system, including transferring and circulating energy and matter. It is an interconnected community of living things including humans, and the physical environment with which they interact.

Ecosystem Indicator
An organism or community of organisms that is used to assess the health of an ecosystem as a whole. When tracked over time, an ecosystem indicator provides information on trends in important characteristics of the system. Also known as an environmental indicator.

Ecosystem Integrity
A measure of the capacity of ecosystems to renew themselves and continually supply resources and essential services. Ecosystem integrity is the degree to which all ecosystem elements-species, habitats, and natural processes-are intact and functioning in ways that ensure sustainability and long-term adaptation to changing environmental conditions and human uses.

Ecosystem Management
The process of sustaining ecosystem integrity through partnerships and interdisciplinary teamwork. Ecosystem-based management focuses on three interacting dimensions: the economy, the social community, and the environment. Ecosystem-based management seeks to sustain ecological health while meeting economic needs and human uses.

Emerging Pollutant
The Lake Michigan Lakewide Management Plan addresses emerging pollutants, which include those toxic substances that, while not presently known to contribute to use impairments or to show increasing loadings or concentrations, have characteristics that indicate a potential to impact the physical or biological integrity of Lake Michigan. These characteristics include presence in the watershed, ability to bioaccumulate, persistence (greater than 8 weeks), and toxicity. Emerging pollutants include atrazine, selenium, and PCB substitute compounds.

End Point Subgoal
End point subgoals describe the desired levels of ecosystem integrity and ecological services required to restore beneficial uses and provide for healthy human natural communities in the basin.

Fish Consumption Advisory (FCA)
An advisory issued by a government agency recommending that the public limit their consumption of fish. Advisories are issued to limit

exposure to toxic substances in the fish that have the potential to impact human health. A fish consumption advisory is prepared annually by each state. Fish caught from selected lakes and streams are tested for toxic substances.

Great Lakes Water Quality Agreement (GLWQA)
An international agreement signed by the United States and Canada in 1972 and updated in 1978 and 1987. The Agreement seeks to restore and maintain full beneficial uses of the Great Lakes system. Language committing the two nations to virtually eliminate the input of persistent toxic substances in order to protect human health and living aquatic resources was included when the Agreement was updated in 1978. The philosophy adopted by the two governments is zero discharge of such substances.

Habitat
That space that is or can be successfully occupied (inhabited) by a species or biotic community or some broader (taxonomic or phylogenetic) entity. Habitat is simply the place where an organism or group of closely related organisms live.

Lake Michigan
Lake Michigan is the only one of the five Great Lakes wholly within the U.S. border. It is bounded by the states of Michigan, Indiana, Illinois, and Wisconsin. It is connected with and flows into Lake Huron through the Straits of Mackinac.

Lake Michigan Basin
Used to describe Lake Michigan and the surrounding watersheds emptying into the lake.

Lake Michigan Lakewide Management Plan (LaMP)
This document is both a reference document and a proposal for a process that will guide remediation of past errors and the achievement of sustainable integrity of the basin ecosystem. It contains clear, comprehensive goals, specific objectives, a strategic plan, and a system of indicators and monitoring for use in judging environmental status and effectiveness of current actions.

Lake Michigan Management Committee (LMMC)
The LMMC guides the overall development and implementation of the Lake Michigan LaMP. The current membership includes: EPA (Lake Michigan Team, Great Lakes National Program Office, and Office of Research and Development), U.S. Fish and Wildlife Service, Army Corps of Engineers, U.S. Geological Survey, U.S. Department of Agriculture (Natural Resources Conservation Service), Illinois Environmental Protection Agency, Indiana Department of Environmental Management, Michigan Department of Environmental Quality, Wisconsin Department of Natural Resources, Great Lakes Fishery Commission, Chippewa/Ottawa Treaty of Fishery Management Authority, and the Grand Traverse Band of Ottawa and Chippewa Indians, Michigan.

Lake Michigan Mass Balance Study (LMMB)
This mass balance research project begun in 1994 is part of the Lake Michigan Lakewide Management Plan and is designed to develop a sound, scientific base of information that will guide future toxic pollutant load reduction and prevention activities.

Lake Michigan Monitoring Coordinating Council (LMMCC)
The Council provides a forum for identifying gaps and establishing monitoring priorities, exchanging information, and forming partnerships. It responds to the need for enhanced coordination, communication, and data management among the many agencies and organizations that conduct or benefit from environmental monitoring efforts in the basin.

LaMP Technical Coordinating Committee (TCC)
The TCC develops documents and programs, and recommends strategies, goals, and objectives. The current membership includes the same agencies/entities as the Management Committee, plus the Oneida Tribe of Wisconsin. There is a steering committee and six subcommittees under the TCC.

Methyl Mercury
Any of several extremely toxic compounds formed from metallic mercury by the action of microorganisms and capable of entering the food chain. Methyl mercury is an organic form of mercury created when inorganic mercury is released into the environment where it volatilizes back to the atmosphere as a gas or as adherents to particulaltes. Methylmercury biomagnifies up the food chain as it is passed from a over food chain level to a higher food chain level through consumption of prey organisms or predators.

Pressure-State-Response Approach
The pressure-state-response approach involves linking environmental indicators to stressors that impact the environment and to program activities. The use of this approach should promote consistency in the development and application of environmental indicators. It is an organizing framework used by U.S. EPA Region 5 in its "Guide for Developing Environmental Goals, Milestones and Indicators," found in LaMP Appendix H.

Remedial Action Plan (RAP)
These are federally-mandated local plans designed to restore environmental quality to Areas of Concern on the Great Lakes (there are 10 in Lake Michigan and there were initially 43 throughout the Great Lakes). The Areas of Concern were identified for their persistent pollution problems. Remedial Action Plans were called for by a protocol added to the Great Lakes Water Quality Agreement in 1987.

Stressor
Any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems and be a cause of beneficial use impairments. Examples of stressors include: pathogens; fragmentation and destruction of terrestrial and aquatic habitats; exotic nuisance species; and uncontrolled runoff and erosion.

Sustainable Development
Sustainable development is the process of economic development to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Total Maximum Daily Load (TMDL)
TMDLs are set by regulators to allocate the maximum amount of a pollutant that may be introduced into a waterbody and still assure attainment and maintenance of water quality standards.

U.S. Policy Committee
The U.S. Policy Committee is a forum of senior-level representatives from the Federal, State, and Tribal governmental agencies that share responsibility for environmental protection and natural resources management of the Great Lakes – to advance the restoration and protection of the Great Lakes Basin Ecosystem. U.S. Policy Committee Partners include the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Coast Guard, U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, U. S. Geological Survey, Agency for Toxic Substances and Disease Registry, U.S. Forest Service, Great Lakes Fishery Commission, Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, Great Lakes Tribal Governments.

Appendix A

LaMP Pollutants: Process for Biennial Updates of Lake Michigan LaMP Pollutant List

This appendix discussion outlines a proposed process for updating the Lake Michigan LaMP pollutant list. The discussion is organized in three sections: (1) Background on LaMP pollutants, (2) LaMP pollutants proposed for 2002, and (3) adaptive management approach for LaMP pollutants. Comments are requested. A more detailed discussion is being added to LaMP 2000 at www.epa.gov/glnpo/lamps.

1. Background

Under Annex 2 of the Great Lakes Water Quality Agreement (GLWQA), "critical pollutants" are to be addressed through the LaMP process. In 1992 and 1993, a list of Lake Michigan pollutants was developed by the Federal and State Lake Michigan LaMP agencies. The pollutants were categorized into three groups: critical pollutants, pollutants of concern, and emerging pollutants. This list was adopted and incorporated in Lake Michigan LaMP 2000. LaMP partners have adopted an adaptive management approach to the LaMP list of pollutants. Ongoing reviews ensure efforts are focused on pollutants still causing beneficial use impairments.

This appendix outlines a proposed procedure to implement adaptive management by evaluating the previously listed LaMP pollutants and unlisted, candidate pollutants. The new procedure is consistent with the previous categorization of pollutants into three groups, but renames the emerging pollutants as a pollutant "watch list." Comments are requested on the new procedure described in this appendix. Listed in descending order with regard to the potential level of impairment or importance to the lake, the three categories of LaMP pollutants are:

(1) Critical Pollutants, to be addressed through LaMP reduction targets;

(2) Pollutants of Concern, to be addressed by local actions facilitated by the LaMP, and

(3) A Pollutant Watch List to be addressed by monitoring and research encouraged by the LaMP.

This proposal also compares the 1993 LaMP pollutant list (adopted in LaMP 2000) with the new pollutant identification criteria and makes recommendations for the LaMP 2002 list of pollutants based upon preliminary information gathered from the States. Additional information will need to be collected and assessed to fully implement the pollutant identification criteria, such as a review of open water data to assess compliance with Great Lakes Water Quality Initiative criteria. Additional pollutants, beyond those identified in 1993, are also considered for inclusion in LaMP 2002 based upon the proposed pollutant identification criteria.

Early in 2001, state and tribal partners expressed concern that a new LaMP pollutant identification process would be inconsistent with existing regulatory programs or not benefit from information gathered through existing programs. In response to these concerns, the pollutant review process builds on the existing requirements found at Sections 303(d) and 305(b) of the Clean Water Act (CWA). Section 303(d) requires each State to prepare lists of waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters. Section 305(b) requires each State to report, to U.S. EPA, the water quality of all navigable waters biennially. Because the implementing CWA regulations were in flux during 2000, EPA waived the requirement for States to submit their lists that year; the lists are next due by October 1, 2002.

Other partners expressed concern about the potential inconsistencies between State water quality criteria and standards. Nationally, water quality monitoring and data analysis are the foundation of water resource management decisions. Beginning with stakeholder meetings in 2000, EPA and its partners have been working together to develop a consolidated 305(b)/303(d) assessment approach that addresses water quality monitoring strategies, data quality and quantity needs, and data interpretation

methodologies. In November 2001, EPA published the 2002 Integrated Water Quality Monitoring and Assessment Report, which will result in a more comprehensive and consistent description of states' waters, including impaired waters. The Consolidated Assessment and Listing Methodology (CALM) aims to help states improve the accuracy and completeness of 303(d) lists and 305(b) reports as well as streamline these two reporting requirements. In addition, the Great Lakes Environmental Indicators (GLEI) Project is a four-year cooperative agreement, among scientists from a consortium of Great Lakes universities and institutions, with two goals. The first goal is to develop environmental indicators of the condition of Great Lakes coastal and near shore zones. The second goal is to link indicators with specific stressors so managers can relate causes of impairment for future monitoring. The GLEI effort is relevant to the identification of impaired waters in tributary mouths and nearshore lake waters. Once indicators are developed, trends in these waters can be tracked.

It is expected that the comparability of the 303(d)/305(b) reports relevant to Lake Michigan will improve over time. As state lists of impaired waters change, the LaMP pollutant identification process will reflect those changes.

The timing of the LaMP pollutant review and identification process is outlined in Table A-1.

2. LaMP Pollutants Proposed for 2002

The criteria for identifying pollutants within each of the three categories identified by the LaMP are outlined below. For critical pollutants and pollutants of concern, these criteria are consistent with the approach taken in 1993 and 2000, but are more clearly stated.

In a limited effort to update the data evaluated to categorize chemicals as critical pollutants, background information was gathered to support the analysis of the proposed 2002 pollutant identification criteria, including the rationale for the 1993 LaMP pollutant list. In addition, the States submitted information to document the basis for listing the open and near-shore waters of Lake Michigan on CWA Section 303(d) lists prepared by Lake Michigan States. Figure A-1 summarizes the information that allows for an analysis of the proposed 2002 pollutant identification criteria. Specifically, the figure identifies those pollutants that have been identified as impairing the open or near-shore waters of Lake Michigan on CWA Section 303(d) lists. In addition, fish consumption advisories in the open waters of the lake, which are not otherwise addressed as part of CWA Section 303(d) listings, are indicated as an "action level exceedance." Pollutants that are identified as sources of impairment in an Area of Concern are identified as an action level exceedance in near-shore waters. Comments are requested on whether releases to tributary mouths and nearshore waters addressed by Superfund remedial and RCRA corrective action programs should also be considered action level exceedances.

Based on this review, the pollutants in each category may be compared from the LaMP 2000 to the proposed categories in this 2002 update (see Table A-2). This will be revised biannually.

Lake Michigan LaMP Critical Pollutants

Under this proposal, any one of these four criteria may be relied upon to define the Lake Michigan LaMP critical pollutants:

- Pollutants identified on Illinois, Indiana, Michigan, or Wisconsin Clean Water Act Section 303(d) lists or in Section 305(b) reports as sources of impairment to the open waters of the lake;
- Pollutants that have been found to exceed Great Lakes Water Quality Initiative (GLI) water quality criteria in the open waters of the lake;
- Pollutants that exceed or trigger a relevant Action Level, such as a fish consumption advisory (FCA) or maximum contaminant level (MCL), in the open waters of the lake; or
- Pollutants associated with other lakewide designated use impairments (e.g., impairment to aquatic life).

Comments are solicited on the proposed use of any one of these four criteria to define critical pollutants for the Lake Michigan LaMP.

Table A-1 Timing of LaMP Pollutant Review Process

Partners\ Input	Spring 2002	Summer 2002	Fall 2002	Winter 2002/2003	Spring 2003	Summer 2003	Fall 2003	Winter 2003/2004	Spring 2004
Federal, State, and Tribal LaMP staff serving on the LaMP Toxic Reduction Sub-committee (TRS)	LaMP 2002 critical pollutants, pollutants of concern, watch list, and review process proposed; comments requested	LaMP Toxic Reduction Subcommittee (TRS) receiving and reading comments	TRS receiving and reading comments	TRS receiving and reading 2002 303(d) lists and 305(b) reports and other comments	TRS receiving and reading comments	TRS collects & reviews additional data submitted since 2002 303(d) lists and 305(b) report	TRS meets to review pollutant data submitted and to evaluate comments on LaMP pollutant process	TRS Proposal to Man. Committee	LaMP 2004
Great Lakes National Program Office	Lake Michigan Mass Balance (LMMB) data reports; sample Lake Michigan	data from 2000 fish; sample Lake Michigan	2002 fish collected		data from 2002 fish; sample Lake Michigan	sample Lake Michigan	2003 fish collected		
States Programs	305(b) reports due, unless consol. with 303(d) lists		2002 305(b) reports due 303(d) lists due biannually						
Tribes	Individually solicited for data				Deadline for data for 2004 LaMP				
Scientists			SOLEC papers		IAGLR papers				
Forum, Private Sector and the Public	LaMP 2002 proposals				June 30 deadline for LaMP pollutant proposals & data for 2004 LaMP		State of Lake Michigan Conference; Preliminary Results of TRS review		

Because dieldrin has been dropped from state fish consumption advisories for the open waters of Lake Michigan, the LaMP 2002 proposal removes dieldrin from the critical pollutant list. The TRS therefore proposes that dieldrin be categorized as a pollutant of concern rather than a critical pollutant and requests comment on this proposal.

Pollutants of Concern

Any one of the following three criteria are proposed to define the Lake Michigan LaMP pollutants of concern:

- Pollutants on State 303(d) lists identified as causing impairments in near-shore waters and Lake Michigan tributary mouths;
- Pollutants exceeding an Agency action level in near shore waters or tributary mouths, including pollutants identified as a source of impairment in a Great Lakes Area of Concern; or
- Pollutants associated with regional use impairments (e.g., impairment of local fish communities or populations).

Comments are solicited on the proposed use of any one of these three criteria to define pollutants of concern for the Lake Michigan LaMP.

Many of the LaMP 2002 Pollutants of Concern do not appear on State 303(d) lists for near-shore waters, although some of those pollutants are still identified as sources of impairment in the Areas of Concern. Two additional categories of pollutants and the addition of three specific chemicals as Pollutants of Concern are proposed on the LaMP 2002 list because these substances are included on State 303(d) lists as causes of impairment for near-shore waters: pathogens, nutrients, endrin, heptachlor expoxide, and BHC (lindane). Nutrients and pathogens are proposed as pollutants of concern in LaMP 2002 because they are causes of impairment for nearshore and tributary waters to the lake. For example, see the basis for the 303(d) listing of the Manistique River and Little Black Creek in Michigan and Lower Green Bay in Wisconsin. Furthermore, the Great Lakes Water Quality Agreement recognizes the need to address pollutants other than toxic substances as demonstrated by Annex 3 and Annex 13. Comments are solicited on this proposal to include these substances as pollutants of concern for the Lake Michigan LaMP.

Pollutant Watch List

All three of the following three criteria are proposed to define the Lake Michigan LaMP watch list:

- potential to impact the Lake Michigan ecosystem;
- presence in the Lake Michigan Watershed; and
- bioaccumulation potential, persistence in water or sediment, or toxicity singly or through synergistic effects.

Comments are solicited on the proposed use of all three criteria to define the pollutant watch list for the Lake Michigan LaMP.

Participants in the LaMP process expressed some concerns about whether these criteria are specific enough to include endocrine disrupting and other toxic effects. In identifying pollutants on the Watch List, this proposal adapts the CWA definition of "toxic pollutant". "The term 'toxic pollutant' means those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, or inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the [U.S. EPA] Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring" (United States Code, Title 33, Section 1362(13)). While citing the CWA definition, the evaluation of watch list pollutants will also consider other definitions of toxicity, including but not limited to definitions found in the Food Quality Protection Act (1996), the Federal Insecticide, Fungicide, and Rodenticide Act (1947), the Safe Drinking Water Act (1974), and the Toxic Substances Control Act (1976), any amendments to these statutes, and their implementing programs. Similarly, a variety of definitions for the terms bioaccumulative and persistent likely exist. For example, the U.S. Environmental Protection Agency (EPA) issued its final policy statement on November 4, 1999 (64 FR 60194) for new persistent,

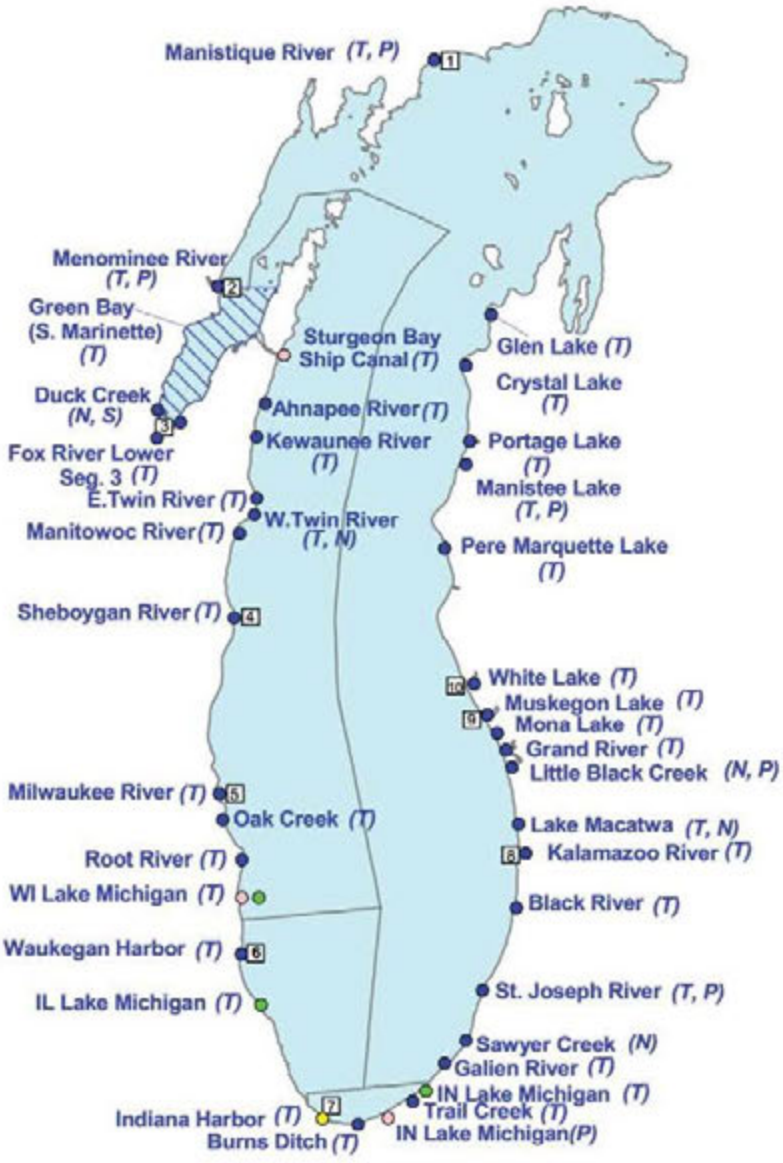
Table A-2 Comparison of LaMP 2000 Pollutants to Pollutants Identified through Proposed Process

	2000	2002
Critical Pollutants	PCBs, Dieldrin, chlordane, DDT/DDE, mercury, dioxin	PCBs, chlordane, DDT/DDE, mercury, dioxin
Pollutants of Concern	PAHs, Hexachlorobenzene, lead, cadmium, chromium, copper, zinc, arsenic, cyanide	PAHs, lead, cadmium, chromium, copper, zinc, arsenic, cyanide, endrin, heptachlor epoxide, lindane, nickel, nutrients, pathogens
2000 Emerging Pollutants 2002 Watch List	atrazine, selenium, PCB substitute compounds	atrazine, selenium, PCB substitute compounds

Lake Michigan Impairments Summary

Tributary mouths, near shore waters, open waters with AOCs

CWA - 303(d) Water Bodies	Pollutant Basis for Impairment
Wisconsin	
Ahnapee River	PCBs
Duck Creek	Nutrients, Sediments
East Twin River	PCBs
Fox River Lower Seg. 3	PCBs
Green Bay - South of Marinette and its tributaries including the Menominee, Oconton, Fox & Peshtigo River	PCBs
Kewaunee River	PCBs
Lake Michigan	PCBs
Lower Green Bay AOC	Nutrients
Manitowoc River	PCBs
Menominee River AOC	Arsenic, PCBs
Milwaukee River Estuary AOC (out Harbor to Lake Michigan)	PCBs
Oak Creek	Metals (Cr, CU, Pb, Zn)
Root River	PCBs
Sheboygan River	PCBs
Sturgeon Bay, Ship Canal	Metals
West Twin River	PCBs, Nutrients
Illinois	
Lake Michigan	PCBs, Chlordane, Hg
Waukegan Harbor	PCBs
Indiana	
Indiana Harbor	PCBs, Hg, Chlordane, Dieldrine, DDT/DDE/DDD, Endrin, Heptachlor Epoxide, BHC (Lindane), PAH, As, Cd, Pb, Ni, Zn
Lake Michigan	PCBs, Hg, Pathogens
Burns Ditch	Hg, Pb
Trail Creek	PCBs, Hg
Michigan	
Black River	PCBs
Crystal Lake	PCBs, Chlordane
Galien River	PCBs
Glend Lake	PCBs, Chlordane, Mercury
Grand River	PCBs, Mercury
Kalamazoo River	PCBs
Lake Macatwa	PCBs, Chlordane, Nutrients
Little Black Creek	Nutrients, Pathogens
Manistee Lake	PCBs, Mercury, Pathogens
Manistique River	PCBs, Pathogens
Menominee River	Pathogens
Mona Lake	PCBs, Mercury
Muskegon Lake	PCBs, Mercury
Pere Marquette Lake	PCBs, Mercury
Portage Lake	PCBs, Mercury
Sawyer Creek	Nutrients
St. Joseph River	PCBs, Pathogens
White Lake	PCBs, Chlordane, Mercury



Areas of Concern:

1. Manistique River
2. Menominee River
3. Fox River
4. Sheboygan River
5. Milwaukee Estuary
6. Waukegan Harbor
7. Grand Calumet River
8. Kalamazoo River
9. Muskegon Lake
10. White Lake

Legend:

- Green Bay
- Lake Michigan
- States Boundaries

(N = Nutrients, T = Toxics, S = Sediments, P = Pathogens)

Locations:

- Harbor
- Nearshore
- Open Waters
- Tributary Mouths

25 0 25 Miles

Map created by: Martha Aviles-Quintero, ORISE Research, US EPA Region 5, 02/13/02

Supporting Information for Placing a Chemical on the Watch List

Information supporting the placement of a chemical on the watch list will be drawn from a number of sources by necessity. For example, Manchester-Neesvig and Sonzogni presented data for polybrominated diphenyl ethers (PBDEs) in Lake Michigan coho and chinook salmon at the 44th Conference of the International Association for Great Lakes Research in June 2001. As another example, the U.S. Geological Survey (USGS) Toxic Substances Hydrology (Toxics) Program provides scientific information on the behavior of toxic substances in the Nation's hydrologic environments. The USGS Toxics Program conducts: (1) intensive field investigations of representative cases of subsurface contamination at local releases; and (2) watershed- and regional-scale investigations of contamination affecting aquatic ecosystems from nonpoint and distributed point sources. In 1999-2000, the USGS Toxics Program monitored several Lake Michigan tributaries for these categories of pollutants: veterinary and human antibiotics, human drugs, industrial and household wastewater products, sex and steroidal hormones and published results in 2002 (Kolpin et al., "Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999 - 2000: A National Reconnaissance"in Environmental Science and Technology, volume 36, 1202-1211). In addition, the U.S. EPA Great Lakes National Program Office (GLNPO) is funding a fish monitoring program conducted by the University of Minnesota to identify emerging pollutants in Great Lakes fish tissue. The GLNPO fish monitoring will likely include polybrominated diphenyl ethers (PBDEs), polychlorinated naphthalenes (PCNs), polybrominated biphenyl (PBB) 153, perfluorooctane sulfonate (PFOS), tetrabromobisphenol A, short-chain chlorinated paraffins, alkylphenol ethoxylates (APES), and chorothalon.

Finally, Federal and State regulatory programs may periodically reassess regulated substances, and the TRS may consider information from those reassessments for Watch List pollutants or forward concerns about Watch List pollutants for consideration during reassessment. For example, an update on the Federal Insecticide, Fungicide and Rodenticide Act's Tolerance Reassessment and Reregistration for Atrazine and CWA proposal for an Atrazine water quality standard is provided elsewhere in this document.

bioaccumulative, and toxic (PBT) chemicals. Comments have been received recommending that endocrine disrupting chemicals be included on the watch list as a category of chemicals. EPA has been interpreting endocrine disruption as fitting within the toxicity definitions listed above and intends to focus on this category when updating the watch list. Comments are solicited concerning alternative or supplemental definitions of toxicity.

The renaming of the Emerging Pollutants category to the pollutant Watch List better represents the LaMP's assessment of the pollutants' potential threat to human health and the environment in Lake Michigan. Data corresponding to the LaMP 2000 emerging pollutants are not provided on CWA Section 303(d) lists; the 2004 LaMP will depend on other sources of information to evaluate the LaMP 2000 emerging pollutants. A potentially large number of pollutants could be placed on the Watch List as information is gathered in the basin. Pollutants may be removed from the Watch List through a determination that no potential to impact Lake Michigan exists or by a determination that the pollutant is not present in the watershed. Comments are solicited regarding the process for removal of pollutants from the Watch List.

3. Adaptive Management Approach for LaMP Pollutants

The LaMP envisions an ongoing adaptive management process to continually review and update the pollutant lists. In practice, parties will submit data to the LaMP for review on a biennial basis to support identification of a chemical in one or none of the pollutant categories (see table above for timing). The updated lists will then become part of the biennial Lake Michigan LaMP report.

Load Reduction Targets for LaMP Pollutants

It should be noted that this effort is not intended to replace other, ongoing processes at multiple levels of government to identify and reduce persistent, bioaccumulative toxic substances in the Great Lakes. For example, the load reduction targets identified in this document do not replace the total maximum daily load (TMDL) required by Section 303(d) of the CWA. In addition, EPA and Environment Canada continue with the implementation of the Binational Toxics Strategy (BTS) for the virtual elimination of persistent toxic substances in the Great Lakes.

Endocrine Disruptors

The endocrine system is responsible for regulating and maintaining biological functions that are critical for normal growth, development, and reproduction. It includes the brain, reproductive organs, and various endocrine glands. Endocrine glands monitor biological processes through hormones with unique receptor sites; hormones binding to their specific receptor sites is a crucial step in the endocrine system's normal operations. Endocrine disruption by exogenic chemicals is not a new concept-the important question is whether the health of humans and wildlife is being adversely affected by the presence of small amounts of different types of man-made chemicals in air, water, and food.

Endocrine disrupting chemicals work through several mechanisms, usually by mimicking natural hormones, blocking receptor sites, or delivering an inappropriate "message". Human health concerns include increases in reproductive tract cancers and abnormal sexual development. In wildlife, documented observations include decreased hatching success in birds, alligators, and turtles, the synthesis and secretion of a female hormone by male fish, changes in immune response, and behavioral modification. Some of the chemical classes that are receiving significant endocrine-related research are alkyphenols, carboxylate derivatives, and dioxinss.

For more information on endocrine disruptors, see *www.epa.gov/oscmont/oscpendo*

Now in its fifth year, the BTS recently reported on the activities of its workgroups addressing mercury, polychlorinated biphenyls, dioxins/furan, hexachlorobenzene/benzo(a)pyrene, octachlorostyrene, pesticides, alkyl-lead, and integration activities (Great Lakes Binational Toxics Strategy 2001 Annual Progress Report, Draft January 16, 2002). The LaMP pollutant process described in this memorandum is not intended to replace these other, ongoing activities. Rather, the Lake Michigan TRS proposes to draw upon these other sources of information to fulfill the GLWQA Annex 2 requirements for Lake Michigan.

Consistent with this intent and Annex 2 of the GLWQA, the overall Lake Michigan goal as expressed in this document is to improve ecosystem health. Given the current, overall "mixed" condition of Lake Michigan, the target is to be headed toward "good" in 2010 and to achieve an overall condition of "good" by 2020. Zeroing in on this target requires activities related to specific pollutants and the recognition that other stressors, including food web changes, influence the progress toward the targets.

Research and Regulatory Attention for the Watch List

As substances that may cause an impairment are identified, the LaMP encourages additional research to determine whether there is a Great Lakes impact. While no water, air or land disposal regulatory standards currently exist for many of the substances on the watch list, the Great Lakes research findings are communicated nationally for regulatory attention. These research findings may result in substances being addressed through voluntary product ingredient substitution rather than new regulations.

EPA has developed a PBT Profiler to encourage voluntary product ingredient substitution. The PBT Profiler is a subset of methods included in the U.S. EPA's Office of Prevention, Pesticides and Toxic Substance's P2 Framework (http://www.epa.gov/opptintr/p2framework) which is an approach to risk screening that incorporates pollution prevention principles in the design and development of chemicals. The objective of the P2 Framework approach is to inform decision making at early stages of development and promote the selection and application of safer chemicals and processes. The PBT Profiler integrates methods for estimating environmental persistence (P), bioconcentration potential (B), and aquatic toxicity (T). The PBT Profiler will predict P, B, and T characteristics from chemical structure. When the user accesses the PBT Profiler on the Internet, the program prompts the user to enter the Chemical Abstract Service (CAS) number of chemicals under consideration. The PBT Profiler is linked a database containing CAS numbers and associated chemical structure for over 100,000 discrete chemical substances. If the CAS number is in the database, the PBT Profiler will translate the CAS number into a chemical structure, predict the PBT characteristics, and provide a PBT Profile in a easy to understand format.

Appendix B

Lake Michigan Areas of Concern

April 16, 2002

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	Impacts on Human, Aquatic, and Wildlife Health, the Environment, and the Economy and their Effects	Programs	Clean-Up Actions	Key Activity Needed	Barrier	Next Step
Grand Calumet River **Indiana**	• PCBs • PAHs • Mercury • Cadmium • Chromium • Lead • Pathogens • Biochemical oxygen demand • Suspended solids • Oil and grease	Grand Calumet River: Lagoon, East Branch and West Branch Indiana Harbor and Ship Canal, The Lake George Branch of the Canal, Wolf Lake, George Lake and Nearshore Lake Michigan.	• Contaminated Sediments • Combined Sewer Overflows • Contaminated groundwater • Contaminated land sites • Habitat Fragmentation • Fire Suppression • ANS	• Restrictions on eating fish (Human health, sportfishing, recreation) • Tainted fish and wildlife flavor (Sportfishing, hunting) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Deformities for fish, birds or animals and tumors in fish (Ecosystem sustainability, human health, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Contaminated drinking water, or poor taste or odor (Human health, fish and wildlife health) • Beach closings (Recreation, human health) • Waste material on shorelines and oily sheen on water (Aesthetics, recreation) • Impaired food supply at bottom of the food chain (Ecosystem sustainability, sportfishing) • Added costs to agriculture and industry (Industry) • Loss of fish and wildlife habitat (Recreation, open space)	• Superfund • RCRA • Clean Water Act • WRDA • Navigational Dredging • Natural Resource Trustee's Damage Assessment	• USX dredging • West Branch Remediation • GSD Sed. Remediation • Navigational dredging • LTV cleanup	• Dredging • CSO Long Term Control Plans • Issue NPDES Permits • BUI Indicator Monitoring • TMDL underway • West Branch assessment	• Public concern regarding location of contaminated material disposal • Local funding and match for federal projects • Legal concerns • Permitting • Monitoring resources	• Dredging at USX (2002) • NRDA-Complete PRP negotiations. • ACOE- WRDA Diagnostic Feasibility Study • USX-Build Corrective Action Management Unit • GSD-Site Characterization • TMDL-Resolve modeling issues • Monitor BUI Indicators • ECI slurry wall
Kalamazoo River **Michigan**	• PCBs • Phosphorus • Sediments	From Morrow Dam, which forms Morrow Pond and extends 80 miles downstream to Lake Michigan.	• Nonpoint pollution • Sediments • Contaminated sediment landfills	• Restrictions on eating fish (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Deformities or reproductive problems for birds or animals (Ecosystem sustainability, human health, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Beach closings (Recreation, human health) • Occasional spills or runoff events odor or visual aesthetics problems (Aesthetics, recreation, wildlife and human health) • Loss of fish and wildlife habitat (Recreation, open space)	• Superfund • Clean Water Act • Brownfields • Natural Resource Trustee's Damage Assessment	• Superfund removal of 150,000 cubic yards of PCB-contaminated sediments from Bryant Mill Pond • Nonpoint pollution projects Erosion control programs	• Dredging/ Excavation • Superfund site cleanup decision action • Stream buffers • Dam removal	• PRP court case • Local funding match for federal projects	• Continue NRDA assessment • Finish remedial investigation/ remedial action • Investigate strategy and determine action
Lower Fox River/ Southern Green Bay **Wisconsin**	• PCBs • NH3 • BOD • Phosphorus • Suspended solids • Mercury • Heavy metals • Pathogens	The lower 11.2 km of the Fox River and a 55 square kilometer area of southern Green Bay out to Point au Sable and Long Tail Point.	• Urban and rural runoff • Wastewater discharges • Sediments • Aquatic nuisance species • Coastal & watershed habitat loss • Dams	• Restrictions on eating fish and fowl (Human health, sportfishing, recreation) • Loss of fish and wildlife habitat (Recreation, open space) • Deformities or reproductive problems for birds or animals (Ecosystem sustainability, human health, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Contaminated drinking water, or poor taste or odor (Human health, fish and wildlife health) • Beach closings (Recreation, human health) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Visible pollution in water (Aesthetics, recreation, wildlife and human health) • Impaired food supply at bottom of the food chain (Ecosystem sustainability, sportfishing)	• Clean Water Act • Superfund • Natural Resource Trustee's Damage Assessment	• Watershed NPS abatement • Remedial investigation/ remedial action nearly completed • Dredging and PCB removal (Deposit in 7,200 cubic yards of sediment removed and Deposit 56/57: 30,000 cubic yards of sediment removed) • Dissolved oxygen wasteload	• Dredging • Pollution Prevention • Stream buffers • Habitat protection and restoration	• Rapid land development • Contaminated material disposal	• Formal agency decision (Comment period ended January 21, 2002) • Removal of 10 million cubic yards of sediment.

Appendix B continued

Lake Michigan Areas of Concern

April 16, 2002

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	Impacts on Human, Aquatic, and Wildlife Health, the Environment, and the Economy and their Effects	Programs	Clean-Up Actions	Key Activity Needed	Barrier	Next Step
Manistique River **Michigan**	• PCBs • Heavy metals • Pathogens	The last 1.7 miles of the river to the mouth of the harbor at Lake Michigan	• Combined sewer overflow • Sediments • PCB-contaminated sawdust • Wastewater discharges	• Restrictions on eating fish (Human health, sportfishing, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Beach closings (Recreation, human health) • Loss of fish and wildlife habitat (Recreation, open space)	• Superfund	• Dredging of contaminated sediments completed in 2001(90,000 cubic yards)	• Sampling and monitoring		• Sampling and monitoring continuing as part of delisting process
Menominee River **Michigan/ Wisconsin**	• Arsenic • Mercury • PCBs • Oil and grease • Pathogens	Lower 4.8 km of river to the mouth and 5 km north and south of the mouth along the bay shore	• Sediments • Coastal watershed habitat loss • Nonpoint pollution • Hardened shorelines	• Restrictions on eating fish (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Beach closings (Recreation, human health) • Loss of fish and wildlife habitat (Recreation, open space)	• RCRA Corrective Action	• First stage of arsenic remediation (13,000 cubic yards) • Combined sewer overflow project	• Dredging • Protect riparian and coastal habitat • Pollution prevention		• Arsenic dredging completed • Paint sludge deposit cleanup above river mouth
Milwaukee Estuary **Wisconsin**	• Phosphorus • Nitrogen • Pathogens • PCBs • Metals • PAHs	The lower 5 km of the Milwaukee River ; the lower 4.8 km of the Menominee River; the lower 4 km of the Kinnickinnic River; the inner and outer Harbor and the nearshore waters	• Urban and rural runoff • Wastewater discharges • Sediments • Habitat loss • Dams	• Restrictions on eating fish and fowl (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Deformities or reproductive problems for fish, birds or animals and tumors in fish (Ecosystem sustainability, human health, recreation) • Harm to bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Beach closings (Recreation, human health) • Significant level of debris in river (Recreation) • Impaired food supply at bottom of the food chain (Ecosystem sustainability, sportfishing) • Loss of fish and wildlife habitat (Recreation, open space)	• Clean Water Act • Clean Air Act • Superfund • Brownfields • Navigational dredging	• Water pollution abatement • Pollution prevention education begun • Dam removal	• Dredging • Nonpoint source pollution control • Stream buffers	• High urban density and rapid development • Assessment incomplete	• Complete assessment
Muskegon Lake **Michigan**	• PCBs • Mercury	The entire 4149 acre lake and several tributaries.	• Sediments • Nonpoint pollution	• Restrictions on eating fish and fowl (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Harmed bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Contaminated drinking water, or poor taste or odor (Human health, fish and wildlife health) • Loss of fish and wildlife habitat (Recreation, open space)	• Brownfields • Navigational dredging	• Wastewater treatment upgraded • Some tributary remedial actions underway	• Dredging • Stream buffers • More assessment	• PCB disposal • Local funding match for federal projects	• Remediation of brownfields and sediments as Clean Michigan Initiative funds become available

Appendix B continued

Lake Michigan Areas of Concern

April 16, 2002

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	Impacts on Human, Aquatic, and Wildlife Health, the Environment, and the Economy and their Effects	Programs	Clean-Up Actions	Key Activity Needed	Barrier	Next Step
Sheboygan River **Wisconsin**	• Solids • Pathogens • Phosphorus • Nitrogen • PCBs • PAHs • Heavy metals	The lower Sheboygan River downstream from the Sheboygan Falls Dam, including the entire harbor and nearshore waters	• Industrial & agricultural runoff	• Restrictions on eating fish and fowl (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Deformities or reproductive problems for fish, birds or animals and tumors in fish (Ecosystem sustainability, human health, recreation) • Harmed bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Impaired food supply at bottom of the food chain (Ecosystem sustainability, sportfishing)	• Superfund • Natural Resource Trustee's Damage Assessment	• Partial removal of PCB-contaminated sediments • Agency decision (2001)	• Completion of PCB remediation • Control buffers • Habitat protection		• 2004 dredging start
Waukegan Harbor **Illinois**	• PCBs	1.2 square kilometers of industrial, commercial, municipal and open lands.	• Sediments	• Harmed bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Beach closings (Recreation, human health) • Impaired food supply at bottom of the food chain (Ecosystem sustainability, sportfishing) • Loss of fish and wildlife habitat (Recreation, open space)	• Superfund • Brownfields	• Corps navigation dredging Phase II • Sediment removal (approximately 1 million pounds of PCBs)	• Dredging • Brownfield development • Habitat restoration	• Contaminated material disposal	• Final dredging and disposal of inner harbor extension sediments
White Lake **Michigan**	• Heavy metals • Stormwater nonpoint pollution • Arsenic • Chromium	Includes White Lake and a one-quarter mile wide zone around the lake.	• Sediments • Industrial contamination • Groundwater contamination	• Restrictions on eating fish (Human health, sportfishing, recreation) • Harmed fish and wildlife health and reproduction (Ecosystem sustainability, human health, recreation) • Harmed bottom dwelling aquatic life (Ecosystem sustainability) • Restricted dredging (Shipping) • Excessive nutrients that cause algae, harming aquatic populations and that leads to bacteria growth (Aesthetics, recreation sportfishing) • Contaminated drinking water, or poor taste or odor (Human health, fish and wildlife health) • Algal blooms reduce recreational and visual appeal (Recreation, ecosystem sustainability) • Loss of fish and wildlife habitat (Recreation, open space)	• Superfund • RCRA	• Public education	• Dredging • Stream buffers	• PRP court case	• Dredging in "Tannery Bay" (2002) • Occidental Chemical site 2002

Appendix C

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For more Lake Michigan Mass Balance publications, see http://www.epa.gov/glnpo/lmmb/pub.html

Unit Conversions

Symbol	Unit	Multipliers
kg	kilogram	10^{3}
g	gram	1
mg	milligram	10^{-3}
ug	microgram	10^{-6}
ng	nanogram	10^{-9}
pg	picogram	10^{-12}

Graphics courtesy of Office of Research and Development
National Health and Environmental Effects Research Laboratory
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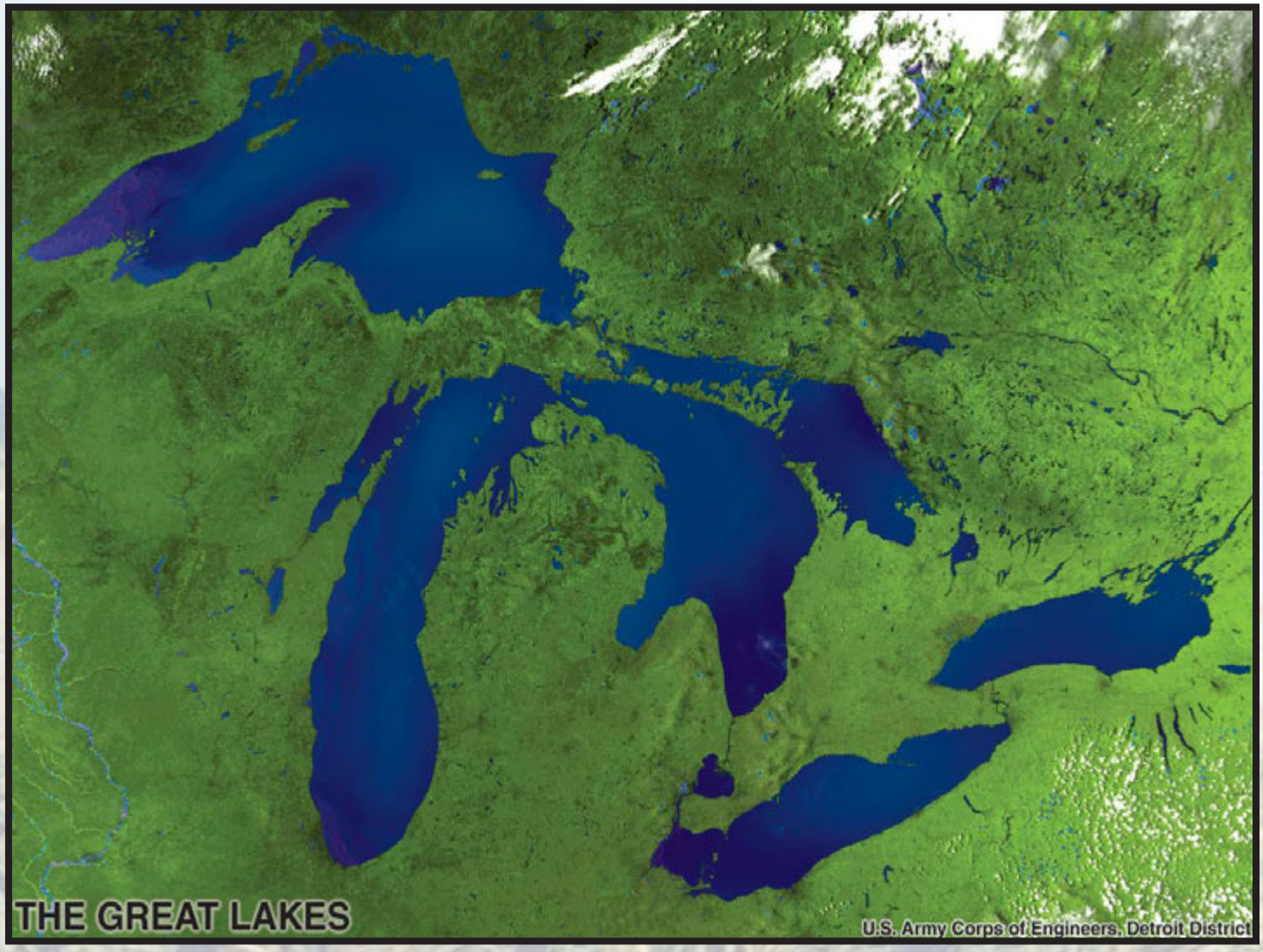
Grosse Ile, Michigan



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Great Lakes Fishery Commission

U.S. Department of Agriculture, Natural Resources Conservation Service

U.S. Environmental Protection Agency (Region 5, Great Lakes National Program Office, Office of Research and Development)

U.S. Fish and Wildlife Service

U.S. Geological Survey

Wisconsin Department of Natural Resources

The Lake Michigan LaMP 2002 is available at:
http://www.epa.gov/glnpo/michigan.html