

Five Year Program Strategy for the Great Lakes National Program Office

FY 1989-1993

**United States Environmental
Protection Agency**

**Great Lakes
National Program Office
230 South Dearborn Street
Chicago, Illinois 60604**

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December 1988



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
GREAT LAKES NATIONAL PROGRAM OFFICE
230 SOUTH DEARBORN STREET
CHICAGO, ILLINOIS 60604



We are very pleased to present this Five Year Strategy for the Great Lakes National Program Office (GLNPO) to the many government, private sector, and citizen organizations that share our dedication to the Great Lakes. This new strategy presents an outline of GLNPO's operating plan for responding to the 1987 revisions to the Great Lakes Water Quality Agreement (GLWQA) with Canada and for responding to our new statutory mandate, provided by the 1987 amendments to the Clean Water Act. It also reaffirms our commitment to ongoing programs initiated under previous agreements with Canada.

The GLWQA obligates both the United States and Canada to take vigorous measures to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." In simple terms, this goal means ensuring that the waters of the Great Lakes are safe for swimming and other recreational activities, that biological populations in the Great Lakes are healthy, and that Great Lakes fish are safe to eat. This goal is shared by organizations that participate in environmental management decisions in the Great Lakes Basin and by U.S. and Canadian residents throughout the region.

As we begin our 11th year, GLNPO is taking on responsibilities in new and challenging areas such as demonstrating techniques for control or removal of contaminated sediments located in geographic Areas of Concern, developing ecological objectives for the Lakes, and developing Lakewide Management Plans for the control of Critical Pollutants. But as we take on our new and difficult responsibilities, we will retain our commitment to efforts in earlier areas of emphasis such as phosphorus reduction, water quality monitoring, and the measurement of contaminants in fish tissue.

In all of these activities, GLNPO will continue to work in partnership with other organizations at the Federal, State, and local levels. The cooperative and collective efforts of these organizations are vital to the U.S. in meeting its commitments under the GLWQA and to the unique resource the U.S. and Canada share and treasure: the Great Lakes.

A handwritten signature in black ink, appearing to read "Valdas V. Adamkus".

Valdas V. Adamkus
Great Lakes National Program Manager

A handwritten signature in black ink, appearing to read "Carol M. Finch".

Carol M. Finch, Director
Great Lakes National Program Office

Preface

This document presents a five year strategy for the Environmental Protection Agency's (EPA's) Great Lakes National Program Office (GLNPO). The strategy has two principal purposes:

- To inform other EPA programs, Federal agencies, the Great Lakes States, and the public of GLNPO's goals and how they will be addressed; and
- To provide a long-term strategic framework for GLNPO, within which annual budget and workplan priorities can be established.

Chapter 1 of this document provides an overview of the Great Lakes National Program Office and its role in relation to the governmental organizations that influence environmental management decisions within the Great Lakes Basin, both in the U.S. and in Canada. Chapter 2 provides an overview of the Great Lakes ecosystem and an historical perspective on water quality problems in the Great Lakes Basin. Chapter 3 describes water quality problems within the Great Lakes Basin and establishes priorities for addressing those problems. Chapter 4 summarizes Federal and State environmental programs that work in the Great Lakes Basin and presents a review of their significant recent accomplishments. Chapter 5 describes the 1987 amendments to the Clean Water Act that define GLNPO's statutory charter to coordinate the U.S. response to the Great Lakes Water Quality Agreement. Chapter 6 provides an overview of the Great Lakes Water Quality Agreement and, in particular, describes the revisions to the Agreement enacted in 1987. Finally, Chapter 7 presents GLNPO's five year strategy for addressing the priorities defined in the Agreement and for fulfilling its statutory mandate.

This five year strategy updates the "Five Year Program Strategy for the Great Lakes National Program Office 1986-1990" published in June of 1985. It incorporates new responsibilities provided under the Clean Water Act Amendments of 1987 and the revisions to the Great Lakes Water Quality Agreement signed by the U.S. and Canada in November of 1987.

This strategy mentions some of GLNPO's interactions with other environmental programs undertaken by EPA, other Federal agencies and the States. The many contributions of these other offices and agencies are vital to meeting the goals of the Great Lakes Water Quality Agreement.

Chapters 1, 4, and 7 indicate some of GLNPO's cooperative endeavors with other organizations. It is beyond the intent of this strategy, however, to mention in detail planned Great Lakes or other activities of these organizations.

The strategy was developed with the assistance of many organizations that work with GLNPO toward achieving the objectives of the Great Lakes Water Quality Agreement, including: EPA's Headquarters offices and Regional offices in New York (Region II), Philadelphia (Region III), and Chicago (Region V); the Great Lakes States; other Federal agencies, including the National Oceanic and Atmospheric Administration (NOAA), the Army Corps of Engineers, the Soil Conservation Service, the U.S. Coast Guard, and the Fish and Wildlife Service; and public interest groups that work on Great Lakes issues.

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The Great Lakes National Program Office



*An Overview of GLNPO and Its Role in Relation to
Governmental Organizations that Influence
Environmental Management of the Great Lakes Basin*

The Great Lakes National Program Office (GLNPO) was created in 1978 to oversee the United States' fulfillment of its obligations under the Great Lakes Water Quality Agreement with Canada. In 1987, the Clean Water Act formally recognized the Great Lakes as a valuable national resource and established a statutory mandate for a Great Lakes National Program Office. This mandate includes responsibility for coordinating the United States' response to the Water Quality Agreement. The goal of the Water Quality Agreement is "to restore and maintain the physical, chemical, and biological integrity of the Great Lakes Basin ecosystem." This emphasis on a comprehensive ecosystem approach to water quality management, embodied in the Agreement, is the cornerstone of GLNPO's operations.

The Agreement's emphasis on an ecosystem approach to environmental management resulted from a growing understanding of the many interrelated and interdependent factors that govern the ecological health of the Great Lakes. Evaluating environmental management decisions and priorities from an ecosystem-wide perspective provides a geographically broad, systemic view of the interactions among the physical, chemical, and biological components of the ecosystem and recognizes that human uses of land and water are central factors affecting the integrity of the Great Lakes. This characteristic of the Agreement dictates that GLNPO be concerned with all types of environmental management decisions in the Great Lakes Basin, including those that affect the Lakes indirectly. At the State level, the Governors of the eight Great Lakes States have formally recognized and endorsed the need for an ecosystem approach to environmental management in the Great Lakes Basin by agreeing, in a charter, to treat the Lakes as a single ecosystem and by establishing uniform goals for their States to meet.

Located in Chicago, Illinois, GLNPO has a staff of scientists, engineers, and other professionals who work with staff throughout EPA, the Great Lakes States, other Federal agencies, Environment Canada, the Ontario Provincial Government, the International Joint Commission, colleges and universities, and public interest organizations toward advancement of the goals and objectives set out in the Agreement. GLNPO staff participate in, coordinate, and facilitate actions by all of these organizations to ensure that environmental management decisions within the Great Lakes Basin uphold the objectives of the Agreement. GLNPO staff also monitor conditions in the Lakes and the progress of U.S. programs in implementing the Water Quality Agreement.

Environmental management decisions within the U.S. Basin are made by a broad range of Federal, State, and local governmental organizations. Many organizations therefore work together as well as independently toward the simultaneous attainment of both the goals of the Agreement and the goals of Federal and State environmental programs. While the specific objectives and priorities for programs at the various levels of government may differ from each other, and from the Agreement to some extent, all share the fundamental goal of protecting and maintaining a high level of environmental quality.

Roles and responsibilities for Great Lakes management vary at different governmental levels. Within EPA, Headquarters program offices set national policies and define programs for cleanup and protection of environmental resources. At the Regional level, line divisions implement permitting and enforcement programs or, where authorities have been delegated, assist States in administering these programs. In addition to implementing Federally-mandated statutory programs for air, surface water, drinking water, and hazardous waste, States also administer their own environmental management programs, working together with local county and municipal governments. GLNPO participates in the planning and policy development activities of EPA Headquarters and Regional programs and of many State and local programs, supporting the goals and objectives of the Great Lakes Water Quality Agreement.

Actions taken by any one of the governmental organizations throughout the Great Lakes Basin may have implications for water quality in the Great Lakes. GLNPO's responsibility is to define problems in the Great Lakes ecosystem, identify government and private sector organizations that can act in solving the problems, and bring together those organizations in developing and implementing effective solutions toward the goal of restoring and maintaining water quality in the Great Lakes Basin.

GLNPO and the many Federal and State environmental programs throughout the Basin use a variety of authorities for managing environmental quality. These management tools derive from two main sources: Federal environmental protection statutes and the Great Lakes Water Quality Agreement.

Federal statutes establish management tools such as facility-specific permitting programs for surface water discharges, hazardous waste management, air emissions, and other activities that affect the environment. They establish compliance monitoring and enforcement authority for ensuring effective cleanup of environmental contamination through programs such as Superfund and the Resource Conservation and Recovery Act (RCRA) corrective action program. Federal statutes also mandate the use of planning and priority-setting for activities such as cleanup of surface water resources, and managing leaking underground storage tanks, and for emergency preparedness.

The Great Lakes Water Quality Agreement provides a number of similar environmental management tools. For example, the Agreement creates priority-setting techniques such as designation of "Areas of Concern" and "Point Source Impact Zones" for Critical Pollutants where applicable water quality standards are not being met in the Great Lakes. The Agreement also establishes tools such as Remedial Action Plans that describe actions to be taken toward attaining water quality objectives in Areas of Concern. Remedial Action Plans are developed by the States with assistance from EPA regional program staff and from GLNPO. These plans incorporate actions that States can take, using authorities and management tools provided by Federal and State statutes, to ensure that water quality standards will be met and that beneficial uses will be restored.

The relationship between implementing Federal and State environmental protection programs and fulfilling the provisions of the Great Lakes Water Quality Agreement is therefore a complex interaction between numerous planning, permitting, and enforcement efforts that serve both the purposes of the statutes and the Agreement. It is this complex interaction that provides the context for GLNPO's primary responsibility: participating with and coordinating the many government and private sector organizations that have the ability or authority to affect water quality in the Great Lakes, with the overall objective of achieving the goals set out by the Great Lakes Water Quality Agreement. To fulfill this primary responsibility, GLNPO conducts activities in four areas:

1. Intra- and Interagency coordination,
2. Environmental surveillance and monitoring,
3. Remedial demonstration projects, and
4. Great Lakes research.

The need for GLNPO's work in each of these areas was reinforced by Congress in passing the 1987 amendments to the Clean Water Act. Section 118 of the Act directs the Office to coordinate actions within and external to EPA that are aimed at improving water quality in the Great Lakes to ensure U.S. compliance with the Great Lakes Water Quality Agreement. The Act further requires GLNPO to manage Great Lakes surveillance and demonstration projects, and to conduct research.

1.1 Intra- and Interagency Coordination

Within EPA, GLNPO works at both the Headquarters and Regional office levels to ensure that Great Lakes concerns are considered in the development of environmental programs and policies. Headquarters program offices design regulatory and other programs under each of EPA's principal statutes. GLNPO works with other national program offices to ensure that Federal regulations and national policies developed under programs such as the National Pollutant Discharge Elimination System (NPDES), the Superfund Program, and the Hazardous Waste Management Program consider the special concerns of the Great Lakes and that, at a minimum, they provide sufficient flexibility to allow facility or site-specific permitting and other decisions made within the Great Lakes Basin to account for important Great Lakes priorities.

GLNPO shares this interest with other programs that focus on a particular geographic resource, such as the Chesapeake Bay Program or the Puget Sound Program. GLNPO works with the Headquarter's Office of Marine and Estuarine Protection and individual estuary programs to support the development of policies and programs that address the special interests and needs of complex ecosystems.

At the Regional level within EPA, line divisions implement each of EPA's media programs (i.e.; surface water, ground water, drinking water, air, hazardous waste, Superfund, toxic substances, and pesticides). Regional staff develop and recommend permit conditions for surface water discharges, air emissions, and hazardous waste management; review, evaluate, and select remedial alternatives for Superfund sites; plan and implement compliance inspection programs; and develop and execute enforcement cases. GLNPO works with program staff in Regions II, III, and V to assist with these activities and ensure that important site-specific decisions reflect Great Lakes concerns and uphold the provisions of the Great Lakes Water Quality Agreement to the maximum extent possible.

Regional office program staff also assist State programs with planning and implementing those Federal programs that have been delegated to the

States. Each year, EPA Headquarters develops national Agency Operating Guidance to communicate overall program priorities and objectives to Headquarters and Regional staff and to State programs. At the Regional level, program staff also develop Operating Guidance for State programs in order to communicate EPA's priorities and objectives for the coming year. GLNPO works to ensure that Great Lakes priorities are accurately reflected in Agency Operating Guidance, at both Headquarters and Regional levels, and that annual State Program Plans incorporate Great Lakes priorities, as appropriate.

For example, within EPA, Regional Water Divisions have the primary responsibility for implementing regulatory, management, and remedial programs under the Clean Water Act. GLNPO priorities for the Great Lakes are considered during the development of annual EPA Regional workplans and State integrated program plans that incorporate such activities as the development of State water quality standards and the implementation of permitting, pretreatment, and compliance and enforcement programs under the National Pollutant Discharge Elimination System, established by the Clean Water Act.

Presently, GLNPO participates in the development of national Agency Operating Guidance for water programs and with Regional Water Division staff in developing State water program guidance. In the future, GLNPO will establish similar procedures for participating in guidance development with all appropriate EPA programs, both at Headquarters and in the Regions.

Outside EPA, GLNPO works with other government agencies that conduct activities or have interests in the Great Lakes Basin. For example, the 1987 Amendments to the Clean Water Act require the establishment of a Great Lakes Research Office within the National Oceanic and Atmospheric Administration (NOAA). GLNPO and NOAA are required under the Act to develop an annual research plan. NOAA has participated with GLNPO in research and surveillance projects in the past and this existing working relationship will be expanded in the future as the Great Lakes Research Office becomes operational.

GLNPO also works extensively with the Army Corps of Engineers. The Corps has long had interests in the Great Lakes because the Lakes are a major conduit for interstate shipping. Dredging, dredged materials disposal, and water level management projects conducted by the Corps are important activities of concern to GLNPO. The Corps also conducts research on many topics of importance to GLNPO and it is anticipated that the Corps will play an important role in new Great Lakes initiatives concerning the management of contaminated sediments in the Lakes.

GLNPO has similar working relationships with the U.S. Fish and Wildlife Service, the Soil Conservation Service, and the U.S. Coast Guard. GLNPO will require assistance and support from other Federal agencies as well. For example, the U.S. Geological Survey (USGS) may be called upon to assist or advise on the vulnerability of surface water quality to contaminated ground water resulting from sources such as hazardous waste sites in the Great Lakes Basin.

GLNPO has two additional responsibilities deriving from the international nature of the Great Lakes Water Quality Agreement. One is to coordinate environmental programs of the United States with Federal and provincial government programs in Canada. Under the terms of the Agreement, the two governments have the responsibility for setting objectives, preparing management plans, implementing remedial programs and monitoring conditions. A second major international responsibility is GLNPO's support of the International Joint Commission (IJC). The IJC evaluates the progress being made by the two governments and the adequacy of their programs in satisfying the Agreement.

To fulfill these distinct responsibilities, GLNPO staff interact with their Canadian counterparts in two ways. In coordinating programs, U.S. and Canadian staff members work together as representatives of their respective governments to solve mutual problems and initiate coordinated projects. In supporting the IJC, U.S. and Canadian staff members serve on various committees and IJC task forces as nonpartisan professional experts, and prepare reports and recommendations for the Commissioners.

Further information on international coordination and the IJC is provided in Chapter 6, the Great Lakes Water Quality Agreement.

1.2 Environmental Surveillance and Monitoring

To understand the environmental results of Great Lakes regulatory programs, it is necessary to monitor conditions in the Lakes and to develop an understanding of the basic biological, chemical, and physical processes that make up the ecosystem. GLNPO, EPA, and the Great Lakes States therefore conduct extensive monitoring programs intended to describe the health of the Great Lakes and their biological communities. Monitoring efforts are an important component of GLNPO's work and account for a major portion of GLNPO's annual expenditures.

Surveillance activities conducted by GLNPO include regular sampling of water, fish tissues, and sediment. GLNPO, together with the States, also operates an air monitoring network in the Great Lakes Basin to measure

the quantities of pollutants entering the Basin from airborne sources. The Great Lakes Atmospheric Deposition (GLAD) Network was originally created to measure contributions of conventional pollutants to the Lakes from the atmosphere. In fiscal year 1988, however, responding to new requirements in the Agreement and the Clean Water Act, GLNPO began expanding the network to include sampling for toxic air pollutants.

In addition to air deposition, GLNPO supports other monitoring and surveillance activities designed to provide information on the magnitude and types of pollutant loadings to the Great Lakes. Of principal concern to GLNPO are loadings from tributaries, point and nonpoint sources, and ground water, and releases from contaminated sediment.

Presently, GLNPO operates a research vessel, the *Roger R. Simons*, and conducts winter sampling surveys by helicopter. During fiscal year 1989, GLNPO will procure a new vessel that will be outfitted with laboratory facilities designed to support the new emphasis on identifying and controlling toxic pollutants in the Great Lakes. In addition, GLNPO's surveillance and monitoring efforts rely on chemical analyses provided by the EPA Region V Central Regional Laboratory through a contract funded by GLNPO.

1.3 Remedial Demonstration Projects

In the past, GLNPO has been active in conducting demonstration projects for remedial technologies and pollution control, particularly in the areas of phosphorus reduction from point and nonpoint sources. Earlier nonpoint source control demonstration projects sponsored by GLNPO have been part of one of the largest such programs in the Nation. These projects involved other Federal, State, and local organizations and have played an important role in the overall progress toward reduction of phosphorus inputs to the Lakes.

The 1987 Amendments to the Great Lakes Water Quality Agreement and the Clean Water Act call for a new demonstration program addressing remedial technologies for cleanup of toxic pollutants with an emphasis on their removal from bottom sediments. During fiscal year 1988, GLNPO has begun implementing its Assessment and Remediation of Contaminated Sediments (ARCS) program and laying the foundation for the demonstration projects.

Under the Clean Water Act, GLNPO is required to give special consideration to conducting contaminated sediments demonstration projects in five locations: Saginaw Bay (in Michigan on Lake Huron);

Sheboygan Harbor (in Wisconsin on Lake Michigan); the Grand Calumet River in Indiana, the Ashtabula River in Ohio, and the Buffalo River in New York. In fiscal year 1989, the Office will develop a strategy for ranking these and other sites as a first step in the selection process. Demonstration projects in this area will also require substantial participation by EPA's Office of Research and Development, the Great Lakes States, the Corps of Engineers, and other agencies.

1.4 Great Lakes Research

Both the Great Lakes Water Quality Agreement and the 1987 Amendments to the Clean Water Act recognize the importance of a coordinated research program designed specifically to address the special problems and concerns of the Great Lakes. GLNPO has in the past worked closely with EPA's Office of Research and Development to identify Great Lakes research priorities and to design and conduct research projects with EPA's Water Quality Laboratory in Duluth, Minnesota, the EPA Large Lakes Research Station (LLRS) at Grosse Ile, Michigan, and EPA's Engineering and Support Laboratories in Cincinnati, Ohio.

The LLRS has organized and implemented research on the transport, fate, and effects of toxic substances in the Great Lakes and has been developing methodologies for dealing with contaminated sediment. Recently, the Duluth Laboratory and LLRS have worked with GLNPO to conduct research on contaminated sediment in Wisconsin's lower Fox River.

Modeling of eutrophication processes by the Grosse Ile laboratory has provided information for understanding how the Great Lakes have responded to phosphorus controls. This laboratory has also conducted work on toxic modeling as well as, prior to 1980, epidemiological research on human health effects of exposure to PCBs through fish consumption. The Duluth laboratory has supported the development of models for estimating the movement of toxic pollutants in the Great Lakes.

GLNPO also funds applied research through other Federal agencies and by contracting directly with universities and private companies. Beginning in fiscal year 1989, pending funding, GLNPO will work with the newly established Great Lakes Research Office within NOAA to develop and implement a comprehensive Great Lakes Research Program. Research is further discussed in Chapter 7 and the relationship among Federal research programs is illustrated in Figure 6.

1.5 Future Directions for GLNPO

This five year strategy lays out specific activities that GLNPO will conduct to fulfill its obligations under the Clean Water Act and the Great Lakes Water Quality Agreement. In establishing these priorities, GLNPO has translated the general goals of the Great Lakes Water Quality Agreement into actions that may be taken by EPA programs, State programs, and other Federal agencies, and defined the specific activities that GLNPO will conduct to ensure that environmental management decisions within the Great Lakes Basin uphold the goals of the Agreement. This strategy therefore lays out a general framework for GLNPO in working toward the goals of the Agreement in areas such as the abatement and cleanup of toxic pollution in the Great Lakes, further reductions in phosphorus discharges from nonpoint sources, and investigation and control of pollution in the Lakes that originates from ground-water sources. For the most part, the identified activities anticipate that Federal and State programs will be funded at requested levels. It is also anticipated that these programs will continue to work on separate tracks toward the achievement of goals defined by their separate Federal and State statutes.

The Agreement commits both the United States and Canada to employing an ecosystem approach to environmental management. It is GLNPO's task to bring together the many different U.S. programs and provide a forum for them to work together toward achieving working relationships that promote multi-media solutions to environmental problems. As individual programs work with GLNPO over the next five years, an overall strategy for managing and protecting the Great Lakes will continue to emerge. It is GLNPO's long-term goal to articulate this strategy so that it clearly defines the roles of all government organizations and the policies and procedures under which each will work in the future toward the shared goal of protecting and maintaining the integrity of the Great Lakes.

The Great Lakes Ecosystem



An Overview of the Great Lakes Basin and an Historical Perspective on Water Quality in the Basin

The Great Lakes system, shown in Figure 1, is the largest reservoir of fresh surface water in North America. Like Lake Baikal in the U.S.S.R., the Great Lakes contain about 18 percent of the world's supply. Only the polar ice caps contain more fresh water. The total U.S.-Canadian shoreline measures 9,402 miles, including islands. Of that figure, 4,530 miles constitute the U.S. shoreline — longer than the Atlantic and Gulf of Mexico coastlines combined. The Great Lakes are a fishery resource, a transportation system, a water supply, a recreation resource, a modifier of climate, and a means of waste disposal. In both Canada and the United States, all of these uses have contributed to the development of one of the world's largest inland concentrations of population and industry.

2.1 Characteristics of the Natural System

The Great Lakes system flows from Lake Superior, at 600 feet above sea level, through the other four lakes and the connecting channels and then out through the St. Lawrence River to the Atlantic Ocean. Although the system contains five distinct drainage basins, the land area is relatively small in relation to the large and numerous bodies of water. One-third of the total 300,000 square mile drainage basin is covered by water. The numerous tributaries receive drainage from a large variety of land uses and types of soil, resulting in a variety of pollution problems. The hydrologic features of the five lakes are compared in Table 1.

Despite their size, the Lakes are especially sensitive to pollution. Less than one percent of the total volume of water in the system flows out the St. Lawrence River each year, leaving toxic pollutants to accumulate in bottom sediments and fish. The relatively closed nature of the system makes the Great Lakes vulnerable to pollution over the long term and their huge

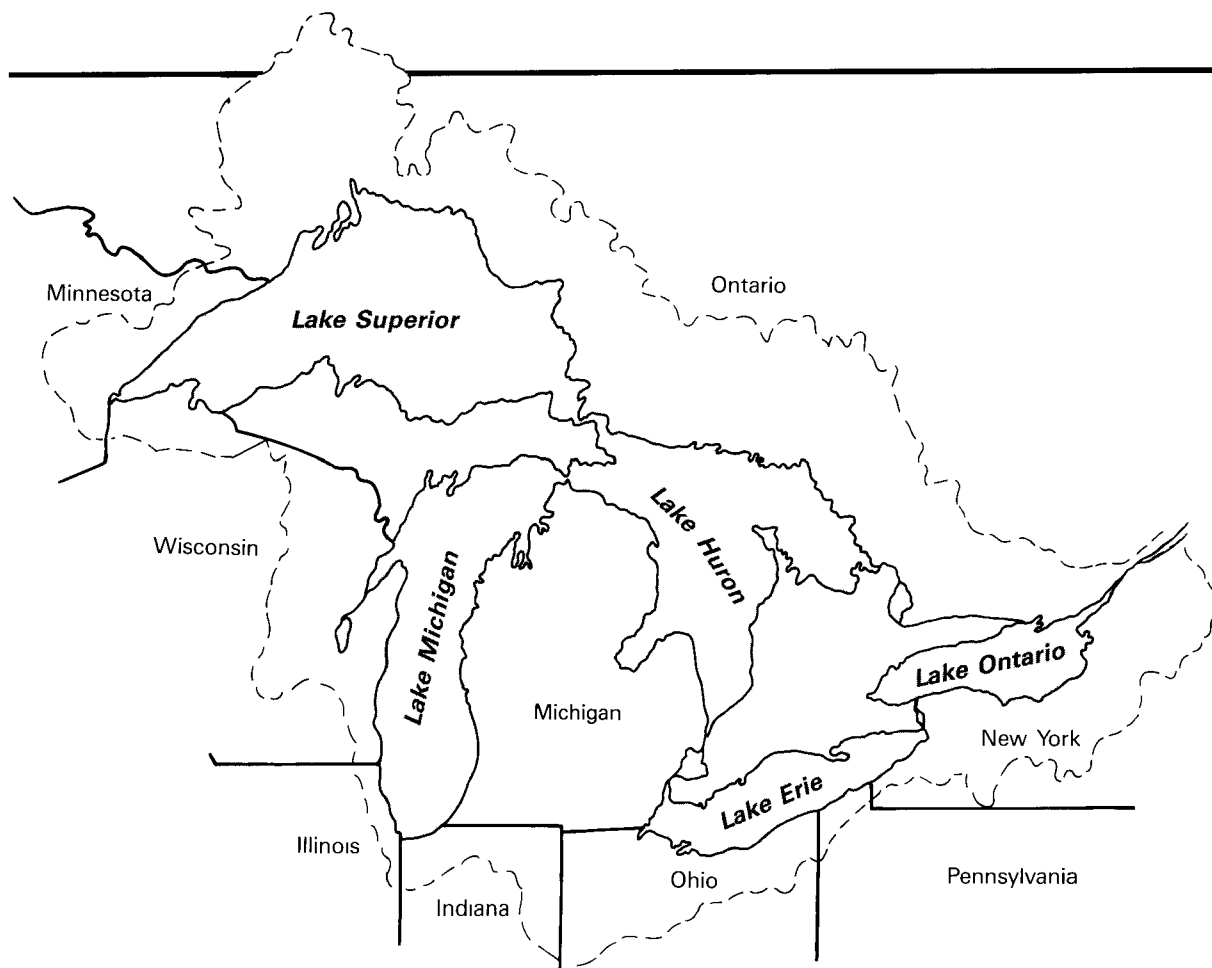


Figure 1. States and Provinces Bordering the Great Lakes System

volume of water makes changes due to pollution very difficult to reverse. Attempts to reverse the effects of pollution must be sensitive to the unique characteristics of each lake. Lake Erie is the shallowest, its shores are highly urbanized, and its major tributaries drain intensively farmed soils. For these reasons, Lake Erie was the first to show lakewide signs of cultural eutrophication but also responded quickly to cleanup, due to the rapid rate at which water flows through it.

Lake Ontario is smaller in area but deeper than Erie. Being downstream, it receives nutrients from Lake Erie and probably receives persistent toxicants from the rest of the system as well as from the Niagara River industrial complex. Lake Ontario has the highest concentration of toxic pollutants.

Lake Michigan's vulnerability to both over-enrichment and toxic pollution is compounded by its long residence time (about 100 years). It receives high loadings of nutrients, heavy metals, and contaminants from the atmosphere over its large surface area. Particularly around large urban areas, Lake Michigan sodium levels are now several times higher than at the turn of the century and are continuing to increase.

The Lake Superior and Lake Huron drainage basins have lower population densities and more forested lands than the Lake Michigan basin. Maintaining Lake Superior's relatively pristine, oligotrophic state is an international objective. In Huron, as throughout the entire Great Lakes system, nearshore waters and embayments are more eutrophic and have higher contaminant levels than the open lake waters. Such shallow areas receive more concentrated loadings of pollutants and have less circulation than the open lakes.

The levels and flows of the entire system are governed much more by the natural hydrologic cycle than by manmade diversions and regulation. The average annual precipitation over the entire Great Lakes Basin is 31 inches, with approximately 10 percent greater precipitation over the Lakes themselves than over the surrounding land. In 1985, 1986, and 1987, lake levels reached record highs. Then, the overall lake level dropped about one foot due to extremely low precipitation in 1987 followed by drought conditions in early 1988. In July 1988, only two lakes—Lake Erie and Lake St. Clair—had levels above average. The Army Corps of Engineers has found that the net cumulative change in lake levels due to operation of control locks and to diversions since 1909 has been only a few inches, except for the Lake Ontario level which is controlled by structures in the St. Lawrence River.

Table 1. Comparative Hydrologic Features of the Five Great Lakes

| Lake | Drainage Area (Square Miles) | Surface Area (Square Miles) | Volume (Cubic Miles) | Residence Time (Years) | Depth (Feet) |
|----------|------------------------------------|--------------------------------|-------------------------|------------------------------|------------------------------|
| Superior | 49,300 | 31,700 | 2,935 | 200 | 489 average 1,335 maximum |
| Michigan | 45,600 | 22,300 | 1,180 | 100 | 279 average 925 maximum |
| Huron | 51,700 | 23,000 | 849 | 25 | 195 average 750 maximum |
| Erie | 22,700 | 9,910 | 116 | 3 | 62 average 210 maximum |
| Ontario | 27,300 | 7,340 | 393 | 6 | 283 average 802 maximum |

2.2 Water Quality in the Great Lakes

Concerns about water quality in the Great Lakes have evolved over time from disease organisms to oxygen depletion and eutrophication and, recently, to toxics, as the leading threat to human and ecosystem health. There are many causes of water quality degradation in the Great Lakes and measuring their relative importance and their interrelation is often very complex.

Before intensive settlement and development of the region, the waters of the Great Lakes and their tributaries were clear and cold. Algal growth was generally low and there were many species of fish, some of which are now extinct. The average size of fish was much larger than today and long-lived species such as sturgeon and lake trout were abundant.

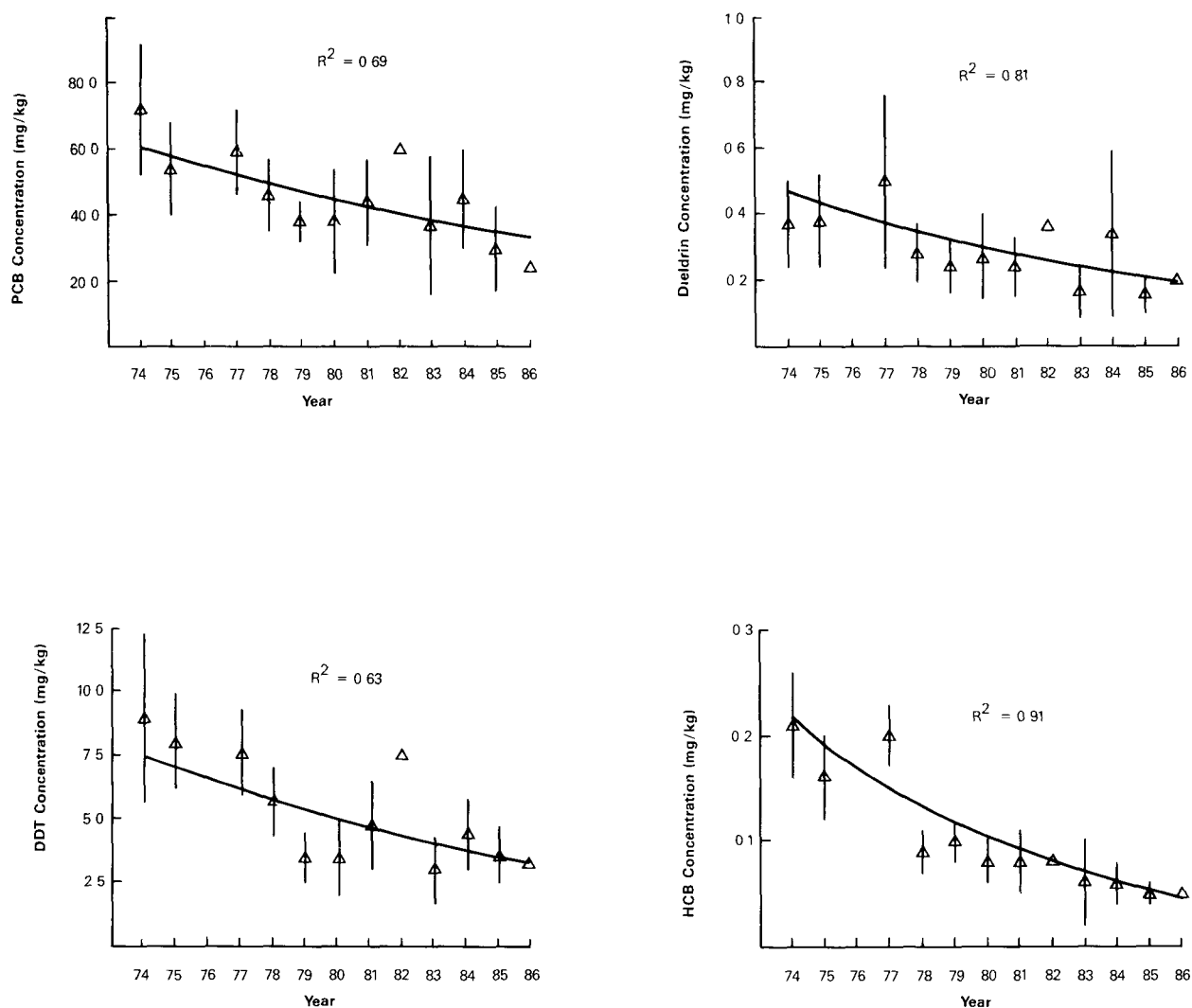
As cities grew, local degradation due to waste disposal at first seemed inconsequential in the large lakes. Later it was realized that fundamental change in such a large system could occur and not become obvious until well advanced.

By the 1880s, contamination of drinking water by human sewage and shoreline pollution led to the recognition that primary treatment of sewage, disinfection of sewage effluent, and improved treatment of drinking water were needed. Even with primary treatment, however, decaying organic wastes from many sources were depleting oxygen in harbor and nearshore waters. Beaches were closed to swimming because of high fecal coliform counts or were unused because of algae, odors, floating oil, or dead fish.

Algal growth increased which in turn depleted Great Lakes oxygen levels and destroyed nearshore and estuary biota. However, the effect of these changes on a whole lake was not recognized until eutrophication became obvious in the most vulnerable lake, Lake Erie. By 1960, large increases in algal productivity and the annual cycle of algal bloom, decay, and oxygen depletion in Lake Erie had been linked to excessive levels of nutrients. The public demanded further pollution control measures and the Federal government responded by requiring secondary treatment of sewage and control of direct discharges of industrial wastes.

By 1972, a scientific consensus had developed that phosphorus was the limiting nutrient for the Great Lakes. Reduction of phosphorus became the chief objective of the first Great Lakes Water Quality Agreement between the U.S. and Canada in that year. Also in 1972, Congress adopted the Federal Water Pollution Control Act amendments (Public Law 92-500).

Herring Gulls at Port Colborne



Wet weight concentration \pm standard deviation

Source: 1987 Report on Great Lakes Water Quality: Report to the IJC

Figure 2. Organochlorine and Lipid Concentrations in Herring Gull Eggs Taken from Port Colborne on Lake Erie

This legislation provided the chief means for fulfilling U.S. obligations under the first binational compact.

By the 1980s, decreased algal growth and increased dissolved oxygen levels provided clear evidence that water quality had improved in the Great Lakes, particularly in nearshore areas. Today, the increase of eutrophication appears to be stopped in the open lakes and restoration seems well within reach. Both countries are close to achieving their phosphorus reduction targets, and can attain them by implementing nonpoint source control programs.

In contrast to the nutrients control success, toxic pollution remains a serious problem and is clearly considered the long-term threat to beneficial uses of the Lakes. Toxic pollutants were first recognized as a widespread problem in the Lakes in the 1960s, when DDT, PCBs, and mercury were found to be affecting reproduction of birds and animals and posing a threat to human health. For some toxics, such as DDT and PCBs, which have been regulated for years, concentrations in the environment have decreased as illustrated in Figure 2. Unfortunately, their rate of decrease has slowed and levels in sediment, fish and birds continue to cause serious problems. It is believed that both wet and dry atmospheric deposition, contamination from bottom sediments, and contaminated ground water are significant sources of toxics.

Current Great Lakes Water Quality Problems



Water Quality Problems Remaining to Be Addressed and Priorities for Addressing Them

Three major categories of water quality problems remain in the Great Lakes today: eutrophication in the two lower lakes and several bays; impairment of beneficial uses in numerous Areas of Concern (AOCs); and accumulation of toxic pollutants throughout the system, most notably in fish, which threatens both human health and the environment.

3.1 Eutrophication and Oxygen Depletion

Lower levels of dissolved solids, reduced biochemical oxygen demand, and diminished algal growth, as well as algal species shifts, in many Great Lakes locations reflect greater control of conventional pollutants, especially from direct discharges. Full attainment of the objectives for phosphorus reduction called for in the Great Lakes Water Quality Agreement, however, will require further control of land runoff. Nitrogen levels continue to increase in the Lakes, but this has not yet been demonstrated to cause environmental problems except in tributary streams. Monitoring of nitrogen levels will be continued.

Eutrophication in the Great Lakes is determined largely by phosphorus concentrations. Thus the problems of excessive algal growth, and Lake Erie oxygen depletion, are being addressed by reducing the amount of phosphorus reaching the Lakes. Target loadings of phosphorus have been achieved for the open lakes in Superior, Huron, and Michigan mainly through reduced direct discharges of wastes from industrial and municipal sources and detergent phosphate bans. Monitoring will be continued to ensure that the reductions in phosphorus levels are adequate to control eutrophication.

For Lakes Erie and Ontario, and for Saginaw Bay in Lake Huron, further efforts are needed to meet the objectives and target loadings for

phosphorus in the Water Quality Agreement. In June 1986, a U.S. plan for phosphorus load reductions to Lake Erie, Lake Ontario, and Saginaw Bay was submitted to the International Joint Commission (IJC). This five-year plan calls for a major review of progress in 1988. If this review shows that voluntary nonpoint source controls are not effective, regulatory controls will need to be considered. The plan focuses on management of crop residues to prevent soil erosion and nutrient loss and on management of animal wastes and commercial fertilizers to minimize nutrients entering streams.

Soil erosion and phosphorus releases have been reduced by use of alternative tillage techniques, which leave crop residues on the surface to hold soil in place. Progress is being made in reducing agricultural nonpoint sources using conservation tillage in locations such as the Maumee River basin in Ohio, but further reductions are needed there and elsewhere. GLNPO will continue to track use of conservation tillage techniques and will work within EPA and with Department of Agriculture and State agencies to reduce nutrient loadings to the Great Lakes by reduction of land runoff.

The total cost of new initiatives called for in the U.S. phosphorus reduction plans is estimated at \$14,310,000, with resulting estimated reductions of 834 metric tons (MT) in Lake Erie; 26 MT in Lake Ontario; and 77 MT in Saginaw Bay. These reductions will result in meeting the phosphorus target loads if existing programs are maintained at 1985 levels and adoption rates for conservation tillage in Ohio prove to be at the high range of estimates. If the adoption rates decline significantly in 1988, additional initiatives will be needed in Ohio.

Results of algal productivity monitoring as well as monitoring of phosphorus loadings and water chemistry conditions will help determine whether existing environmental controls are sufficient to maintain water quality in Lake Superior and to enhance conditions in Huron and Michigan. The need for stricter controls in these lakes depends on whether the biological community is sufficiently protected by current limits on conventional pollutants.

3.2 Use Impairment in Areas of Concern

Although water quality in the Great Lakes has improved in recent decades, the IJC has identified 42 geographic AOCs, 30 of which are in the U.S. (five of these are shared with Canada), where beneficial uses are still impaired. In these locations, even though there may be less pollution than formerly, existing water quality standards and the objectives of the Great Lakes Water Quality Agreement are not being met.

The AOCs are depicted in Figure 3. Most are in nearshore and estuarine areas near the mouths of tributaries; most are also near major metropolitan areas.

Both conventional and toxic pollutants are problems in AOCs. Table 2 provides a summary of the water quality problems identified in each of the areas. Reduction of conventional pollution is at an advanced stage where results can be measured and controls refined. Control of toxic pollutants is at a much earlier stage.

All AOCs are affected by multiple site-specific problems for which Remedial Action Plans are being designed. Since most of the AOC's are at the mouths of tributaries, the accumulations of toxic chemicals may be due to contributions from upstream as well as from nearby sources. The principal source of toxic pollutants in AOCs may be sediments contaminated by past discharges or may be continuing discharges of pollutants.

3.3 Lakewide Toxic Pollution

The most obvious indicator of the problem of toxics in the open lakes is the numbers of fish consumption advisories that have been issued by the States. Table 3 summarizes the United States-issued fish consumption advisories developed and agreed to by each of the Great Lakes States and issued for 1987. These advisories are based on a few relatively well known toxic pollutants including mercury, PCBs, mirex, DDT, chlordane, and dioxins. However, many other substances are also known to be present in the fish and elsewhere in the system. In addition to the human health hazard, toxic pollutants may also be responsible for reproductive disorders that can prevent the establishment of naturally reproducing fish and fish predator populations, such as mink and bald eagles.

The United States and Canada have verified the presence of 362 compounds of concern in the Great Lakes system and are in the process of determining which of these have toxic effects of concern. Those identified as posing significant human or ecosystem health risks will receive priority attention and additional control efforts if needed.

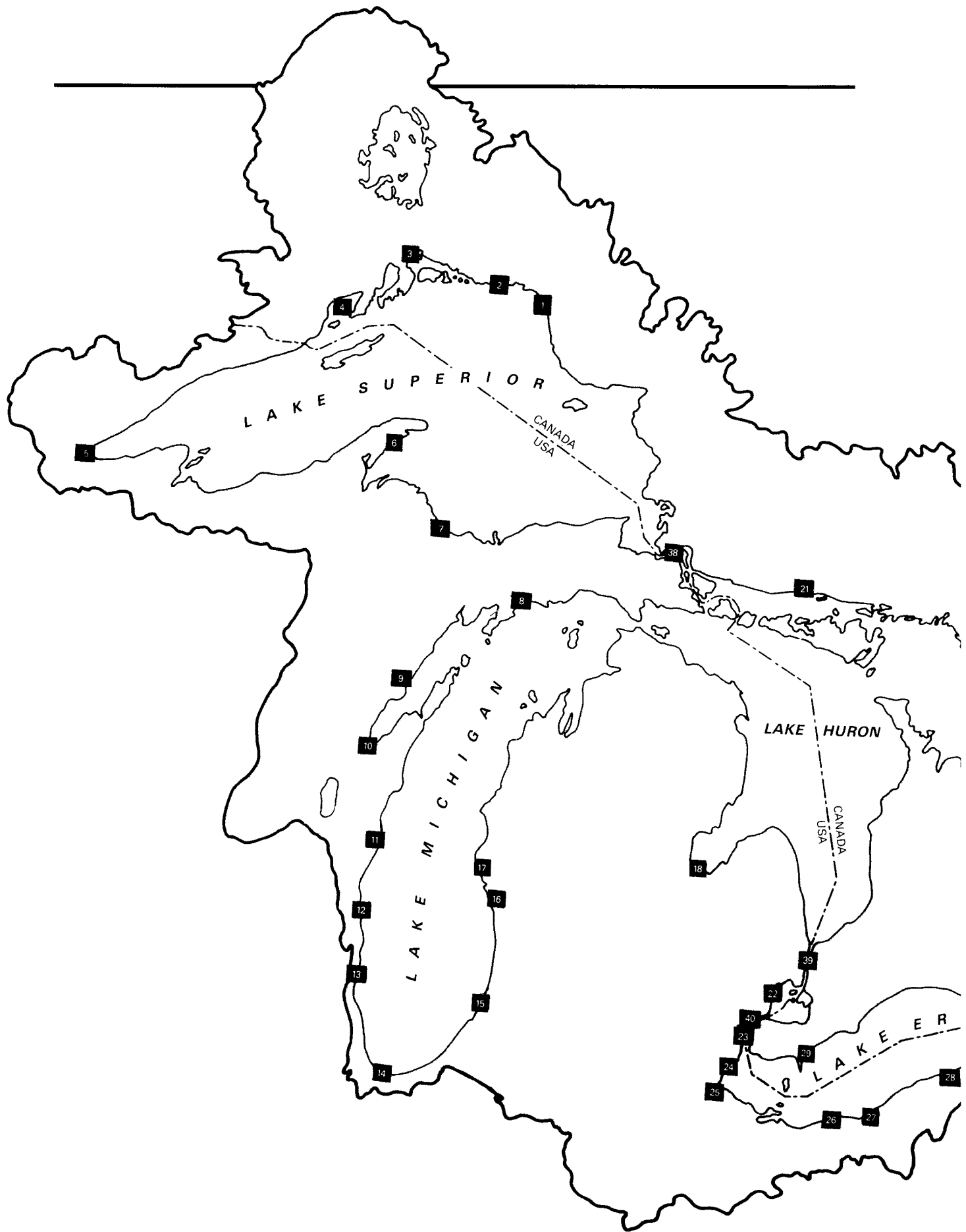
The 1987 revisions to the Water Quality Agreement call for the formal designation of these highest priority compounds as Critical Pollutants. In addition, the Agreement calls for the preparation of Lakewide Management Plans which will identify the remedial actions needed to attain the Agreement objectives as a step toward elimination of Critical Pollutants.

**Table 2. A Summary of Water Quality Problems
Identified in Areas of Concern**

| | Areas of Concern | Toxics in Water | Toxics in Sediments | Health Advisories on Fish | Fish Tumors ¹ | Impacted Biological Community | Elevated Bacteria Levels | Elevated Phosphorus Levels | Dissolved Oxygen Depletion |
|--------------------------------|-------------------------------|--------------------|------------------------|---------------------------------|-----------------------------|-------------------------------------|--------------------------------|----------------------------------|----------------------------------|
| Superior | Peninsula Harbor | • | • | • | N/D | • | X | • | X |
| | Jackfish Bay | • | • | • | N/D | • | • | X | • |
| | Nipigon Bay | • | • | • | N/D | • | • | X | X |
| | Thunder Bay | • | • | • | • | • | • | • | • |
| | St. Louis River/Bay | • | • | • | N/D | • | X | X | X |
| | Torch Lake | • | • | • | • | • | X | X | X |
| | Deer Lake-Carp Creek/River | X | • | • | N/D | • | X | • | • |
| Michigan | Manistique River | • | • | • | N/D | • | X | X | X |
| | Menominee River | • | • | • | • | • | X | X | X |
| | Fox River/S. Green Bay | • | • | • | • | • | • | • | • |
| | Sheboygan Harbor | • | • | • | N/D | • | X | X | X |
| | Milwaukee Estuary | • | • | • | N/D | • | • | • | • |
| | Waukegan Harbor | • | • | • | N/D | • | X | X | X |
| | Grand Calumet/Indiana Harbor | • | • | • | N/D | • | • | • | • |
| | Kalamazoo River | • | • | • | N/D | • | • | • | • |
| | Muskegon Lake | • | • | • | N/D | • | X | • | • |
| | White Lake | • | • | • | N/D | • | X | X | X |
| Huron | Saginaw River/Bay | • | • | • | X | • | • | • | • |
| | Collingwood Harbour | X | • | • | N/D | • | • | • | X |
| | Penetang Bay to Sturgeon Bay | X | X | • | N/D | • | X | • | X |
| | Spanish River | X | • | • | N/D | • | X | • | X |
| Erie | Clinton River | X | • | X | N/D | • | • | • | • |
| | Rouge River | • | • | • | • | • | • | • | • |
| | Raisin River | • | • | • | • | • | • | • | • |
| | Maumee River | • | • | X | N/D | • | • | • | • |
| | Black River | • | • | • | • | • | • | • | • |
| | Cuyahoga River | • | • | X | • | • | • | • | • |
| | Ashtabula River | • | • | • | N/D | • | • | • | • |
| | Wheatley Harbour | X | • | • | N/D | • | • | • | • |
| Ontario | Buffalo River | • | • | • | • | • | • | • | • |
| | Eighteen Mile Creek/Olcott H. | • | • | • | N/D | • | X | X | X |
| | Rochester Embayment | • | • | • | N/D | • | • | • | X |
| | Oswego River | • | • | • | N/D | • | • | • | X |
| | Bay of Quinte | • | • | • | X | • | • | • | • |
| | Port Hope | • | • | • | X | • | X | • | • |
| | Toronto Waterfront | • | • | • | • | • | • | • | X |
| | Hamilton Harbour | • | • | • | • | • | • | • | • |
| Connecting Channels | St. Mary's River | • | • | • | • | • | • | • | X |
| | St. Clair River | • | • | • | X | • | • | • | X |
| | Detroit River | • | • | • | • | • | • | • | X |
| | Niagara River | • | • | • | • | • | • | • | X |
| | St. Lawrence River | • | • | • | X | • | • | • | X |

¹In many cases, where fish tumors have been found, further work is warranted to determine the extent of the problem and the causative factor. In other cases, fish tumors have been directly linked to contamination by polynuclear aromatic hydrocarbons.

☐ Problem exists
 X Problem not evident
 N/D No data available
 Source: 1987 Report on Great Lakes Water Quality Report to the IJC



1. Peninsula Harbor
2. Jackfish Bay
3. Nipigon Bay
4. Thunder Bay
5. St. Louis River
6. Torch Lake
7. Deer Lake
8. Manistique River
9. Menominee River
10. Fox River and Southern Green Bay
11. Sheboygan
12. Milwaukee Estuary
13. Waukegan Harbor
14. Grand Calumet River and Indiana Harbor Ship Canal
15. Kalamazoo River

16. Muskegon Lake
17. White Lake, Montague
18. Saginaw River System and Saginaw Bay
19. Collingwood Harbor
20. Pentang Bay to Sturgeon Bay
21. Spanish River
22. Clinton River
23. Rouge River
24. Raisin River
25. Maumee River
26. Black River
27. Cuyahoga River
28. Ashtabula River
29. Wheatley
30. Buffalo River
31. Eighteen Mile Creek
32. Rochester
33. Oswego River
34. Bay Quinte
35. Port Hope
36. Toronto
37. Hamilton Harbor
38. St. Mary's River
39. St. Clair River
40. Detroit River
41. Niagara River
42. St. Lawrence River

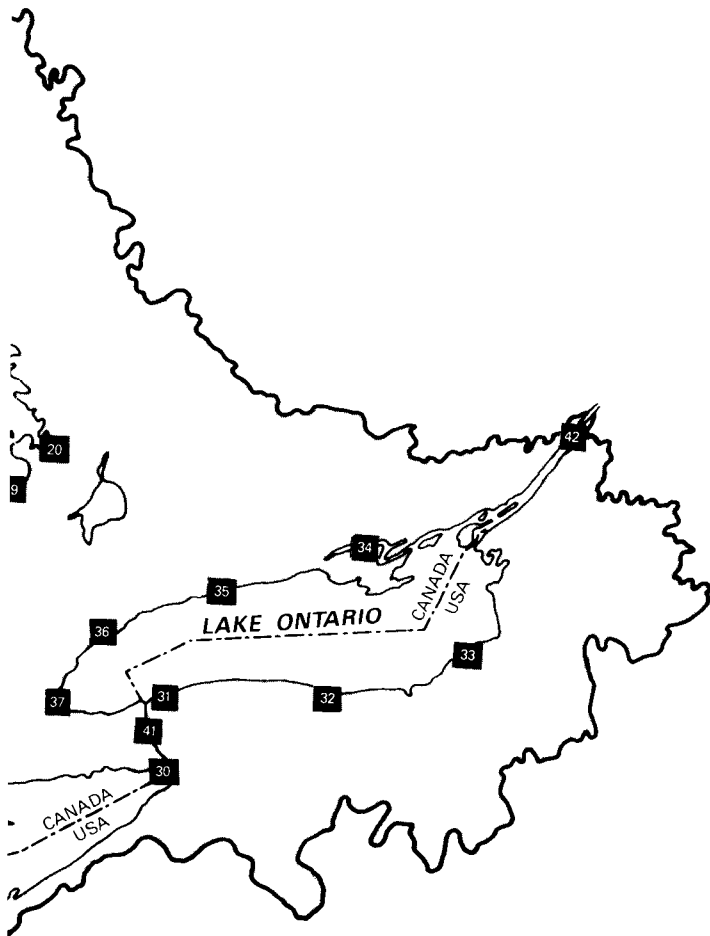


Figure 3. Areas of Concern in the Great Lakes Basin

Source: 1987 Report on Great Lakes Water Quality: Report to the IJC

At present, the sources and consequences of toxic pollutants are generally not understood well enough to determine whether current programs are adequate to achieve the goals of the Great Lakes Water Quality Agreement (i.e., virtual elimination of toxic substances). GLNPO recognizes the need for a research and monitoring strategy to investigate the sources, fates, and effects of toxic chemicals and to delineate their distribution in the Lakes, as an integral component of the formulation of remedial alternatives and the preparation of Lakewide Management Plans. In addition, a “mass balance” approach is being developed for use in the Great Lakes as a unifying technique for identifying and evaluating multiple pollutant sources.



Mass Balance Approach to Studying and Managing Toxic Substances

Traditionally, water quality management focused on control of pipes that discharge pollutants to surface waters. Such point sources were the easiest to identify, characterize, and control. In many cases, however, their control did not solve water quality problems.

With recognition that pollutants are also introduced indirectly from contaminated air, soil, sediments, and ground water, the management approach to Great Lakes water quality had to be reassessed. This reassessment led to the initiation of a “mass balance” approach in which the total contributions of pollutants from all sources are estimated and analyzed.

The mass balance approach uses the law of conservation of mass in evaluating the sources, transport, and fate of contaminants. This, in turn, allows prioritization and allocation of research, remedial actions, and regulatory efforts for water quality management. The approach requires that the quantities of contaminants entering the system, less quantities stored, transformed or degraded within the system, must equal the quantities leaving the system. Once an estimated quantity has been established for each pollutant of concern, the long-term effects on water quality of the lakes can be simulated by mathematical modeling.

The mass balance approach can be applied at various levels of intensity and precision. Mass balance modeling has been successfully used to support the regulation of nutrient loads to the Great Lakes during the past decade. Building on this success, Annex 2 of the Water Quality Agreement includes use of the mass balance approach in the development of Lakewide Management Plans for Critical Pollutants, in order to estimate total loads and the amount of reductions needed to attain ambient water quality objectives. Although the sources, pathways, and sinks for organic toxics are less well understood, it is anticipated that, in the near term, the mass balance approach can provide sufficient information to guide policy decisions on the reduction of toxics. In later years, it may be possible to use the mass balance approach directly to establish regulatory controls for toxics.

Table 3. Great Lakes Public Health Fish Consumption Advisory 1987

Certain species of fish at some sites in the Great Lakes have been found to be contaminated at levels requiring health advisories. These are listed below; precautions noted should be followed in order to prevent or reduce human exposure to potentially toxic materials. It is especially important that nursing mothers, pregnant women, women who expect to bear children, and children below age 15 not eat the fish listed below because of the uncertainties over the effect of chemical contaminants on the unborn and on children.

| Areas | Restrict Consumption ¹ | Do Not Eat |
|---|---|---|
| Lake Michigan ² (Applies to Michigan, Illinois, Indiana, and Wisconsin waters) | Lake Trout 20-23", Coho Salmon over 26", Chinook Salmon 21-32", and Brown Trout up to 23" | Lake Trout over 23", Chinook over 32", Brown Trout over 23", Carp, and Catfish |
| Green Bay ² (Wisconsin Waters South of Marinette/Menominee) | Splake up to 16" | Rainbow Trout over 22", Chinook over 25", Brown Trout over 12", Trout over 15", Splake over 16", Northern Pike over 28", Walleye over 20", White Suckers, White Bass, and Carp. |
| Lake Superior (Applies to Michigan, Wisconsin, and Minnesota waters) | Lake Trout up to 30", Walleye up to 26" (Wisconsin waters) | Lake Trout over 30", Walleye over 26" (Wisconsin waters) |
| Lake Huron ² | Lake Trout, Rainbow Trout, and Brown Trout | — |
| Saginaw Bay | Lake Trout, Rainbow Trout, and Brown Trout | Carp and Catfish |
| Lake Erie ² | Carp and Catfish (New York waters — eat no more than one meal per month) | Carp and Catfish (applies to Michigan, Ohio, and Pennsylvania waters) |
| Lake Ontario ² (New York waters) | White Perch, Coho Salmon up to 21", Rainbow Trout up to 18" (eat no more than one meal per month) | American Eel, Channel Catfish, Lake Trout, Chinook Salmon, Coho Salmon over 21", Rainbow Trout over 25", Brown Trout over 18" |
| Lake St. Clair (applies to Michigan and Ontario waters) | Walleye over 18", White Bass over 14", Smallmouth Bass over 14", Yellow Perch over 12", Carp over 22", Rock Bass over 8", Black Crappie over 10", Largemouth Bass 12-13", Bluegill and Pumpkinseed over 8", Freshwater Drum over 12", Carpsucker over 18", Brown Bullhead over 10", Catfish over 22", and all Northern Pike | Largemouth Bass over 14", Muskie, and Sturgeon |
| St. Clair River (applies to Michigan and Ontario waters) | Gizzard Shad over 10" | — |
| Detroit River | — | Carp |

¹ Also applies to tributaries into which migratory species enter.

² Nursing mothers, pregnant women, women who anticipate bearing children, and children age 15 and under should not eat the fish listed in any of the categories listed above.

Source: 1987 Report on Great Lakes Water Quality: Report to the IJC

The Great Lakes National Program Office Research and Monitoring Strategy for Toxic Pollutants



Research specific to the problem of toxic substances in the Great Lakes is needed for many reasons. The Lakes have many characteristics, most notably their size and the numbers of pollutant sources, that make them unique. The Lakes are a sink for pollutants from approximately one fifth of the U.S. population and industry. Long food chains in the Lakes cause toxic pollutants to be bioaccumulated at higher rates than in other freshwater bodies, where water retention times are lower and aquatic communities are less diverse. While these characteristics contribute to special problems in the Great Lakes, they also make the Lakes an "early warning system" for environmental pollution problems. Research on toxic pollutant problems in the Great Lakes can therefore serve not only to help solve Great Lakes water quality problems, but also to provide environmental managers responsible for other freshwater systems with an understanding of the most important factors affecting the movement and fate of toxic pollutants and the most effective management techniques for protection and remediation.

To fully understand the toxic pollution problem in the Great Lakes, research is needed on the effects of long-term exposures to chronic low-level toxic concentrations, the effects of short-term exposures to critical concentrations of toxics, and on total loadings of toxic pollutants to the Lakes. There is a need to examine toxic pollutant loadings from all media (air, ground water, sediment, surface water) in terms of their effect on the whole ecosystem. This need was the basis for initiating the mass balance study.

Multiple Federal and State agencies as well as the academic community have important roles in Great Lakes research and monitoring. The role of each organization is generally established by applicable laws and further defined by the existing expertise. The figure is included for purposes of illustration and shows the general emphasis for each of the Federally supported programs that participated in Great Lakes research, as of November 1985. This figure was included in a draft action plan for Federal research and monitoring on the Great Lakes, prepared by EPA, NOAA, and the Fish and Wildlife Service. It illustrates the need for cooperation among the organizations and between their monitoring and research groups.

Only a well-designed and coordinated interagency research and monitoring strategy can satisfy the objective of understanding the Great Lakes ecosystem. Programs must provide a scientifically defensible basis for managers to make decisions that will improve the quality of the Lakes. The research and monitoring strategy should include key management questions and should foster development of a sampling program and supporting studies targeted at those questions.

The approach to toxic substance research should proceed along several parallel, but related, paths. The first and most important step is to establish

a general long-term surveillance strategy for toxic substances, including measurement of inputs and ambient concentrations in water, sediment, and biota. Based on risk assessment techniques, EPA should establish a priority list of specific chemicals for monitoring at specific sites. An assessment of existing and required analytical capabilities to support the monitoring program will also be needed. While surveillance proceeds, a fundamental understanding of the important physical, chemical, and biological processes that work in the nearshore areas, connecting channels, harbors, and estuaries of the Great Lakes is needed and should also be developed in parallel.

Research Emphasis — November 1985

| | Physical | Chemical | Biological | Health |
|------------------|---|--|--|---|
| Management | Corps of Engineers | | U.S. Fish and Wildlife Service National Fisheries Research Center-Great Lakes | Federal Health Agencies |
| Surveillance | | U.S.E.P.A. Great Lakes National Program Office | | |
| Applied Research | N.O.A.A Great Lakes Environmental Research Laboratory and Sea Grant | U.S.E.P.A. ERL-Duluth Large Lakes Research Station | | No Known Active Great Lakes Health Research |
| Basic Research | | E.P.A. Exploratory Research N.S.F. Grants | | |

**Great Lakes Federal Strategy for Toxic Substances
Research Emphasis**

Laboratory research should seek causes of reproductive failures in fish and seek to identify any unexpected shifts in species that may result from exposures to toxic chemicals.

As this research proceeds, comprehensive and coordinated studies should be conducted to collect data, validate theoretical models, and address Areas of Concern. Throughout the conduct of this basic and applied research, scientists should participate in the environmental policy process. Scientists should set aside time for technical assistance to the regulatory process in EPA, to the IJC, and to the Corps of Engineers.

Because of large lake volumes, pollutants are rapidly diluted in the open waters of the Great Lakes. As a result, episodes of acute toxicity rarely occur. Long lake retention times, however, make chronic toxicity from prolonged exposure to low concentrations a major concern. Also, accumulations of some toxic pollutants biomagnify through the food chain to become as much as a million times more concentrated in fish than in water. Chronic toxicity problems are further exacerbated by low sediment burial rates (and, hence, prolonged exposures of fish and benthic organisms to contaminated sediments) and possible synergistic effects of toxic chemicals.

Effects of toxic pollutants that have been measured in the Great Lakes include health risks to humans as well as deformities, neoplasia, and reproductive disorders in birds, fish, mammals, and invertebrates. As the ability to detect toxic pollutants and their effects improves, it is likely that new pollutants will be discovered that will also require control or elimination.

The largest identified concentrations of toxic pollutants in the Great Lakes are in the AOCs. As remedial actions are taken to clean up the AOCs, loadings from these areas to the waters of the open lakes will be reduced. The extent to which such reductions will contribute to attaining water quality objectives in the open lakes can be evaluated using the mass balance approach. For pollutants with a major airborne deposition contribution, however, AOC reductions will have limited impact, except locally.

Problems of toxic pollutants are not limited to the Areas of Concern. As illustrated in Figure 4, many other locations outside the Areas of Concern have been found to have toxic pollutant concentrations, primarily in sediments.

Some toxic pollutant concentrations in the Great Lakes system have declined over the years, as previously illustrated in Figure 2. Key questions remain: How far will they be reduced by existing programs? How far must

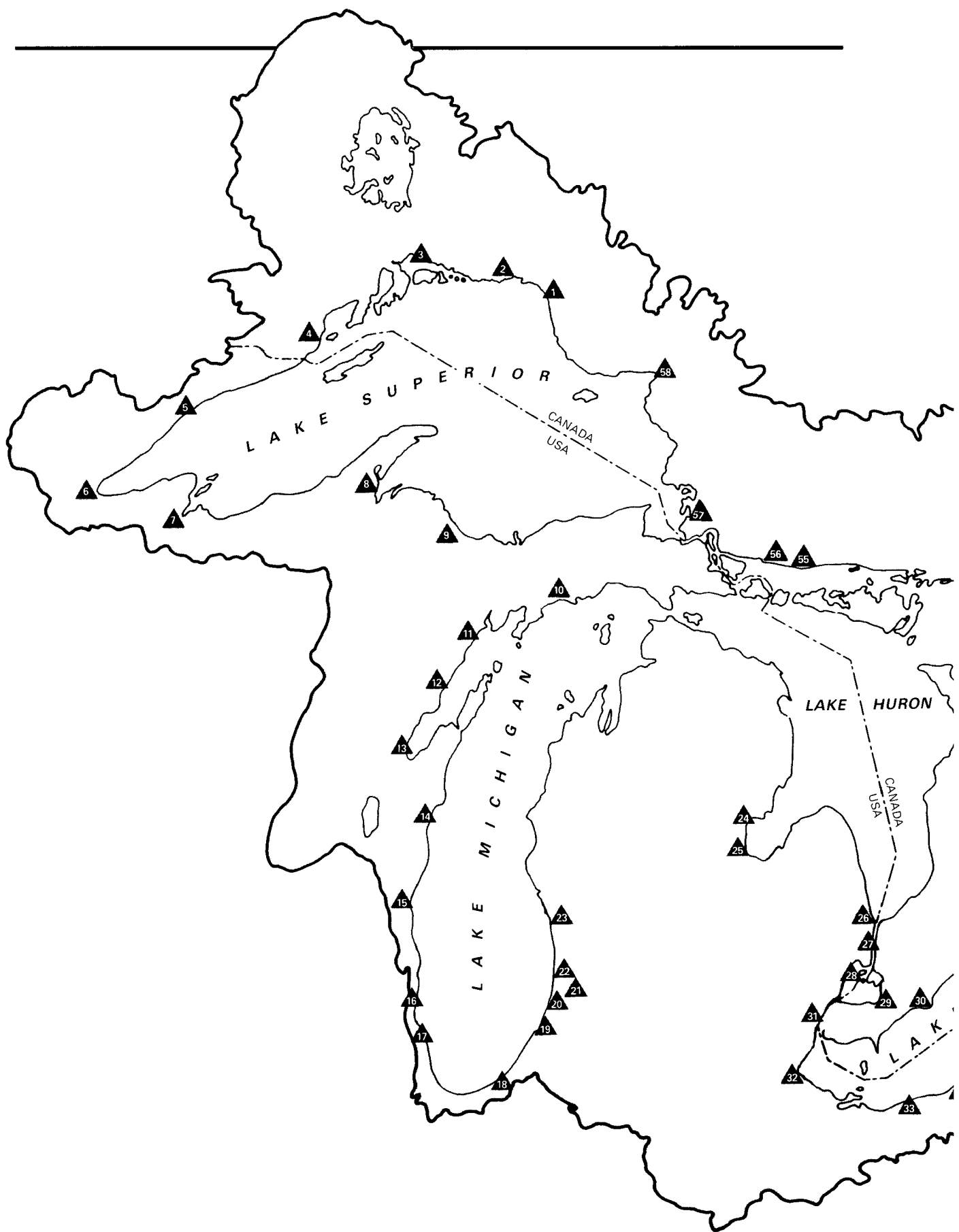
they be decreased to provide adequate protection for human and ecosystem health? What additional actions are needed to attain water quality objectives? These questions will be the focus of GLNPO's work in this area over the next five years.

Toxic pollutants released into the environment during the manufacture, transport, use, and disposal of various products may reach the Lakes by many pathways. Research in the 1970s showed that atmospheric deposition is a major source of pollutants in the Lakes for organic chemicals such as PCBs and toxaphene and for metals such as lead, zinc, and cadmium.

Atmospheric transport is believed to be the only source for some toxic chemicals to the Upper Great Lakes, where neither direct discharges nor land runoff can account for their presence or elevated levels in fish. More information is needed about sources to the atmosphere, including the role of combustion, evaporation, and volatilization, to support the development of regulatory controls. The Lakes themselves may contribute to atmospheric contamination, since volatilization of PCBs from the water surface into the air has been reported.

Sediments are another source of both toxic chemicals and nutrients that have settled out of the water column to become in-place pollutants. In many Areas of Concern, toxic pollutants are concentrated in sediments that may be in "toxic hotspots" or dispersed over wide areas in embayments and in tributaries. They tend to accumulate below direct discharges of effluents with a high solids content and may remain in place indefinitely. In areas where sediments have high concentrations of toxic chemicals, fish have even higher concentrations in their tissues. Concern about these contaminated sediments has grown with discovery of high rates of lip and liver tumors in bullheads that feed on the bottom. Sediments become a source of contamination when toxic pollutants are released by biological action, by physical disturbance from boats or storms, or by dredging navigation channels. Although the highest concentration of toxics in sediments was deposited before discharge regulations were in effect, accumulation of many pollutants is continuing.

Discharge from waste sites and other sources of ground-water contamination, through surface runoff or through ground water, is another source of contaminants to the Lakes. Concern about this source has increased with the confirmation of loadings from landfills to the Niagara River, and with the known ground-water contamination from the many hazardous and solid waste disposal sites that are adjacent to the Great Lakes or their tributaries. EPA's Superfund and Resource Conservation and Recovery Act programs address identified problems at these sites. GLNPO will need to work closely with these programs to ensure that impacts to the Lakes are identified and that resultant remedial actions meet the



- 1 Marathon — mercury, PCB's, dioxin, PCP
- 2 Jackfish Bay — mercury, phenols
- 3 Nipigon Bay — mercury, phenols
- 4 Thunder Bay — PCP, mercury
- 5 Silver Bay — asbestiform fibers
- 6 Western Basin — asbestiform fibers
- 7 Ahland — PAH's, heavy metals
- 8 Keweenaw Peninsula — copper mine tailings
- 9 Deer Lake/Carp River — mercury
- 10 Manistique River — PCB's
- 11 Menominee/Marinette — arsenic
- 12 Green Bay — PCB's, mercury, PCDF's
- 13 Fox River — PCB's, mercury, chlorinated organic, PCDF's
- 14 Sheboygan River — PCB's
- 15 Milwaukee — PCB's, heavy metals, PAH's
- 16 Waukegan Harbor — PCB's
- 17 Great Lakes Naval Training Center — heavy metals
- 18 Indiana Harbor/Grand Calumet River — PCB's, heavy metals, PAH's
- 19 Kalamazoo River — PCB's
- 20 Grand River — heavy metals
- 21 Muskegon River — PAH's
- 22 Muskegon Lake, Mona Lake, Little Bear Creek — chlorinated organics, heavy metals
- 23 White Lake — PCB's, chromium, chlorinated organics
- 24 Pine/Tittabawassee/Saginaw Rivers — PBB's, dioxin, PCB's, PCDF's
- 25 Saginaw Bay — PCB's, PCDF's, DDT
- 26 Sarina — PAH's, mercury, PCS's, chlorinated organics, octochlorostyrene
- 27 St. Clair River — heavy metals, PCB's chlorinated organics, alkyl lead, PCS's, octochlorostyrene
- 28 Lake St. Clair — mercury
- 29 Thames River — pesticides
- 30 Wheatley Harbour — pesticides, PCB's
- 31 Detroit River — PAH's, PCB's, heavy metals
- 32 Monroe — PCB's, heavy metals
- 33 Black River — heavy metals, PAH's
- 34 Cleveland Area — heavy metals
- 35 Ashtabula River — heavy metals, PCB's PAH's, PCS's, HCB's, HCB's
- 36 Port Colbourne — heavy metals
- 37 Buffalo River — PAH's, phenols, heavy metals, chlorinated organics, octochlorostyrene
- 38 Niagara River — mirex, PCB's PAH's, heavy metals, chlorinated organics
- 39 Niagara Falls (Love Canal) — dioxin, chlorinated organics
- 40 Olcott — heavy metals
- 41 Rochester Embayment — heavy metals
- 42 Oswego Harbor — mirex, PCB's, heavy metals
- 43 Sackets Harbor — mercury
- 44 Massena/Grass River — PCB's
- 45 Cornwall — PCB's, heavy metals
- 46 Maitland — alkyl lead
- 47 Moira River — heavy metals
- 48 Bay of Quinte — mercury, dioxin, PCP
- 49 Port Hope — uranium, radium, heavy metals
- 50 Whitby Harbour — polychlorinated biphenyl ethers
- 51 Toronto — PCB's, pesticides, dioxin mirex, heavy metals
- 52 Hamilton Harbour — PCB's, heavy metals, phenols
- 53 St. Catharines — PCB's
- 54 Collingwood — heavy metals, PCB's
- 55 Spanish River — PCB's, heavy metals, phenols
- 56 Serpent Harbour — heavy metals, DDT, radionuclides
- 57 St. Mary's River — phenols
- 58 Michipicoten Harbour — PCP



Figure 4. Locations of Known Toxic Pollutant Problems in the Great Lakes Basin

Source: U.S.E.P.A. publication, *Toxic Substances in the Great Lakes*, June 1980

objectives of the statutes and the Great Lakes Water Quality Agreement. The impacts on the Lakes, if any, from the underground injection of waste, or from underground storage tanks, have yet to be investigated.

Safe disposal and treatment of contaminated sediment after removal is of great concern. Whether the environmental impact is greater from removal of contaminated sediments or from leaving them in place is a major issue in many Areas of Concern.

Likewise, decisions to treat contaminated ground water that is, or will be, discharging to the Lakes is an issue that should be based on overall environmental impacts.

Stormwater runoff, from both urban and industrial sites, and agricultural runoff are potentially large sources of chemicals. Continuing increases in the use of pesticides in both urban and rural areas remain a major concern that needs to be further evaluated. The Clean Water Act Amendments of 1987 place renewed national emphasis on nonpoint source, combined sewer overflow and stormwater problems. New and existing EPA programs will be addressing these problems through national assessments and control programs in the next few years. GLNPO will work with these programs to ensure that Federal policies account for the special needs of the Great Lakes ecosystem.

Regulatory and Remedial Programs



Existing Federal and State Environmental Programs and a Review of Accomplishments

Tools available for correcting pollution problems and enhancing environmental quality in the Great Lakes derive from Federal mandates created through a variety of Congressional Acts.

4.1 Program Descriptions

U.S. water pollution control programs are implemented through a partnership between EPA's Regional Water Divisions and the States that operate these programs under delegated authority. The Clean Water Act requires a comprehensive program of technology-based effluent controls for pollution from point sources. In addition, controls based on ambient water quality must be established where technology-based requirements alone are not sufficient to protect receiving waters.

These controls are imposed and enforced under the National Pollutant Discharge Elimination System (NPDES) of the Clean Water Act. Discharges of specific toxic pollutants from point sources are being limited as NPDES discharge permits are reissued. Under the pretreatment program, industrial dischargers of toxic pollutants to publicly owned treatment works (POTWs) are required to treat their effluents to reduce or eliminate the level of toxic pollutants if these pollutants pass through the POTW or interfere with the POTW's treatment process. All point source dischargers to the Great Lakes are subject to permit requirements and all of the major Great Lakes cities in the U.S. have pretreatment program requirements specified in their NPDES permits. Improved controls for discharges of toxic pollutants and planning for improvements to water quality in areas where toxic pollutants are especially problematic will be important areas of emphasis for State and Federal water programs in the next few years. As biological monitoring and fate and effect research define information needs

for mass balance modeling, GLNPO will develop studies to provide information that will enable State and Federal programs to determine where strict effluent limits for toxic pollutants are most needed.

Since point source discharges are not the only sources of toxic pollutants entering the Great Lakes, other authorities must be exercised in order to fully control and correct the toxics problem facing the Lakes. These laws include the nonpoint source control authorities and dredge and fill regulations established under the Clean Water Act and under laws of various States, the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Clean Air Act, and the National Environmental Policy Act (NEPA).

The *Toxic Substances Control Act* (TSCA) empowers the Administrator of EPA to regulate chemical substances and mixtures that present an unreasonable risk to human health or the environment and to take action with respect to chemical substances and mixtures that pose imminent hazards. Under TSCA, EPA gathers certain basic information on chemical risks from chemical manufacturers and processors. EPA may require companies to conduct specific tests on the toxicity of chemicals before they are manufactured for distribution in commerce. To prevent unreasonable risks, EPA may select from a broad range of control actions available under TSCA, ranging from requiring hazard warning labels to outright bans on the manufacture or use of especially hazardous chemicals. EPA may regulate chemicals at any stage in their life-cycle: during manufacturing, processing, distribution in commerce, use, or disposal.

The *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA) governs the licensing or registration of pesticide products. No pesticide may be marketed in the United States until EPA reviews an application for registration, approves each specific use pattern, and registers the product. Decisions are based upon data demonstrating that use will not result in unreasonable human health or environmental effects. FIFRA balances the risks a pesticide may pose with its benefits to society.

The *Safe Drinking Water Act* (SDWA) has three provisions to protect ground-water resources. The Sole Source Aquifer Program requires EPA to review all Federally funded or supported projects within sole source aquifers to ensure that such projects have no adverse impact on the aquifer. The Wellhead Protection Program requires States to identify wellhead protection areas around public water supplies and to develop ground-water management plans for these areas. The Underground Injection Control Program protects underground sources of drinking water. These sources of

drinking water are aquifers, or portions of aquifers, that contain water with less than 10,000 parts per million of dissolved solids and that supply public water systems, or have the potential to do so.

The *Resource Conservation and Recovery Act (RCRA)* and its subsequent amendments provide EPA's authority to regulate the transportation, treatment, storage, and disposal of solid and hazardous waste in the U.S. Subtitle D of RCRA encourages States to develop comprehensive plans for the management of solid wastes (i.e., domestic solid wastes, agricultural wastes, and small quantities of industrial wastes). Subtitle C establishes a system for controlling hazardous industrial waste from the time it is generated until its ultimate disposal, in effect from "cradle to grave." Amendments to RCRA passed in 1984 provided new authorities for cleaning up existing contamination at hazardous waste sites and for encouraging industry to develop techniques for minimizing the quantities of hazardous waste generated. Under Subtitle I, RCRA controls certain underground storage tanks by establishing performance standards for new tanks and requiring leak detection, prevention, and corrective action at underground tank sites.

The *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)* authorized the Federal government to develop a system for identifying and cleaning up chemical and hazardous substance releases harmful to public health and the environment; established a "Superfund" to pay for cleaning up environmental contamination in instances where no responsible parties can be found or where the parties cannot pay for cleanup; and authorized EPA to recover the costs of cleaning up chemical and hazardous substance releases through litigation against responsible parties. Further legislation under the *Superfund Amendments and Reauthorization Act (SARA)* redirects the remedial process to include an emphasis on permanent remedies and innovative treatment technologies; increases the emphasis on State involvement in the initiation, development, and selection of remedial actions; and expands removal authorities.

Under the *Clean Air Act*, EPA is empowered to effect reductions in atmospheric concentrations of toxic pollutants by establishing and enforcing national emission standards. Other Federal standards for motor vehicle emissions, new sources of air pollution, and municipal solid waste combustion have also been promulgated under the Act. In addition to Federal regulation, reductions in atmospheric toxic pollution result from implementation and enforcement of State and local air toxics programs.

The *National Environmental Policy Act (NEPA)* directs all Federal agencies to determine the potential environmental impacts of their proposed activities and to consider those impacts in their decision-making process. EPA is the central clearinghouse for ensuring an on-the-record review for all Federal activities.

The eight Great Lakes States also have their own environmental laws and regulations to protect the Lakes. The purpose of some State programs is to implement delegated Federal authorities, while others implement State policies that supplement Federal policy or address other issues.

4.2 Program Achievements

Since passage of the Federal Water Pollution Control Act of 1972, considerable progress has been made toward controlling pollution in the Great Lakes Basin, under the Clean Water Act and the many other environmental statutes administered by EPA. The most notable progress relates to cleanup of municipal and industrial discharges to surface waters. U.S. direct discharges into the Great Lakes system are now regulated under 3,819 discharge permits, 2,633 industrial permits, and 1,186 municipal sewage treatment facility permits. Through 1987, \$8 billion in Federal and State grants had been invested in the Great Lakes Basin for municipal sewage treatment works.

In 1986, more than 95 percent of the Great Lakes States population within EPA Region V was served by municipal sewage treatment facilities, and 99 percent of the sanitary wastes in sewered areas received at least secondary treatment. Additional treatment for phosphorus removal was provided for 79 percent of sewage, and 206 of 273 major facilities complied with the 1 milligram per liter (mg/l) effluent limit for phosphorus. Advanced waste treatment was used in 15 percent of treatment facilities and eight percent provided high-level nitrogen control.

Figure 5 shows the reduction in phosphorus discharged from the major municipal sewage treatment plants to Lakes Erie and Ontario. The approximately 80 percent reduction since 1972 has reduced the U.S. phosphorus loadings down to the limits set in the Agreement with Canada. Biochemical oxygen demand and discharges of suspended solids have been reduced by approximately the same magnitude. Such substantial compliance is reflected in clearer water, less algal growth, and the return of desirable fish species to many locations.

Considerable progress has been made under other statutes as well. Since Federal regulations for hazardous waste generation, transport, treatment, storage, and disposal facilities were promulgated in 1980, EPA's Regional programs and delegated State programs have identified 25,958 permittees and permit applicants in the counties of the Great Lakes Basin. Statutory provisions added in 1984 will ensure that the full scope of environmental contamination resulting from improper handling of hazardous waste will be

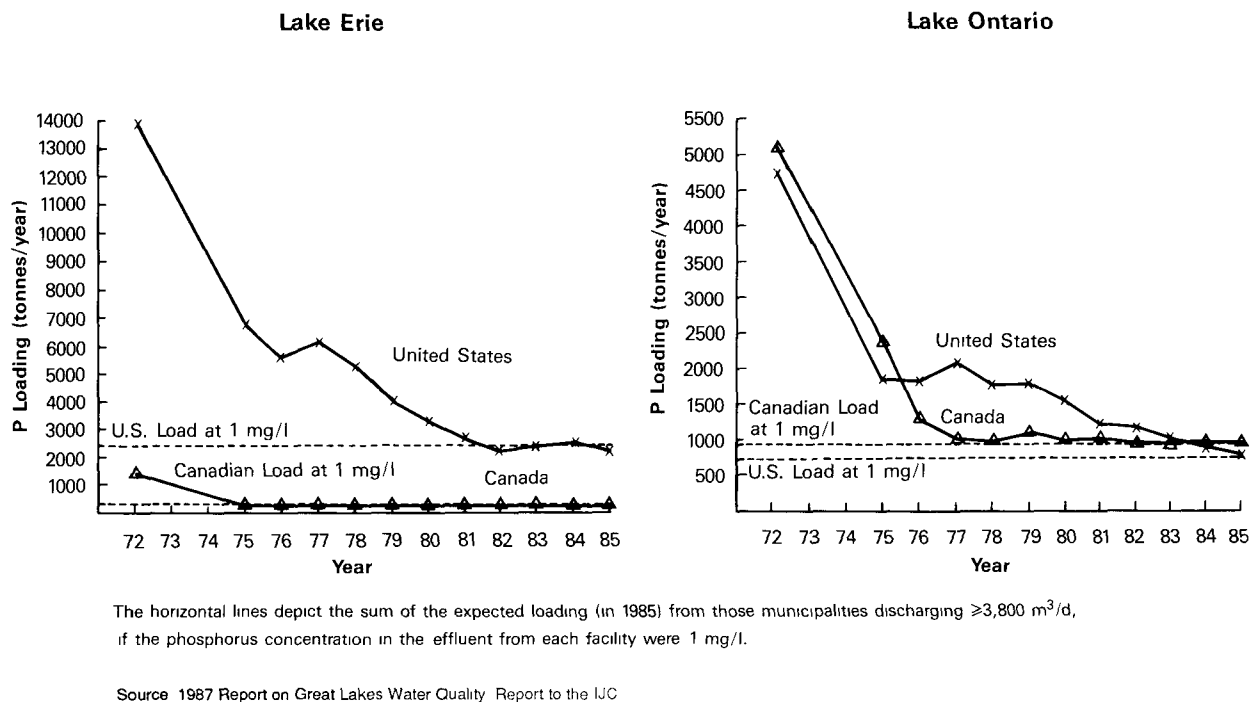


Figure 5. Reported Municipal Phosphorus Loadings to the Lower Great Lakes

controlled. Under the RCRA corrective action program, facility owners and operators will be required to clean up all existing contamination before permits will be granted.

Uncontrolled hazardous materials sites in the Basin have also received considerable attention since passage of the Superfund Act in 1980. EPA's National Priority List (NPL), required by the Superfund Act, identifies hazardous waste sites of national importance that are eligible for Federal cleanup funds. This list includes over 131 sites located in the Great Lakes Basin. Moreover, States such as Michigan, New York, Ohio, and Minnesota have created their own State Superfunds to address sites that do not warrant listing on the NPL but have high State priority for cleanup.

State air programs in the Great Lakes Basin have made considerable progress toward implementing the provisions of the Clean Air Act and, particularly over the last several years, have greatly reduced sulfur dioxide emissions within the Basin. Attention has now turned to the control of

air toxics. All eight States in the Basin are coordinating emissions inventory procedures for air toxics and jointly developing permit guidelines to assure appropriate controls on air toxic sources.

The Great Lakes States have realized many important accomplishments toward achieving the goals of the Agreement in recent years. As an example, in 1987, the Governor of Ohio established a Lake Erie Office charged with coordinating all State policies, programs, and procedures to protect and ensure the wise development of Lake Erie; advising on the implementation of a basin wide approach to Lake Erie issues; promoting education and the wise management of Lake Erie resources; improving State partnerships with local governments; and establishing a coastal management program.

The State of Michigan has an Office of the Great Lakes within its Department of Natural Resources and produces an annual State of the Great Lakes Report. The Annual Report for 1987-1988 reports a number of successes including a new State Nonpoint Source Pollution Program; the completion of a strategy for a State-run loan program to finance construction of municipal wastewater treatment facilities; and the initiation of source reduction impact statements as part of the State permitting process to address toxic discharges. Future initiatives are also outlined in the Report. These include (1) a Michigan Environmental Enforcement and Research Trust Fund that would use judgments against and settlements with polluters to fund enforcement of environmental laws and sponsor Great Lakes research and (2) the establishment of a Great Lakes Congress to inform Michigan citizens about Great Lakes issues.

The State of New York is carrying out provisions of a Declaration of Intent, signed in February 1987 by the New York State Department of Environmental Conservation, Ontario Ministry of the Environment, Environment Canada, and EPA. This four-party agreement includes a commitment for a 50 percent reduction in persistent toxic chemicals of concern to the Niagara River by 1996. The State's Niagara River Toxic Management Plan, first produced in July 1987 in response to the toxics commitment, calls for controls on both point and nonpoint sources of pollution. Another four-party toxic management plan, for Lake Ontario, is also being developed in 1988.

The State of Wisconsin has had important achievements toward the goals of the Agreement. The Remedial Action Plan for the Lower Green Bay/Lower Fox River was signed by the Governor of Wisconsin as an amendment to Wisconsin's Water Quality Management Plan. The development of this plan is a good example of the value of public participation. A 70-member Citizen's Advisory Committee, with four technical subcommittees, advised the Wisconsin Department of Natural

Resources in the preparation of the plan. All parties worked together to identify their goals for the Bay and River in the year 2000 and to develop 16 Key Actions and many specific recommendations necessary to achieve this "Desired Future State." The "Desired Future State" includes a healthy bay environment, a balanced edible sport/commercial fishery, water-based recreational opportunities, good water quality that protects public health and wildlife, balanced shoreline use, productive wildlife and plant communities, and an economical transportation network that minimizes adverse environmental effects.

Key actions include reducing phosphorus and sediment loads, increasing the numbers of sport fish, enhancing public and private shoreline uses, and increasing public education efforts. The all-encompassing nature of the plan led to inclusion of a recommendation to create a coordinating council as an institutional structure for implementation. The council members will include local, State, and Federal officials, and citizen members representing business, industry, recreational, and environmental interests.

The Great Lakes States have also worked jointly toward achieving the goals of the Great Lakes Water Quality Agreement. In June 1986, the Governors of the eight Great Lakes States signed "The Great Lakes Toxic Substances Control Agreement." This agreement pledges the States to treat the Lakes as a single ecosystem despite political boundaries, acknowledges that toxic pollutants are the foremost problem to be addressed, and lays out goals for the States. More recently, the Governors agreed to establish a permanent fund for Great Lakes studies.

During the next five years, GLNPO will work closely with State and EPA Headquarters and Regional programs to focus regulatory, permitting, and enforcement actions in the Basin on the most critical pollution problems. GLNPO has already begun to work with new programs for ground-water pollution, for example, to ensure that the information needed to support management decisions is made available in a format that facilitates decision-making. In the next five years, GLNPO will expand its work with hazardous and solid waste programs and will play an active role in assisting State water programs with planning for cleanup of toxic pollution in surface waters.

The Clean Water Act



GLNPO's Charter to coordinate the U.S. Response to the Great Lakes Water Quality Agreement

The Clean Water Act Amendments of 1987 included Section 118, which formally recognizes the Great Lakes as a valuable national resource and establishes a Congressional mandate for the Great Lakes National Program Office. Under various elements of Section 118, the Program Office is specifically mandated to:

- Develop and implement specific action plans to carry out the responsibilities of the U.S. under the Great Lakes Water Quality Agreement, in cooperation with appropriate agencies and with full public participation (c)(1)(A)
- Establish a Great Lakes system-wide surveillance network to monitor the water quality of the Lakes, with emphasis on monitoring toxic pollutants (c)(1)(B)
- Serve as liaison with, and provide information to, the Canadian Members of the International Joint Commission, and the Canadian counterpart to EPA (c)(1)(C)
- Coordinate actions of the Agency aimed at improving Great Lakes water quality (c)(1)(D)
- Coordinate actions of the Agency with the actions of other Federal, State, and local agencies so as to ensure the input of those agencies and authorities in developing water quality strategies and obtain the support of those agencies and authorities in achieving the objectives of such agreement (c)(1)(E)
- Develop a five year plan and program for reducing the amount of nutrients introduced into the Great Lakes (c)(2)

-
- Carry out a five year study and demonstration projects relating to the control and removal of toxic pollutants in the Great Lakes, with emphasis on the removal of toxic pollutants from bottom sediments (c)(3).

The EPA Administrator is required to:

- Ensure that GLNPO enters into agreements concerning Great Lakes activities with appropriate EPA offices and State agencies that describe duties and responsibilities, time periods, and resources to be committed (c)(4)
- Include a separate budget line item for GLNPO annually (c)(5)
- Submit a comprehensive annual report to Congress that describes the achievements of the preceding fiscal year, progress in implementing a Great Lakes water quality surveillance system, long-term prospects for Great Lakes water quality improvement, and efforts planned for the succeeding year (c)(6).

The Act also establishes a Great Lakes Research Office (GLRO) within the National Oceanic and Atmospheric Administration (NOAA) to identify research issues, inventory research programs, establish a research exchange, develop a data base and comprehensive research program, and conduct research and monitoring activities (d). GLNPO and GLRO are required to prepare a joint research plan annually (e).

The Army Corps of Engineers, Soil Conservation Service, Coast Guard, Fish and Wildlife Service, and NOAA are required to submit annual reports to the EPA Administrator on activities affecting compliance with the Great Lakes Water Quality Agreement.

The Clean Water Act Amendments of 1987 contain other sections that will be important for supporting Great Lakes objectives over the next five years. Two of these sections address control strategies for toxic pollutants and management of nonpoint sources of pollution:

- The toxics provision, Section 304, requires States to submit to EPA a list of waters that are expected to fall short of water quality standards even after discharges have met current cleanup requirements, due to the presence of toxic pollutants. States must identify the specific discharges responsible for the toxic pollution and propose strategies for reducing toxic discharges from these facilities.

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- A new program, Section 319, was created to control nonpoint source pollution. This program requires a State assessment of waters that are not expected to meet water quality standards because of nonpoint source pollution and development of a management program for controlling this pollution.

The Great Lakes Water Quality Agreement



*An Overview of the 1972, 1978, 1983, and 1987
Water Quality Agreements with Canada*

6.1 Overview

The Boundary Waters Treaty of 1909 affirmed that Canada and the United States have equal rights to the use of waterways that cross the international border and that neither country has the right to pollute its neighbor's resources. The International Joint Commission (IJC) was established as an independent body to assist the two governments under the treaty. For many years the treaty primarily provided a non-confrontational process for limited regulation of water levels and flows for navigation and power production.

The first Water Quality Agreement between the U.S. and Canada was signed in 1972. In response to an increasing understanding of the Great Lakes and their pollution problems, the 1978 Agreement, and the 1983 supplement, evolved in several important respects. First, while the 1972 Agreement called for control of pesticides as the principal means for controlling toxic pollution, the 1978 Agreement called for control of all toxic substances that could endanger the health and well-being of any living organism. Second, under the 1978 Agreement, water quality restoration and enhancements were called for throughout the Great Lakes Basin, not just in the waters of the Great Lakes. Third, the 1983 supplement required phosphorus target loads and required commitments to prepare and implement load reduction plans.

In 1987 the Water Quality Agreement was again amended. The basic purpose of the Agreement remained to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin ecosystem." To achieve this purpose, the Parties agreed to:

- Develop programs, practices, and technology necessary for a better understanding of the Great Lakes Basin ecosystem; and

-
- Eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes system.

A major provision of the 1972 Agreement that has been carried over to the present Agreement is the setting of specific water quality objectives. These objectives specify ambient levels of pollutants that must be attained to protect beneficial uses. Attainment of these water quality objectives is the major mechanism for implementing the purpose and goals of the Agreement.

In addition to setting objectives, the Agreement calls for preparation of management plans, implementation of remedial actions to address pollution sources, and monitoring of compliance and environmental conditions. Implementation in each country depends on the integration of remedial programs into National, Provincial, and State laws and policies. Responsibilities under the Agreement are shared equally by the Parties (the two governments as Parties to the Agreement).

The 1987 revision recognizes the need for strengthened efforts to address the continuing contamination of the Great Lakes Basin ecosystem, particularly by persistent toxic substances. It acknowledges that many of these toxic substances result in part from sources of air pollution within and beyond the Great Lakes Basin and that these substances may lead to polluted ground water and sediments that become potential sources of contaminant loadings to the Lakes. The revised Agreement provides an awareness that further research and program development is required to enable effective remedial actions and recognizes the need for decisive leadership in the implementation of control measures. In placing new emphasis on management and accountability, the roles of the two governments and the IJC are given clearer definition. For example, the Parties are called upon to provide numerous reports to the IJC as summarized in Table 4. The IJC is to then conduct reviews and evaluations followed by recommendations to the two countries (the Department of State in the U.S.) on the adequacy of the reported activities in satisfying the terms of the Agreement.

6.2 Role of the International Joint Commission

The IJC consists of six Commissioners, half appointed by the Chief Executive of each country. The Commission addresses a variety of boundary waters concerns along the international border by calling attention to problems, recommending actions to the governments, or evaluating actions of the governments.

**Table 4. Summary of Reporting Requirements and Milestones
Added by the 1987 Water Quality Agreement**

| Annex | Dates | Subject |
|---|--|--|
| Annex 1; Specific Objectives | 4/1/88 7/1/88 & biennially 12/31/88 | Resolve toxicity definitions Review specific water quality objectives and establish toxic substance action levels Compile and maintain lists of known or suspected toxic pollutants |
| Annex 2; Remedial Action Plans and Lakewide Management Plans | 12/31/88 & biennially 9/30/89 & biennially | Progress Report Identification and review of Point Source Impact Zones |
| Annex 12; Persistent Toxic Substances | 12/31/88 & biennially | Progress Report on reducing generation of contaminants |
| Annex 13; Pollution from Nonpoint Sources | 12/31/88 & biennially | Progress Report |
| Annex 14; Contaminated Sediment | 6/30/88 12/31/88 & biennially 12/31/88 & biennially 12/31/88 12/31/88 & biennially | Begin design of demonstration program Progress Report Methods evaluation Approach and procedure for management of contaminated sediments Evaluate technologies |
| Annex 15; Airborne Toxic Substances | 10/1/88 12/31/88 & biennially | Confer on air deposition network Progress report |
| Annex 16; Pollution from Contaminated Ground Water | 12/31/88 & biennially | Progress Report |

The Water Quality Agreement created two boards to provide advice to the IJC concerning water quality within the Great Lakes Basin: the Water Quality Board and the Science Advisory Board.

The purpose of the Water Quality Board is to advise the IJC about progress under the Agreement and to propose needed actions. Members

serve as resource experts rather than as representatives of their agencies. U.S. members are generally drawn from State environmental management agencies, with the Great Lakes National Program Manager traditionally serving as chairman of the U.S. section.

The Science Advisory Board advises both the IJC and the Water Quality Board about needed scientific research and carries out special investigations on request. Its membership includes managers of Great Lakes research programs and other experts. Both boards are assisted by committees and task forces.

The IJC operates a binational Great Lakes Regional Office in Windsor, Ontario, that provides secretariat services to the two boards of experts called for in the Agreement. The agencies represented on the boards fund the participation of their staffs and the activities required to serve the boards. No reimbursement for services by government agencies is provided by the IJC.

6.3 Role of the Parties

The role of the U.S. and Canada (the Parties) is to implement their Water Quality Agreement. Formal international communication between the U.S. and foreign governments is conducted in the U.S. by the Department of State. The State Department led the delegation that negotiated the 1987 Amendments to the Agreement. In addition to clarifying the role of the Parties, these Amendments also call upon the Parties, in Article X(3), to meet twice a year to “coordinate their respective work plans with regard to implementation . . . and to evaluate progress made.”

The U.S. Department of State and its Canadian counterpart, External Affairs, Canada, have delegated lead responsibility to USEPA and its counterpart, Environment Canada, for the semiannual meetings. These agencies, in turn, have assigned this responsibility to their respective national program managers. Thus the Great Lakes National Program Manager in Chicago now has three distinct Great Lakes roles: 1) Great Lakes National Program Manager for USEPA across the eight Great Lakes States; 2) U.S. co-chairman of the binational coordination meetings; and 3) U.S. co-chairman of the IJC Water Quality Board. Staff support for all three of these functions is provided by GLNPO.

6.4 Summary of the Water Quality Agreement

General purposes and obligations are described in the text of the Agreement. Specific measures to reduce and prevent pollution are listed in the annexes. For EPA, the following provisions are the most important:

Article II of the Agreement sets forth the intent of the Parties “to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem.” It also states the policy that “*The discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated.*”

Article III sets forth general objectives that state that the waters of the Great Lakes should be free from materials that adversely affect various beneficial uses or adversely affect aquatic life.

Article IV calls for the development of specific water quality objectives according to a process identified in Annex 1. The article states that, “*The Specific Objectives adopted pursuant to this Article represent the minimum levels of water quality desired in the boundary waters of the Great Lakes System and are not intended to preclude the establishment of more stringent requirements.*”

Article IV also sets forth the basis for the management framework contained in Annex 2. “*The Parties recognize that there are areas in the boundary waters of the Great Lakes System where, due to human activity, one or more of the General or Specific Objectives of the Agreement are not being met. Pending virtual elimination of persistent toxic substances in the Great Lakes System, the Parties, in cooperation with State and Provincial Governments and the Commission, shall identify and work toward the elimination of: (i) Areas of Concern pursuant to Annex 2; (ii) Critical Pollutants pursuant to Annex 2; and (iii) Point Source Impact Zones pursuant to Annex 2.*”

Annex 1 identifies specific water quality objectives. The 1987 supplement to Annex 1 calls for priority lists of substances to be periodically reviewed and considered in the development of new objectives. The supplement also calls for the development of ecosystem objectives for each Lake.

Annex 2 (1987) sets forth general principles for Remedial Action Plans to address geographic Areas of Concern and for Lakewide Management Plans to address Critical Pollutants in the Lakes. It also identifies various beneficial uses to be protected and describes how Areas of Concern and Critical Pollutants are to be designated.

Annex 3 (1978) focuses on phosphorus control. It calls for restoration of aerobic conditions year-round in the central basin of Lake Erie, substantial elimination of nuisance algal growth in Ontario and Michigan, and

maintenance of the oligotrophic status and relative algal biomass of Lakes Huron and Superior. The need to meet target loads for phosphorus for each lake established under this annex is recognized in the administration of the NPDES and construction grants programs under the Clean Water Act.

Plans to meet additional load reductions to Lake Erie, Lake Ontario, and Saginaw Bay were submitted by the States in June 1986.

Annex 11 (1978) addresses surveillance and monitoring. It calls for joint surveillance and monitoring to assess compliance with requirements for pollution control in the various jurisdictions, to identify the need for improved pollution control, to evaluate water quality trends, and to identify emerging problems. GLNPO operates the U.S. Great Lakes surveillance and monitoring program under the Agreement. Compliance monitoring is conducted by the individual States with EPA oversight.

Annex 12 (1978) addresses persistent toxic substances. It states that “persistent toxic substances” should be regulated in order to virtually eliminate the input of toxic substances to the Great Lakes ecosystem. Regulation should protect human health and assure continued productivity of aquatic resources. This annex requires research on how to protect fish and wildlife as well as humans from exposure to toxic pollutants and establishes an early warning system for future problems due to these pollutants. This Annex reinforces the function of the Great Lakes as a national indicator for environmental problems in the biosphere. U.S. compliance with the Great Lakes Agreement depends on the integration of remedial activities, research, and monitoring with domestic environmental programs.

Annex 13 (1987) addresses pollution from nonpoint sources. It recognizes the contribution of nonpoint source pollution by requiring that land-based activities that contribute to water quality problems be identified and that watershed management plans be prepared for high priority hydrologic units to reduce nonpoint source inputs. It also calls for the identification, preservation and, where necessary, rehabilitation of wetlands threatened by urban and agricultural development and waste disposal activities.

Annex 14 (1987) focuses on contaminated sediment. It calls for identification of the nature and extent of sediment pollution of the ecosystem. It also calls for the development of methods to evaluate the impact of polluted sediment, for the development of technologies to remedy this pollution, and for demonstrations of new technologies.

Annex 15 (1987) addresses airborne toxic substances. It requires research, surveillance and monitoring, and implementation of pollution control

measures to reduce atmospheric deposition of toxic pollutants, particularly persistent toxic substances, to the Great Lakes Basin ecosystem.

Annex 16 (1987) addresses pollution from contaminated ground water. It calls for coordination of existing programs to control contaminated ground water affecting the boundary waters of the Great Lakes System.

Annex 17 (1987) deals with research and development. It recognizes the need for research to determine the mass transfer of pollutants between the ecosystem components of water, sediment, air, land, and biota and the need for development of load reduction models for pollutants in the Great Lakes system.

Provisions were also added in 1987 to strengthen accountability and management of the Agreement. A number of reporting dates were added that are shown in Table 4. In addition, the *Annex 1 Supplement* requires biennial consultation on specific water quality objectives; revised ranking lists for toxics; and the development of ecosystem objectives for the boundary waters of the Great Lakes system.

A Five Year Program Strategy



*Specific Activities Planned by the
Great Lakes National Program Office*

7.1 Overview

The principal goals of the five year program strategy for the Great Lakes National Program Office are to:

- Support the completion of Lakewide Management Plans for Lakes Michigan, Ontario, and Erie to determine the steps needed to make fish safe to eat.
- Support the completion and implementation of Remedial Action Plans to restore beneficial uses in all geographic Areas of Concern.
- Obtain sufficient information about sources, fates, and effects of pollutants to support a mass balance approach in remedial programs, using GLNPO surveillance activities including the Green Bay study and the GLAD network.
- Conduct a demonstration program to assess and address contaminated bottom sediments.
- Evaluate results of point source and nonpoint source remedial programs to determine whether additional controls are needed to restore oxygen levels in Lake Erie.
- Strengthen partnerships with the Great Lakes States, other EPA programs, and other Federal agencies in carrying out all responsibilities.
- Protect the Lakes from human abuse by improving public understanding of the Great Lakes system and related issues.

Actions described in this chapter are responsive to both the Clean Water Act and the Great Lakes Water Quality Agreement. Although many of the actions are dependent upon the level of funding and implementation of EPA's regulatory programs, the overall strategy enables GLNPO to focus its own activities logically, use available resources more effectively, and provide priorities for directing available and projected resources. The strategy will also help EPA Regional and State programs to understand how GLNPO priorities align with their own program priorities. As described in Chapter 1, Great Lakes environmental management activities are carried out by organizations at all levels of government in the U.S. GLNPO's success is dependent on close and continuing cooperation with other Federal agencies, EPA offices, the States, and public groups. This strategy will serve as a starting point for establishing working relationships that will be formalized in Memoranda of Understanding, as required by Section 118 of the Clean Water Act.

The remainder of this chapter provides a brief status report and list of planned activities for each of nine major areas: eutrophication, toxic pollutants, surveillance and monitoring, environmental management plans, remedial activities, research, technology development and transfer, international/interagency/intra-agency coordination, and public education and involvement.

7.2. Eutrophication

7.2.1 Background

Great progress has been made in controlling conventional pollution in the Great Lakes. In particular, over the last 15 years, substantial reductions in phosphorus concentrations have been achieved. A concerted effort by the U.S. and Canada to reduce phosphorus loadings began in 1972 and represents an unprecedented international accomplishment. Phosphorus loadings from point sources have been reduced by an estimated 80 to 90 percent through regulation and financial assistance for environmental controls on point sources. The primary form of financial assistance has been the upgrading of sewage treatment plants. Reductions in phosphorus from industry and in domestic laundry detergents have also contributed. These reductions have resulted in dramatic improvements in near shore water quality and some improvement in open lake conditions.

In 1983, the U.S. and Canada approved a supplement to the Great Lakes Water Quality Agreement confirming the maximum phosphorus loads that the Lakes could tolerate. The countries agreed to prepare load reduction plans to achieve further reductions.

Presently, all major U.S. dischargers as a group are meeting a 1 milligram per liter (mg/l) effluent limit for phosphorus. Although some individual dischargers are not meeting the effluent limit, these dischargers are offset by those doing better than the effluent limit. By 1990 all publicly owned treatment works should be meeting the 1 mg/l effluent limit for phosphorus; however, phosphorus contributions from combined sewer overflows and treatment plant bypasses still need to be addressed.

Detergent phosphate bans have played an important role in reducing the amount of phosphorus reaching the lakes and continue to be an important means of control, especially for combined sewer overflows and treatment plant bypasses.

The nonpoint source phosphorus program was started more recently. Additional reductions from these sources will be needed to meet target load reduction plans. This program focuses on management of crop residues to prevent soil erosion and nutrient loss and on management of animal wastes and commercial fertilizers to minimize nutrient loadings to streams. The program relies heavily on conservation tillage, particularly no-till management practices, and on public education concerning prudent and economical uses of phosphorus-containing fertilizers.

Several recent technological advancements have implications for Great Lakes eutrophication. GLNPO has participated in evaluating and demonstrating techniques such as biological and physical phosphorus removal technology, and in-line storm flow control devices. Each of these has shown great potential for reducing phosphorus and other pollutant input to the Lakes from point sources. GLNPO recognizes the necessity of a continuing commitment to advancing new technologies and, especially, promoting the use of new technologies throughout the farming communities in the Great Lakes Basin.

7.2.2 GLNPO'S Five Year Strategy — Eutrophication

- FY 1989*
- Based on the 1983 Agreement on Phosphorus Load Reduction, GLNPO will coordinate a five year review of State phosphorus plans, due in December 1988, to determine the effectiveness of existing control programs.
 - Based on the 1987 Amendments to the Clean Water Act, GLNPO will develop, in consultation with the States and water programs, an update of the U.S. Phosphorus Load Reduction Plan to fulfill the requirement for a five year plan and program for reducing the amount of nutrients introduced into the Lakes. This plan will incorporate any management

program for reducing nutrient runoff from nonpoint sources established under Section 319 of the Clean Water Act.

- GLNPO will coordinate the development of a biennial report on progress in developing specific watershed management plans and implementing programs and measures to control nonpoint sources of pollution, as required by the Water Quality Agreement. The first is due December 31, 1988.
 - In cooperation with the Ohio Department of Natural Resources, GLNPO will continue to develop remote sensing methods for tracking nonpoint source best management practice (BMP) adoption.
 - In cooperation with the Soil Conservation Service, GLNPO will track the extent to which nonpoint source management practices have been adopted, through both observation and predetermined onsite visits and measurements.
 - ★ GLNPO will participate in the National Association of Conservation Districts Great Lakes committee to integrate soil conservation and water quality concerns and activities.
 - ★ GLNPO will monitor the implementation of phosphorus management plans and will also monitor and analyze other conventional parameters such as sodium, chlorides, and nitrogen to determine their contribution to any changes in lake trophic status. Results will be incorporated in an annual report to Congress.
 - GLNPO will initiate an inventory of nitrogen sources to the Great Lakes.
 - GLNPO will convene a technology workshop for State and local governments on low-cost nutrient control techniques.
 - ★ GLNPO will guide and support other EPA programs in carrying out remedial activities by participating in annual program guidance development and by providing technical expertise regarding the Great Lakes.
- FY 1990
- GLNPO will complete a series of algal productivity tests using the shipboard laboratory and produce a report on the feasibility of this methodology and any future recommendations.
 - GLNPO will complete the development of remote sensing methods for tracking nonpoint source BMP adoption.

★ An ongoing activity throughout the five year period

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- GLNPO will complete the nitrogen inventory begun in FY 1989.
 - GLNPO will continue to coordinate activities with the Soil Conservation Service to support the implementation of nonpoint source management practices.
 - GLNPO will continue ongoing activities identified above.
- FY 1991*
- GLNPO will coordinate the development of the second biennial report on progress in developing specific watershed management plans and implementing programs and measures to control nonpoint sources of pollution as required by the Water Quality Agreement.
 - GLNPO will coordinate the implementation of appropriate remote sensing methods to track nonpoint source BMP adoption.
 - GLNPO will continue ongoing activities identified above.
- FY 1992*
- GLNPO will initiate an assessment of eutrophication control strategies within the Basin in preparation for the 1993 renegotiation of the Agreement with Canada.
 - GLNPO will continue to coordinate activities with the Soil Conservation Service to support the implementation of nonpoint source management practices.
 - GLNPO will continue ongoing activities identified above.
- FY 1993*
- GLNPO will coordinate the development and submission of the third biennial report on progress in developing specific watershed management plans and implementing programs and measures to control nonpoint sources of pollution as required by the Water Quality Agreement.
 - GLNPO will continue ongoing activities identified above.

7.3 Toxic Pollutants

7.3.1 Background

Toxic pollutants are the most significant environmental problem facing the Great Lakes. Toxic pollutants are numerous, their pathways into the Lakes are varied, and their effects on the environment, aquatic life, and human health are not well understood. Studies have shown that toxic pollutants

within the Great Lakes Basin are associated with changes in human infant behavior; other national studies associate toxic pollutants with reproductive disorders and cancer. As noted in Table 3, certain species of fish at some sites in the Great Lakes have been found to have toxic contamination at levels requiring health advisories. About 30,000 chemical compounds are used in the Great Lakes Basin, and an additional 1,000 new chemicals are developed each year within the United States. As of 1987, 362 compounds of concern had been identified within the Great Lakes ecosystem. These compounds are being reviewed to identify their toxic effects. The problem of toxic pollutants has therefore raised water quality management to a new level of complexity.

Both the 1987 Amendments to the Clean Water Act and the Great Lakes Water Quality Agreement place an unprecedented policy emphasis on the control of toxics. They require that:

- The discharge of toxic substances in toxic amounts be prohibited,
- The discharge of persistent toxic substances be virtually eliminated,
- The water quality of the Great Lakes Basin ecosystem be restored and enhanced.

The primary management approach anticipated by the Clean Water Act and the Agreement is to set and attain specific ambient water quality objectives and standards for pollutants. This does not mean that some specific level of pollution is acceptable. Rather, management priorities will direct resources to achieve reductions sufficient to attain the water quality objectives of the Agreement as a key step toward total restoration.

To attain the objectives, Lakewide Management Plans will be prepared and implemented to guide basin-wide remedial efforts for Critical Pollutants; Remedial Action Plans will be prepared and implemented to restore beneficial uses in Areas of Concern; and Point Source Impact Zones will be identified and reduced to the maximum extent possible. Also, watershed management plans, as called for in Annex 13 of the Agreement, will be prepared and implemented to address nonpoint sources of toxic pollution.

All of these activities will be carried out primarily by the States with assistance and guidance from appropriate EPA Regional programs and from GLNPO. As the Great Lakes States implement new provisions of the Clean Water Act aimed at controlling discharges of toxic pollutants to surface waters, GLNPO will work with Regional water programs to ensure that the State priorities and management plans are based on the best available information and reflect both the goals of the Great Lakes Water Quality Agreement and the Clean Water Act.

Of particular importance for GLNPO will be the development of a mass balance approach for describing and analyzing sources and fates of toxic pollutants on a regional basis. The mass balance approach for studying toxic pollutants will become an important element of Lakewide Management Plans in the future.

Preliminary work on the mass balance approach was conducted on the River Raisin and the Upper Great Lakes Connecting Channels in Michigan. GLNPO and the Wisconsin Department of Natural Resources, in conjunction with NOAA, and EPA's Office of Research and Development, now plan to pilot the mass balance study for toxics in a mid-sized ecosystem prior to expansion to whole-lake situations. Green Bay has been chosen for this pilot effort. For this study, a modeling framework will be tested and applied to provide greater understanding of the sources, transport, and fate of toxic pollutants with the objective of guiding future regulatory activity. The model must be capable of alerting managers to the presence of previously unidentified sources, of describing the relative significance of the sources, and of predicting the response of the ecosystem to proposed regulatory actions involving a single source or a combination of sources. To accomplish this, the transfer of toxic compounds from sources to important sport and commercial fish species will be modeled. Due to the high costs of monitoring contaminants, indicator compounds have been selected to serve as surrogates for larger classes of contaminants known to be problems in the Great Lakes. This study will test the ability of involved Federal, State and local governments, and academic institutions to mobilize their technical and physical resources to carry out and apply the results of multimedia studies.

7.3.2 GLNPO'S Five Year Strategy — Toxic Pollutants

- FY 1989
- As required by Annex 1 of the Water Quality Agreement, GLNPO will coordinate activities to produce, by December of 1988, a listing of substances believed to have the potential to cause acute or chronic toxic effects in aquatic, wildlife, or human populations and which are believed to have the potential of being discharged to the Great Lakes (based on the definition of chronic toxicity developed in FY 1988).
 - GLNPO will coordinate the development of an approach, including risk assessment, for designating Critical Pollutants, as required by Annex 2 of the Water Quality Agreement.
 - GLNPO will continue the field monitoring program for the mass balance pilot study in Green Bay.

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- As required by Annex 12 of the Water Quality Agreement, GLNPO will coordinate the preparation of a progress report on activities undertaken to reduce the discharge of contaminants to the Great Lakes.
 - ★ GLNPO will assist the States in developing a common process for generating fish consumption advisories.
 - ★ GLNPO will provide assistance as necessary in the development and implementation of water-quality based effluent limits for NPDES permits, including reviewing standards and pretreatment requirements, wasteload allocations and selected permit modifications.
 - ★ GLNPO will work with EPA Headquarters and Regional waste management programs to ensure that remedial plans for Superfund sites and that permitting and enforcement actions for RCRA facilities reflect the long-term goals of the Agreement.
 - GLNPO will initiate a formal review of specific water quality objectives as required by the Water Quality Agreement.

FY 1990

- GLNPO will coordinate the completion of the water quality objectives review process as required by the Water Quality Agreement and support the implementation of any recommendations. GLNPO will coordinate and support the designation of any additional Critical Pollutants.
- GLNPO will complete the field monitoring program for the mass balance pilot study in Green Bay.
- GLNPO will work with EPA and State waste management programs to ensure that information on waste minimization, developed under RCRA, is reported to the IJC by December 31, 1989.
- GLNPO will complete all modeling studies addressing toxic pollutant sources, transport, and fate in Green Bay.
- GLNPO will continue ongoing activities identified above.

FY 1991

- GLNPO will produce a final report on the Green Bay mass balance study.
- GLNPO will coordinate the preparation of the second biennial progress report on activities undertaken to reduce the discharge of contaminants to the Great Lakes.
- GLNPO will initiate the application of the mass balance approach for toxics in Lake Ontario and/or Lake Michigan.

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- GLNPO will review all toxic modeling studies completed and under way and assess capabilities to support decisionmaking.
 - GLNPO will continue ongoing activities identified above.
- FY 1992*
- GLNPO will coordinate a formal review of specific water quality objectives as required by the Water Quality Agreement in preparation for the 1993 renegotiation of the Agreement with Canada.
 - GLNPO will coordinate and support the designation of any additional Critical Pollutants.
 - GLNPO will continue the application of the toxics mass balance approach on a lakewide basis as initiated in FY 1991.
 - GLNPO will continue ongoing activities identified above.
- FY 1993*
- GLNPO will coordinate the preparation of the third biennial progress report on activities undertaken to reduce the discharge of contaminants to the Great Lakes.
 - GLNPO will continue the application of the toxics mass balance approach on a lakewide basis as initiated in FY 1991.
 - GLNPO will continue ongoing activities identified above.

7.4 Surveillance and Monitoring

7.4.1 Background

The Great Lakes surveillance and monitoring program has five major objectives, which derive from the Great Lakes Water Quality Agreement:

1. Assess the degree to which jurisdictional control requirements are being met.
2. Provide definitive information on achievement of water quality objectives.
3. Evaluate water quality trends.
4. Identify emerging environmental problems.
5. Support development of Lakewide Management Plans and Remedial Action Plans.

The original Great Lakes International Surveillance Plan (GLISP), initiated in 1976, called for intensive monitoring of one lake at a time with each lake monitored once or twice a decade. This cycle of intensive surveys was completed with Lake Superior in 1983. For conventional pollutants, a new long-term surveillance program has now evolved that requires less intensive collection of chemistry data but provides information about each lake annually.

The focus of GLNPO's monitoring efforts also has changed over time. Originally, the surveillance program was principally concerned with describing water chemistry. This focus resulted mainly from overriding concerns about eutrophication and high phosphorus loadings. The new emphasis on toxic pollutants in the Great Lakes has added a new focus to surveillance and monitoring efforts. Determining the relative importance of toxic pollutants requires an understanding of ecosystem structures, interactions between biota, and the relationship of biota to environmental conditions. GLNPO's surveillance and monitoring program has responded to this change by strengthening the biological monitoring components of its programs.

The present Great Lakes surveillance and monitoring program has four major components: limnology, fish, sediments, and pollutant loadings. GLNPO efforts in each area are described below.

7.4.2 Limnology

The limnology program describes and tracks trophic status of the Lakes. This program supports the development, testing, and refinement of eutrophication models that assist in annual monitoring of water chemistry, plankton populations, and biological productivity. The models are used for data interpretation, for defining the applicability of specific data sets, and for the design of monitoring programs for the collection of data. The models were transferred from EPA's mainframe computer to personal computers in 1986 and new software was developed to assist the surveillance-research-management process. The productivity measurements made as part of the limnology program will assist in describing the trophic status and the effect of nutrients in the Lakes. The measurements will also assist in interpreting trends in algal and plankton productivity and in anticipating resultant impacts on fish communities.

Over the next five years, the major emphases of the limnology program will be (1) monitoring the attainment of open lake nutrient objectives; (2) determining biological responses to nutrient control; and (3) restoring aerobic conditions in the bottom waters of the central basin of Lake Erie.

7.4.3 Fish

The Great Lakes Fish Contaminant Monitoring Program, since its inception in 1977, has been a coordinated effort by 20 State and Federal agencies. Because of the difficulty of measuring toxic chemicals in lake water, the monitoring program measures the bioconcentration of certain indicator chemicals in fish. Through this program, major declines in contaminants such as DDT, PCBs, and dieldrin have been documented in Great Lakes fish following regulatory action. However, during the same period, numerous other persistent pesticide and industrial chemicals have been identified in Great Lakes fish as part of the early warning component of the program. For some of these compounds, such as toxaphene, mirex and dioxin, regulatory action has since been taken. For the majority of these compounds, however, there is insufficient information to judge their effects on human health and the environment. Until further information on such compounds is obtained, regulatory programs cannot be initiated.

Over the next five years, emphases of the fish program will be (1) trend monitoring in the open lakes; (2) detection of emerging problems in harbors and tributary mouths; (3) monitoring potential human exposures; and (4) monitoring other indicators of ecosystem health.

7.4.4 Sediments

GLNPO conducts harbor and estuary sediment sampling to identify toxic hot spots and to aid in the identification of areas that are contributing large amounts of toxics to the Lakes. Future plans are to extend sampling to sediments in the main body of the Lakes to measure the distribution, storage, and fate of toxics in the ecosystem. This sampling will provide a chronology of toxic inputs to the Lakes and will support mass balance models for Critical Pollutants. Sampling will also support development of Lakewide Management Plans as required in the Great Lakes Water Quality Agreement and the Assessment and Remediation of Contaminated Sediment program mandated by the Clean Water Act Amendments of 1987. GLNPO coordinates this work with the development of national sediment criteria and sediment contaminant cycling studies conducted by EPA's Office of Research and Development laboratories at Duluth, Minnesota and at Grosse Ile, Michigan.

7.4.5 Pollutant Loadings

GLNPO conducts and supports numerous monitoring and surveillance activities designed to provide information on the magnitude and types of pollutant loadings to the Great Lakes. One of the most important

purposes of collecting this information is to support the development of the mass balance approach for describing and analyzing pollutants on a regional basis. Pollutant loading data therefore must describe inputs through all potential pathways. Some, such as air deposition, GLNPO monitors directly. Others, such as point source loadings to surface water, are monitored by the States with assistance or advice as needed from GLNPO. Still others, such as pollutant transfers from contaminated sediments, are or will be estimated using predictive models and limited environmental monitoring data. Monitoring techniques, technologies, and pollutant loading measurements of principal concern to GLNPO over the next five years include:

- *Air Deposition* loading monitoring by the Great Lakes Air Deposition (GLAD) network, established in 1981 and currently being expanded.
- *Tributary* loading monitoring by the Great Lakes States (coordinated by GLNPO).
- *Point source* loading information gathered through the water programs in EPA and the Great Lakes States in their efforts to track NPDES permits and monitor compliance rates.
- *Nonpoint source* loading information gathered by the EPA water programs as they identify and monitor land runoff from a variety of practices.
- *Ground-water* loading information that will be developed by EPA ground-water programs as they identify potential problem areas.
- *Sediment release rate* information that is being developed as part of GLNPO's program for contaminated sediments.

7.4.6 GLNPO'S Five Year Strategy—Surveillance and Monitoring

- FY 1989
- GLNPO will acquire a research vessel to replace the *Roger R. Simons*, as anticipated by EPA's FY 1988 Appropriations Act.
 - ★ GLNPO will conduct a comprehensive, annual water quality sampling and analysis program of water chemistry, plankton populations, and fish contaminants in the open waters of the Great Lakes in response to the Great Lakes International Surveillance Plan (GLISP) using its research vessel and other appropriate approaches such as winter helicopter surveys.

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- ★ GLNPO will prepare a synthesis of the sampling results and incorporate the information in an annual report to Congress.
 - ★ GLNPO will track U.S. implementation of GLISP by the States and report progress to the IJC.
 - ★ GLNPO will continue to monitor the fish contaminant problem in the Great Lakes, report on trends in fish contamination, and coordinate interagency activities on fish monitoring, advisories, and risk assessments.
 - GLNPO will co-chair an international symposium on the measurement of fish community health and produce a summary report.
 - As required by the Water Quality Agreement, GLNPO will coordinate activities for an agreement on the air deposition network components by October of 1988 and produce the first biennial report on the implementation of the joint U.S./Canadian air deposition network by December 31, 1988.
 - GLNPO will set up the U.S. routine air toxic deposition sites for Lake Huron and Lake Erie and initiate monitoring programs.
 - GLNPO will conduct an implementation workshop for the States on enhanced tributary monitoring programs.
 - ★ GLNPO will continue to coordinate development of approaches for quantifying and assessing the impacts of ground-water/surface water interactions.
 - ★ GLNPO will work to establish risk-based procedures and criteria for assessing ground-water impacts on surface water bodies.
 - ★ GLNPO will begin to evaluate the effectiveness of using chronic and acute biotoxicity screening tests of ground-water near surface water bodies to determine potential toxic impacts.
 - ★ GLNPO will continue other efforts to better quantify loading information and to describe the relationship between the various inputs and ambient water quality and ecosystem health.
 - ★ GLNPO will support studies and programs aimed at the development of ecosystem indicators for use in the Great Lakes.
 - ★ GLNPO will continue to support water program activities to track point and nonpoint loadings and to target available resources to appropriate source controls.

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- ★ GLNPO will coordinate and support research to improve understanding of intermedia transfer of toxics for development of mass balance models, e.g., air-water exchange and sediment-water exchange.

FY 1990

- GLNPO will complete refitting the replacement research vessel and outfit the vessel for toxic monitoring programs in the open waters of the Great Lakes.
- GLNPO will complete its evaluation of, and issue recommendations on, the use of water intakes in water quality monitoring programs.
- GLNPO will coordinate appropriate changes to the fish health monitoring program based on results of the FY 1989 symposium.
- GLNPO will begin a series of field studies to determine ground-water flux and contaminant loadings through ground water to the Lakes.
- GLNPO will initiate programs for sediment sampling on a whole-lake basis to support the development of Lakewide Management Plans and the mass balance approach.
- GLNPO will set up the U.S. master and routine air toxic deposition sites for Lake Superior and initiate monitoring programs.
- GLNPO will coordinate and assist States in the implementation of enhanced tributary monitoring programs.
- GLNPO will continue ongoing activities identified above.

FY 1991

- GLNPO will design and implement enhanced toxics monitoring programs in the open waters of the Great Lakes.
- GLNPO will set up the U.S. master and routine air toxic deposition sites for Lake Ontario and initiate monitoring programs.
- GLNPO will produce the second biennial report on the implementation of the joint U.S./Canadian air deposition network.
- GLNPO will initiate, as available and appropriate, routine monitoring of indicators of ecosystem health in the Great Lakes.
- GLNPO will begin work with EPA's ORD and Office of Ground-Water Protection and USGS to develop estimates of contaminant loadings derived from field measurements and from models of ground-water contaminant transport.

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- GLNPO will continue ongoing activities identified above.
- FY 1992
- GLNPO will conduct a review of the effectiveness of monitoring programs.
 - GLNPO will summarize surveillance and monitoring activities under Annex 11 in preparation for the 1993 renegotiation of the Agreement.
 - GLNPO will continue ongoing activities identified above.
 - GLNPO will continue to work with EPA's ORD and Office of Ground-Water Protection and USGS to develop estimates of contaminant loadings derived from field measurements and from models of ground-water contaminant transport.
- FY 1993
- GLNPO will produce the third biennial report on the implementation of the joint U.S./Canadian air deposition network.
 - GLNPO will report on the evaluation of ground-water toxic loadings to the Lakes.
 - GLNPO will continue ongoing activities identified above.
 - GLNPO will continue to work with EPA's ORD and Office of Ground-Water Protection and USGS to develop estimates of contaminant loadings derived from field measurements and from models of ground-water contaminant transport.

7.5 Environmental Management Plans

7.5.1 Background

The 1987 amendments to the Great Lakes Water Quality Agreement call for three responses when water quality objectives are not met: development and implementation of Remedial Action Plans for addressing geographic Areas of Concern, development of Lakewide Management Plans, and designation of Point Source Impact Zones.

7.5.2 Remedial Action Plans for Areas of Concern

Since 1985 the International Joint Commission has focused binational activities on geographic Areas of Concern. These are areas in the Great

Lakes Basin that fail to meet the objectives of the Water Quality Agreement where such failure has caused or is likely to cause impairment of beneficial uses. The purpose of establishing Areas of Concern is to encourage jurisdictions to rehabilitate these acute, localized problem areas and to restore their beneficial uses. It is also expected that restoration of Areas of Concern will reduce loadings to the open lakes. The areas are classified according to their stage in the remedial process. In these areas, existing programs are not expected to be sufficient to restore water quality to acceptable levels.

States are responsible for preparing Remedial Action Plans (RAPs) to guide specific rehabilitation activities in all 30 Areas of Concern in the U.S. RAPs are intended to define actions and timetables for restoring beneficial uses in Areas of Concern. Restoration of uses is to be achieved through implementation of existing programs operated under Federal and State legislation and any additional measures required to control sources and remedy environmental problems.

GLNPO assists the States with RAP development by providing contract services to the States for preparing draft RAP documents and by reviewing draft RAPs and providing technical guidance. GLNPO is responsible for monitoring RAP development activities in the U.S. and, beginning in 1988, will report biennially to the IJC on the status of RAP development and implementation in the U.S.

7.5.3 Lakewide Management Plans

The 1987 Agreement places renewed emphasis on lakewide management. In Annex 2, Lakewide Management Plans (LMPs) are required for open lake waters. This is a new provision designed to reduce loadings of designated Critical Pollutants on a lakewide basis in order to meet specific water quality objectives.

GLNPO has begun working with the States and EPA Regional water programs staff to define the contents of LMPs and to initiate the development of specific plans. The mass balance pilot study, underway in Green Bay, Wisconsin, will be one of GLNPO's most important contributions to the LMP process. GLNPO is also responsible for reporting to the IJC on the status of LMP development in the U.S. The first biennial report will be completed in December of 1988; subsequent reports will be provided every other year. Two lakewide initiatives are already under way—for Lakes Michigan and Ontario.



Lake Michigan Toxic Pollutant Control/Reduction Strategy

Lake Michigan is the largest body of fresh water totally within the borders of the United States. It is used by millions for drinking water and for recreation, such as boating, swimming, and sport fishing. It is also an important commercial fishery and transportation resource. At present, however, Lake uses are impaired because of the concentrations of toxic pollutants found in its waters, sediments, fish, and birds. For example, Lake Michigan lake trout contain the second highest levels of PCBs and DDT in the Great Lakes system, and cannot be sold commercially because their level of pollutants exceed human health-related U.S. Food and Drug Administration guidelines.

Region V and the States of Illinois, Indiana, Michigan, and Wisconsin have agreed to work together to end the Lake's toxic substances pollution problem. To do this, they have prepared the Lake Michigan Toxic Pollutant Control/Reduction Strategy. The objective of the strategy is to fully restore the multiple uses of Lake Michigan and to protect human health and the Lake Michigan ecosystem by achieving a significant reduction in the loading rates of problem toxic pollutants. Each of the States has negotiated specific commitments for FY 1988 and 1989 in their annual State program plans.



Lake Ontario Toxics Management Plan

On February 4, 1987, the "Four Parties" (Environment Canada, the Ontario Ministry of the Environment, the U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation) signed a Declaration of Intent to prepare a Toxics Management Plan for Lake Ontario. A draft plan has been prepared and has undergone extensive public review; a final plan will be available in late 1988.

The draft plan cites bioaccumulation of toxic chemicals in fish to levels that make them unsafe for human consumption as the most serious known problem in the Lake. Toxics are also suspected of causing such other adverse ecosystem impacts as deformities and reproductive failures in fish-eating birds.

The goal of the Lake Ontario Toxics Management Plan is a lake that provides drinking water and fish that are safe for unlimited human consumption and allows natural reproduction within the ecosystem of the most sensitive native species, such as bald eagles, osprey, mink, and otters.

In order to achieve this goal, it is anticipated that the Plan will include four objectives:

- Reductions in toxic inputs driven by existing and developing programs
- Further reductions in toxic inputs driven by special efforts in geographic Areas of Concern
- Further reductions in toxic inputs driven by lakewide analyses of pollutant fate, and
- Zero discharge.

7.5.4 Point Source Impact Zones

Another environmental management tool for addressing nonattainment areas is designation of Point Source Impact Zones. The 1987 Water Quality Agreement defines a Point Source Impact Zone as an area of water contiguous to a point source where water quality does not comply with Agreement objectives. The Agreement requires listing these zones and reducing their size and effect as much as possible through improved management and regulatory controls and the application of advanced waste treatment technologies.

GLNPO is working with the EPA Regional water programs and States to define strategies for reducing Point Source Impact Zones. Beginning in September of 1989, GLNPO will also issue biennial reports to the IJC concerning the status of efforts in the U.S. to reduce Point Source Impact Zones.

7.5.5 GLNPO'S Five Year Strategy—Environmental Management Plans

- FY 1989*
- The 1987 Water Quality Agreement calls for the elimination of Areas of Concern through the completion and implementation of Remedial Action Plans and requires biennial reporting. GLNPO will coordinate the preparation of the first biennial progress report on the status of efforts to eliminate Areas of Concern through completion and implementation of Remedial Action Plans, as required by the Agreement, by December 31, 1988.
 - ★ GLNPO will continue to support the Great Lakes States in completing RAPs.
 - ★ GLNPO will work with the States and EPA Regional water programs to have completed RAPs certified as amendments to State Water Quality Management Plans and monitor their implementation.
 - ★ GLNPO will work with Regional and State programs to ensure that all applicable laws are used to the fullest extent in the implementation of RAPs.
 - ★ With the staff of the IJC, GLNPO will monitor the restoration of designated uses within the Areas of Concern.
 - GLNPO will conduct a workshop with the States and Canada to develop a prototype for the contents of Lakewide Management Plans.

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- GLNPO will work with EPA Region II and the State of New York to begin implementing the Lake Ontario Toxic Management Plan.
 - GLNPO will coordinate the preparation of the first biennial progress report on Lakewide Management Plans, as required by the Water Quality Agreement, by December 31, 1988.
 - GLNPO will coordinate the development and implementation of a strategy to reduce Point Source Impact Zones, in accordance with the Water Quality Agreement, and will produce the first biennial progress report in September of 1989.
- FY 1990*
- GLNPO will support and assist EPA's water program in Region V and the States adjoining Lake Michigan to complete a draft Lakewide Management Plan for Lake Michigan.
 - GLNPO will work with appropriate EPA offices and with States to initiate a Lakewide Management Plan for Lake Erie.
 - GLNPO will develop a schedule for completion of remaining Lakewide Management Plans.
 - GLNPO will continue ongoing activities identified above.
- FY 1991*
- GLNPO will coordinate the preparation of the second biennial progress report on the completion and implementation of RAPs.
 - GLNPO will coordinate the preparation of the second biennial progress report on Lakewide Management Plans.
 - GLNPO will coordinate the preparation of the second biennial progress report on Point Source Impact Zones.
 - GLNPO will continue ongoing activities identified above.
- FY 1992*
- GLNPO will review the status of all environmental management planning activities (RAPs, LMPs, and Point Source Impact Zones) in preparation for the 1993 renegotiation of the Agreement.
 - GLNPO will continue ongoing activities identified above.

FY 1993

- GLNPO will support the States in completing all RAPs.
- GLNPO will coordinate the preparation of the third biennial progress report on the completion and implementation of RAPs.
- GLNPO will coordinate the preparation of the third biennial progress report on Lakewide Management Plans.
- GLNPO will coordinate the preparation of the third biennial progress report on Point Source Impact Zones.
- GLNPO will continue ongoing activities identified above.

7.6 Remedial Activities

7.6.1 Background

Remedial programs are carried out by Federal, State, and local governmental organizations throughout the Great Lakes Basin, working under authorities granted by Federal and State environmental statutes. GLNPO's primary responsibility is to participate in, coordinate, and facilitate the activities conducted under those programs that influence priority problems in the Great Lakes Basin. On an ongoing basis, GLNPO is concerned with all environmental programs that operate in the Basin. In addition, GLNPO has, in the past, played an active role in conducting research and demonstration projects involving remedial technologies.

Over the next five years, GLNPO will continue to work with EPA Regional and State programs to ensure that both ongoing and new program initiatives, such as biomonitoring and pretreatment, uphold the objectives of the Great Lakes Water Quality Agreement. In addition, GLNPO will focus special efforts in four emerging areas:

- The importance of contaminated sediments to the overall problem of toxic pollutants in the Great Lakes;
- The significance of pollutant contributions made or potentially made by ground water that is discharged to the Great Lakes;
- The significance of pollutants deposited in the Great Lakes from the atmosphere; and

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- The development of a Geographic Information System to integrate existing data bases and provide for analyses of multimedia information on Great Lakes problems.

Special efforts in these areas that GLNPO will pursue during the next five years are described briefly below.

7.6.2 Contaminated Sediments

All of the Great Lakes Areas of Concern in the U.S. have known polluted sediment problems. GLNPO has begun to address this problem by providing assistance to the States to develop Remedial Action Plans that address the problems of polluted sediments.

Both the 1987 Amendments to the Clean Water Act and Great Lakes Water Quality Agreement direct GLNPO to assume an active, leadership role on this issue. The Act requires GLNPO to develop a five year study and demonstration projects relating to the control and removal of toxic pollutants from contaminated sediments. Priority consideration is to be given to projects at the following locations: Saginaw Bay, Michigan; Sheboygan Harbor, Wisconsin; Grand Calumet River, Indiana; Ashtabula River, Ohio; and Buffalo River, New York. Annex 14 of the Agreement calls for identification of the nature and extent of sediment pollution of the ecosystem and the development of methods to evaluate the impact of this polluted sediment and for development and demonstration of remedial technologies.

7.6.3 Ground Water

Contaminated ground water in the Great Lakes Basin, from both direct and tributary sources, has recently been recognized by the U.S. Congress, the International Joint Commission and the Great Lakes Water Quality Agreement to be an important potential source of Great Lakes contamination, the impacts of which must be investigated and evaluated. Annex 16 of the Water Quality Agreement requires the coordination of all ground-water control programs affecting the Great Lakes system. GLNPO has developed a draft Ground-Water/Hazardous Waste Strategy to (1) estimate the extent and magnitude of ground-water pollution (particularly ground-water pollution from hazardous and solid waste disposal sites) in the Great Lakes and (2) develop plans to eliminate or minimize this pollution, in specific areas and basin-wide. This strategy is a first step toward addressing the requirements of both the Agreement and the Clean

Water Act. This strategy will be closely coordinated with activities in response to Annex 13 of the Water Quality Agreement, which requires that wetlands threatened by waste disposal activities be identified, preserved, and where necessary, rehabilitated.

7.6.4 Air Deposition

EPA began a strategy for the control of both routine and accidental releases of toxic air pollutants in 1985. In 1986, the Agency began planning for and conducting activities to encourage States to assess the scope and severity of current air toxic exposures. Air program grants are available to States for compiling emission inventories for certain source categories, investigating capabilities to model deposition patterns for toxic pollutants, and developing permit review procedures that explicitly consider air toxic impacts on the Great Lakes. More information is needed, however, to determine the nature, sources, and magnitude of the air toxic deposition problem in the Great Lakes. GLNPO is collecting data and information to support an analysis of the problem, including data resulting from the Green Bay mass balance study and from the fish contaminant monitoring program. The Great Lakes Air Deposition (GLAD) Network will be an important source of information for this effort. Expansion of GLAD, with the cooperation and assistance of the States, will allow regular monitoring for toxic pollutants that are or may be deposited to the Lakes.

7.6.5 Geographic Information System

To support all of its work in remedial programs, GLNPO, in conjunction with a Region V initiative, will be developing a geographic information system (GIS) for the Great Lakes Basin over the next few years. The purpose of this system will be to facilitate automated geographic analyses of multimedia data. The system will integrate existing data bases maintained by EPA, the Great Lakes States, and other Federal agencies with the Great Lakes programs. It will be an important tool for identifying critical pollution problems and pollutant sources in the Basin.

Initially, the Great Lakes GIS will be used in ground-water, wetlands, and remedial action plan applications. Ultimately, however, it will become an important management tool for developing and evaluating remedial and regulatory options by EPA and the States. The EPA National Water Quality Laboratory in Duluth, Minnesota will provide assistance in the development of the GIS. The Great Lakes States and other Federal agencies will also participate in planning and design of the system.

7.6.6. GLNPO'S Five Year Strategy—Remedial Activities

FY 1989

- GLNPO will develop a strategy and ranking scheme for the Assessment and Remediation of Contaminated Sediment (ARCS) program to systematically and objectively rank Areas of Concern for inclusion in the demonstration phase of the program.
- Under the ARCS program, GLNPO will initiate research and pilot-scale demonstrations on promising remedial technologies.
- GLNPO will perform assessments of the nature and extent of the contaminated sediment problem at selected Areas of Concern to test the assessment methodology and provide information for matching technologies with locations for the demonstration phase of the program.
- ★ GLNPO will monitor progress and coordinate with other programs and agencies to clean up contaminated sediments in Areas of Concern.
- ★ GLNPO will work with Canada, the EPA Regions, and States to fulfill activities under Annexes 7 and 15 of the Water Quality Agreement including, for example, an assessment of the efficacy of Confined Disposal Facilities in containing toxics.
- ★ GLNPO will work with EPA Headquarters on the development of freshwater sediment criteria.
- ★ GLNPO will continue research on the fate and effects of sediment-bound contaminants to predict effects of alternative actions.
- GLNPO will, as required by the Water Quality Agreement, complete the first biennial progress report on the ARCS program by December of 1988.
- ★ GLNPO will assess combined sewer overflows (CSO) and work with the EPA water program to initiate appropriate regulatory actions.
- GLNPO will work with EPA Headquarters and Region II, III, and V water and waste management programs to develop a coherent interactive approach for meeting Annex 16 ground-water requirements.
- GLNPO will work with EPA's Office of Information Resources Management (OIRM), Office of Research and Development (ORD), appropriate EPA Regions and States, and the IJC to convene a conference on Great Lakes Basin GIS efforts.
- ★ GLNPO will begin to assemble and map, using (GIS) technology, an inventory of known and potential sources of ground-water contamination including waste disposal sites that may affect the Great Lakes.

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- ★ GLNPO will support EPA's Office of Ground-Water Protection in its efforts to develop a national ground-water data base on STORET, which will include information developed by all regulatory programs.
 - ★ GLNPO will work with EPA's ORD and the Office of Solid Waste and Emergency Response (OSWER) to develop and apply ground-water flux measurement methods and ground-water flow and contaminant transport models that will be used to estimate loadings to the Great Lakes.
 - As required by the Water Quality Agreement, GLNPO will coordinate existing control programs that influence ground-water quality in the Great Lakes and produce the first biennial progress report by December 31, 1988.
 - GLNPO will begin to integrate EPA, Fish and Wildlife Service, and other Federal agency activities affecting Great Lakes wetlands protection programs.
 - ★ GLNPO will work with Region V to develop a GIS project for wetlands in Region V and the Great Lakes Basin to support coordination of the Advance Identification of Disposal Sites (AIDS) program with RAP initiatives.
 - ★ GLNPO will work to pilot the use of GIS technology for mass balance modeling in Green Bay and for multimedia environmental assessment tracking in support of the Ashtabula RAP.
 - ★ GLNPO will work with EPA Headquarters and Regions II, III and V to address environmental concerns, in addition to human health concerns, in Superfund actions.
 - GLNPO will work with EPA Headquarters to develop a Superfund Environmental Assessment Manual that is responsive to Great Lakes issues.
 - ★ GLNPO will provide technical support to EPA Regional waste management and water programs to ensure that regulatory actions are consistent with the Agreement.
 - GLNPO will initiate EPA and State program reviews of the implementation of point source biomonitoring and associated stream biosurvey programs.
 - GLNPO will review the need for an overall assessment of pretreatment program effectiveness based on Water Quality Board reports.

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- GLNPO will work with the EPA's air program to complete an emission inventory for air toxics to the Great Lakes.
 - ★ GLNPO will support EPA's air program initiatives for State toxic programs and monitor results.

FY 1990

- GLNPO will select sites and sponsor full scale demonstrations at selected locations for the ARCS program.
- GLNPO will begin mapping hydrologic conditions around known and suspected sources of contaminated ground water in the Great Lakes Basin.
- GLNPO will initiate the development of an overall Great Lakes wetland strategy.
- GLNPO will work with the Regions to map Great Lakes wetlands using remote sensing procedures.
- GLNPO will work with OIRM, ORD, Regions, States, and the IJC to form a Great Lakes GIS technical advisory committee.
- GLNPO will work with the Great Lakes community in applying GIS techniques to the development of Lakewide Management Plans and in tracking remedial progress in Great Lakes AOC's.
- GLNPO will complete program reviews of the implementation of point source biomonitoring and associated stream biosurvey programs.
- GLNPO will continue ongoing activities identified above.

FY 1991

- By December of 1990, GLNPO will coordinate the preparation of the second biennial progress report on the ARCS Program.
- GLNPO will continue full-scale demonstrations of contaminated sediment remedial technologies.
- By December of 1990, GLNPO will coordinate the preparation of the second biennial progress report on ground-water contamination affecting the Lakes.
- GLNPO will complete the development of an overall Great Lakes wetland strategy.

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- GLNPO will review how GIS technology is applied in analyzing Great Lakes problems, and plan future projects.
 - GLNPO will work with the Regions and States to determine potential impacts of waste sites on wetlands using GIS technology.
 - GLNPO will continue to support the GIS technical advisory committee.
 - GLNPO will apply GIS mass balance techniques to a specific Lakewide Management Plan.
 - GLNPO will continue mapping hydrologic conditions around known and suspected sources of contaminated ground water in the Great Lakes Basin.
 - GLNPO will assess the adequacy of combined sewer overflow controls in conjunction with a review of the effectiveness of remedial action plans.
 - GLNPO will continue ongoing activities identified above.

FY 1992

- GLNPO will perform assessments of overall Great Lakes vulnerability to contamination from ground water.
- GLNPO will continue to support the GIS technical advisory committee.
- GLNPO will summarize all available information on point source loadings of toxics and nutrients to the Lakes in preparation for the 1993 renegotiation of the Agreement.
- GLNPO will summarize the effectiveness of the Great Lakes wetlands strategy in preparation for the 1993 renegotiation of the Agreement.
- GLNPO will continue ongoing activities identified above.

FY 1993

- By December of 1992, GLNPO will issue a final report on the ARCS program, including guidance on characterization of contaminated sediments, selection of remedial technologies, estimating costs, and predicting effectiveness of alternative actions versus no action.
- Also by December of 1992, GLNPO will coordinate the preparation of the third biennial progress report on ground-water contamination affecting the Lakes.
- GLNPO will continue to support the GIS technical advisory committee.
- GLNPO will continue ongoing activities identified above.

7.7 Research

7.7.1 Background

In the United States, Great Lakes research programs are spread among several agencies and many locations. U.S. research for the Lakes can be categorized as water quality management research, ecosystem dynamics research, and fishery resources research. These various components are carried out by several agencies, including EPA, that coordinate and cooperate with each other, as shown in Figure 6.

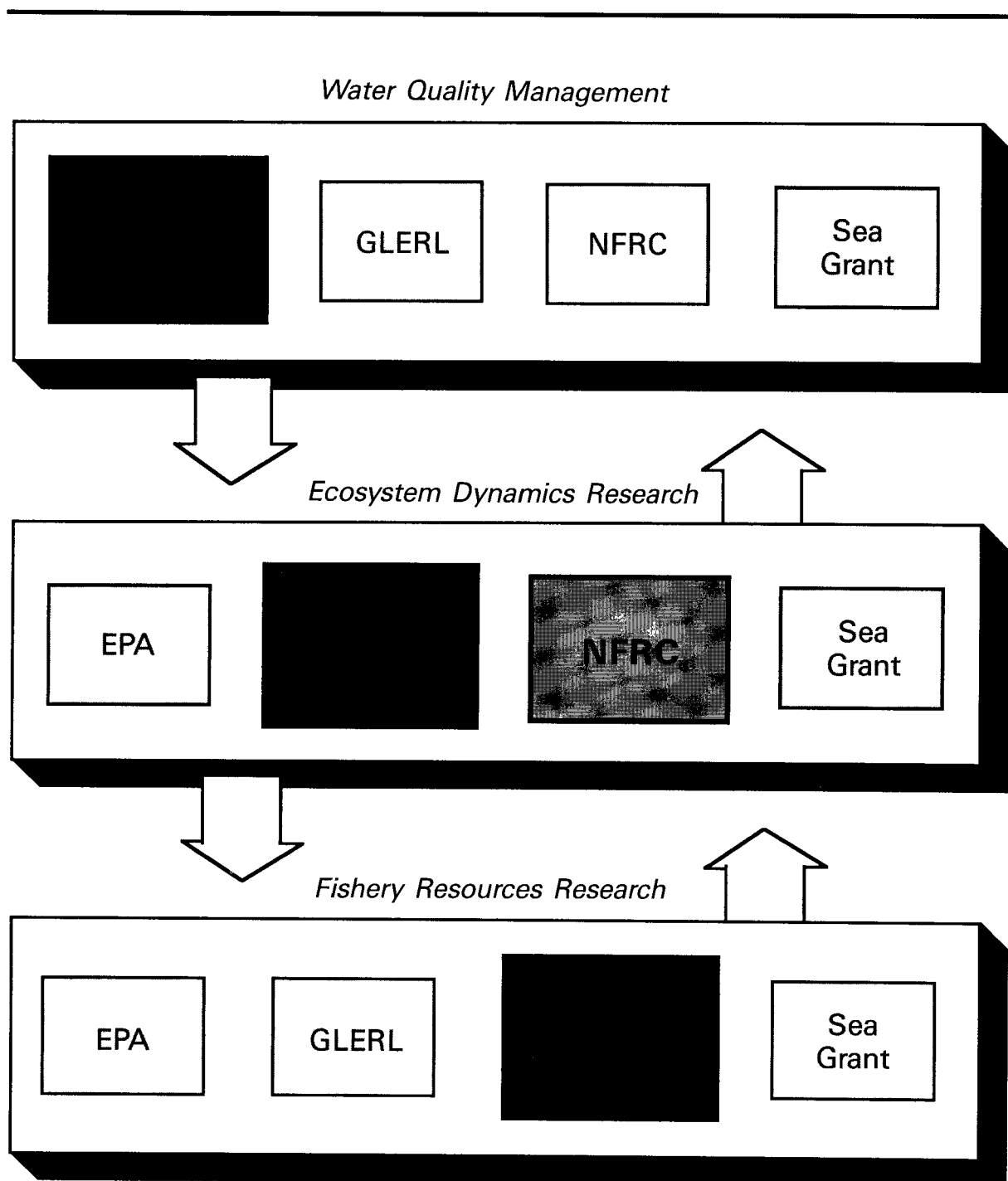
Within EPA, Great Lakes research is carried out principally by the Large Lakes Research Station (LLRS) at Grosse Ile, Michigan and by the National Water Quality Laboratory at Duluth, Minnesota. Research is sponsored by the Office of Research and Development in EPA Headquarters as well as by GLNPO. Contracts with universities, private consultants, and other Federal agencies supplement EPA programs.

The NOAA Great Lakes Environmental Research Laboratory (GLERL), at Ann Arbor, Michigan, carries out basic hydrologic and limnologic research. GLERL research has contributed to an increased understanding of the role of phosphorus in the Great Lakes ecosystem. A long-term GLERL study of how toxic pollutants cycle in the Great Lakes will assist in the development of management programs.

The National Fisheries Research Center—Great Lakes (NFRC), of the U.S. Fish and Wildlife Service, provides research and monitoring in support of Great Lakes fishery management agencies and coordinates with the Great Lakes Fishery Commission, a joint Canada-U.S. agency. The Fish and Wildlife Service also participates in the fish contaminant monitoring programs that are coordinated by GLNPO. Finally, the Fish and Wildlife Service funds Cooperative Fishery Research Units at selected universities. These units conduct research on fishery management and contaminants in freshwater areas, including the Great Lakes.

State and Federal funding for Great Lakes research is provided to the Sea Grant College programs in State universities. Federal Sea Grant funding is provided by NOAA. The Sea Grant colleges presently conduct research on bioaccumulation of pollutants in fish and effects on other biota.

GLNPO has supported research by the Argonne National Laboratory, the Illinois Water Survey, and various universities on atmospheric deposition to Lake Michigan. Argonne has also carried out research on Lake Michigan biological systems. Research by the Army Corps of Engineers has focused on Great Lakes water levels and flows and on dredging and disposing of



KEY

EPA. U.S. Environmental Protection Agency

GLERL: Great Lakes Environmental Research Laboratory (NOAA)

NFRC: National Fisheries Research Center, Great Lakes (U.S. Fish and Wildlife Service)

Figure 6. Federal Agency Participation in Great Lakes Research

dredged materials. GLNPO also funds a variety of research and development activities to address toxics in the Great Lakes, including studies on improved tributary monitoring methods for toxics and an investigation of the toxic effects of contaminants unique to the Great Lakes.

Funds for research on Great Lakes issues are provided through EPA, the National Oceanic & Atmospheric Administration, the U.S. Fish & Wildlife Service, and the U.S. Army Corps of Engineers. As each of these organizations operates under separate regulatory or resource management missions, it is important for these agencies to coordinate efforts to optimize Federal expenditures. The Clean Water Act Amendments of 1987 establish a Great Lakes Research Office (GLRO) within NOAA that is tasked to coordinate Great Lakes Research.

7.7.2 GLNPO's Five Year Strategy—Federally Funded Research

- FY 1989*
- GLNPO will develop with NOAA an overall research needs listing for the Great Lakes.
 - ★ GLNPO will coordinate within EPA and with other Federal agencies and national research programs to focus Great Lakes research on the following topics identified in the Water Quality Agreement:
 - Mass transfer of pollutants within and between Great Lakes components of water, sediment, air, land, and biota;
 - Pollutant load reduction models;
 - Processes affecting delivery of pollutants by tributaries;
 - Relationships between productivity and exotic species;
 - Relationship of contaminated sediments and ecosystem health;
 - Pollutant exchange between Areas of Concern and other parts of the Great Lakes;
 - Effects of varying lake levels on aquatic life;
 - Ecotoxicity effects of pollutants (for use in developing water quality objectives);
 - Options for the recovery of fish and wildlife populations affected by water quality problems and by non-native species;
 - Pollution control technologies;
 - Health-based exposure standards for contamination, considering multi-media exposure routes and the interactive effects of chemicals; and
 - Approaches to population-based studies on the effects of toxic substances on human health.

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- ★★ As required by the Clean Water Act, GLNPO will develop a joint research plan with NOAA's Great Lakes Research Office by the end of each fiscal year.

FY 1990

through 1993 • GLNPO will continue ongoing activities identified above.

7.8 Technology Development and Transfer

7.8.1 Background

As a National Program Office and an international participant in the field of environmental protection, GLNPO has an important role in the development of environmental technology and is an information clearinghouse for such technology. For example, GLNPO works with the National Estuary Program on approaches to solving common problems. GLNPO also has been active in international forums for technology exchange and provides technical support for the U.S.-U.S.S.R. environmental exchange program on water quality management research.

The management approach used by the U.S. and Canada to address Great Lakes environmental problems is of continuing interest to environmental scientists and managers throughout Europe and Asia. GLNPO provides information about these approaches and their results through participation in international meetings on Large Lakes issues and individual briefings for visiting scientists and officials.

The Great Lakes have been a proving ground for the testing of new environmental technology. In 1972, Section 108(a) of the Clean Water Act authorized \$20 million for EPA to demonstrate the engineering and economic feasibility, and the practicality, of pollution control in the Great Lakes Basin—probably the largest continuous nonpoint source control demonstration program in the United States. GLNPO worked closely with EPA's Office of Research and Development, Headquarters and Regional water programs, and State and local government organizations, to conduct projects that covered a range of objectives including the demonstration of specific control technologies; the control of agricultural pollution through implementation of Best Management Practices (BMPs); public education on water issues; the documentation of water quality results through monitoring; the evaluation of combined sewer systems; and the evaluation of various land application techniques for sewage disposal.

★★ The Clean Water Act Amendments of 1987 establish, under Section 118(d), a Great Lakes Research Office (GLRO) within NOAA and require GLNPO and GLRO to prepare a joint research plan annually [Section 118(e).] The conduct of this activity for FY 1989 and any subsequent fiscal year is dependent on the funding of GLRO.

The Black Creek project, in Allen County, Indiana, provided important information relating to stream bank erosion, sedimentation basin effectiveness, and water quality modeling. A particularly important concept emerging from Black Creek was the concept of treating critical areas. The ANSWERS computer model (Areal Nonpoint Source Watershed Environmental Response Simulation) was developed to identify those areas that contribute most to water quality problems and therefore support the targeting of limited resources. The approach provides an effective, coherent identification of pollutant sources and simulates the effect of treatment. The project also reinforced the concept that a vigorous information and education program is essential to implementing BMPs.

The Washington County, Wisconsin, project, after extensive researching and drafting, resulted in two model sediment control ordinances, one controlling agricultural sources of pollution, and the other controlling construction sources of sediment. An extensive county-wide education program increased public awareness of soil conservation and water quality, and a comprehensive school curriculum was developed by local teachers.

The Red Clay project developed a nine-step "Framework for Local Management Agency Implementation," based on more than four years of erosion and sediment control activities and water quality demonstrations in four northwest Wisconsin counties and one Minnesota county. This framework provides a generalized problem-solving methodology for local governments, which can guide the implementation of long-range nonpoint source water pollution abatement programs.

Other conservation tillage projects encouraged farmers to implement conservation practices and showed the effectiveness of locally sponsored projects. Combined sewer overflow projects demonstrated effective flow control devices. Sewage application projects showed that applying sewage effluent to the land improved the quality of receiving lakes. Adoption of demonstrated techniques in Saginaw Bay, Michigan, resulted in estimated savings of \$20 million.

These projects will provide an important historical base and institutional and technical insights from which new State and local nonpoint source initiatives can draw. Moreover, GLNPO will continue to conduct and sponsor demonstration projects and technology transfer efforts throughout the Great Lakes Basin.

7.8.2 GLNPO's Five Year Strategy—Technology Development and Transfer

- FY 1989*
- GLNPO will continue to transfer phosphorus control technology to States and local agencies by cosponsoring a technology transfer workshop.
 - ★ GLNPO will continue to advise and assist the National Estuary Program and will participate in annual technology transfer forums.
 - ★ GLNPO will continue to distribute information on low-cost alternatives for combined sewer overflow problems.
 - GLNPO will initiate the development of a technology transfer strategy working with the Office of Marine and Estuarine Protection and other appropriate offices.
- FY 1990*
- GLNPO will begin a technology transfer program based on the results of the contaminated sediment demonstrations.
 - GLNPO will continue ongoing activities identified above.
- FY 1991*
- GLNPO will begin technology transfer programs on mass balance modeling and air deposition monitoring.
 - GLNPO will continue ongoing activities identified above.
- FY 1992*
- GLNPO will conduct an assessment of technology transfer programs for phosphorus controls, National Estuary Program support, combined sewer overflow problems, contaminated sediment demonstrations, mass balance modeling, and air deposition monitoring.
 - GLNPO will continue ongoing activities identified above.
- FY 1993*
- Based on the FY 1992 assessment, GLNPO will either continue or phase out existing programs and determine new topics for technology transfer.

★ An ongoing activity throughout the five-year period.

7.9 International/Interagency/Intra-agency Coordination

7.9.1 Background

GLNPO is often a coordinator or facilitator of other organizations. Nearly all of GLNPO's ongoing activities and special projects involve coordination with groups outside the United States, with other Federal agencies in the U.S., with other organizations in EPA, or with State and local governments.

Interactions with Canada and the IJC are the most important international responsibilities of GLNPO. Another significant international activity that GLNPO supports is implementation of the U.S.-U.S.S.R. Joint Agreement on Cooperation in the Field of Environmental Protection, signed in 1972. This agreement is a comprehensive bilateral commitment to cooperation in eleven major areas of mutual interest, including the Prevention of Water Pollution. A Working Group meets annually to plan the program and cooperative efforts for future joint work.

To date, a total of five international symposia have been held and their proceedings jointly published. Topics have included aquatic toxicology, microbiology, remote sensing, and mathematical modeling. Current projects are:

- *River Basin Water Quality Planning and Management* — During 1987, information was exchanged on water quality management programs and sediment studies, and on the impacts of agriculture on water quality and related modeling techniques.
- *Protection and Management of Water Quality in Lakes and Estuaries* — Mesocosm studies were conducted on the effects of a pesticide and other pollutants on aquatic plants and animals.
- *Effects of Pollutants on Aquatic Organisms and Ecosystems* — Two American specialists visited the U.S.S.R. in 1987 and conducted joint research on interactions of atmospheric acid deposition and mobilization of trace metals in soil.

GLNPO frequently works with other Federal agencies. This responsibility has received renewed attention in the Clean Water Act Amendments of 1987, which require GLNPO to develop specific action plans in cooperation with appropriate agencies. As a result of the Amendments, the Army Corps of Engineers, Soil Conservation Service, Coast Guard, Fish and Wildlife Service and NOAA will submit annual reports to EPA on activities affecting compliance with the Great Lakes Water Quality Agreement.

GLNPO has a regular need for coordination with other EPA programs, in Headquarters and in Regions II, III, and IV. GLNPO interaction with the Region V Water Program has been formalized through a Memorandum of Understanding (MOU) that is periodically evaluated. In accordance with the Clean Water Act Amendments of 1987, GLNPO will be writing similar agreements with all appropriate programs and Regions to define responsibilities associated with protecting the Great Lakes.

7.9.2 GLNPO's Five Year Strategy — International/Interagency/ Intra-agency Coordination

- FY 1989
- ★ GLNPO will continue to support the Parties in implementation of all aspects of the Water Quality Agreement.
 - ★ GLNPO will implement and coordinate joint surveillance and monitoring plans with Canada to work toward the goal of designing data systems with compatible information.
 - ★ GLNPO will enter into joint studies and agreements to transfer technology applicable to the Great Lakes to other nations and to State and local organizations.
 - ★ GLNPO will continue to support the implementation of the U.S.-U.S.S.R. Joint Agreement on Cooperation in the Field of Environmental Protection.
 - ★ GLNPO will work cooperatively with other Federal agencies to develop and implement specific plans and programs.
 - GLNPO will enter into agreements with NOAA, the Fish and Wildlife Service, the Corps of Engineers, the Coast Guard, and the Soil Conservation Service to fulfill specific provisions of the Great Lakes Water Quality Agreement.
 - ★ GLNPO will coordinate the preparation and submission of annual reports, as required by the Clean Water Act, to the EPA Administrator.
 - ★ GLNPO will conduct regular meetings with State representatives prior to binational water quality meetings.
 - ★ GLNPO will track and assist the implementation of the Governors Toxic Substances Control Agreement.

★ An ongoing activity throughout the five year period.

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- ★ GLNPO will work cooperatively with the Regions to ensure that Great Lakes priorities under the Clean Water Act and Water Quality Agreement are implemented through annual State program plans.
 - ★ GLNPO will work cooperatively with Headquarters offices to ensure that annual guidance to the Regions includes Great Lakes priorities based on the Clean Water Act and Water Quality Agreement.
 - GLNPO will enter into or revise existing Memoranda of Understanding, as required by the Clean Water Act, with appropriate program offices in EPA Region V.
 - ★ GLNPO will provide support for the development and implementation of a Great Lakes geographic information system in conjunction with the EPA Environmental Research Laboratory in Duluth, and EPA Region V.
- FY 1990
- GLNPO will enter into Memoranda of Understanding, as required by the Clean Water Act, with appropriate Offices in Regions II, III, and Headquarters.
 - GLNPO will continue ongoing activities identified above.
- FY 1991
- GLNPO will review the effectiveness of existing agreements with other Federal agencies and initiate revisions as appropriate.
 - GLNPO will continue ongoing activities identified above.
- FY 1992
- GLNPO will develop an overall strategy for renegotiating the Water Quality Agreement and initiate the process.
 - GLNPO will evaluate the effectiveness of existing Memoranda of Understanding with other EPA offices and initiate revisions as appropriate.
 - GLNPO will continue ongoing activities identified above.

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- FY 1993
- GLNPO will complete the review of all program areas assessed in preparation for renegotiating the 'Agreement and conduct the renegotiation.
 - GLNPO will continue ongoing activities identified above.

7.10 Public Education and Involvement

7.10.1 Background

The Clean Water Act mandates that “public participation be provided for, encouraged, and assisted in the development of any plan or program.” States share responsibility with EPA for this participation.

Public support has been essential in implementing programs to control conventional pollutants. Accordingly, GLNPO plans a public information program to increase public understanding of toxic pollution and the new approaches to environmental management called for by the 1987 Amendments to the Clean Water Act and the Great Lakes Water Quality Agreement. Public participation has been very effective in local projects, such as the remedial action planning process.

The Center for the Great Lakes recently completed a survey of the status of public involvement in RAPs around the Lakes. In 18 of the 42 Areas of Concern, a specialist in public involvement has been hired. In 44 percent of these areas, written materials have been distributed to the public, such as status reports, newsletters, or draft plans. In 13 of the areas, a group of key individuals representing a variety of interests in the community has been appointed to a public or citizens advisory committee.

One of GLNPO's five year goals is to improve public understanding of the Great Lakes system. GLNPO's approach to achieving this goal includes: providing the public with information concerning the Great Lakes, their condition, and issues concerning their use and abuse; making use of existing information and education resources; developing a series of issue papers; developing materials targeted to specific audiences; and supporting State activities for public involvement in local planning.

7.10.2 GLNPO's Five Year Strategy — Public Education and Involvement

- FY 1989
- GLNPO will complete a comprehensive strategy for public education and involvement.

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- ★ GLNPO will support and encourage State actions for public involvement in development of Remedial Action Plans and Lakewide Management Plans.
 - GLNPO will compile and disseminate existing teaching materials on Great Lakes issues, including the Great Lakes Atlas.
 - GLNPO will support a pilot project to integrate Great Lakes material with existing curricula work in selected school districts.
 - ★ GLNPO will conduct regular meetings with representatives of public interest groups on a schedule consistent with the Parties' semiannual meetings.

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| <i>FY 1990</i> | <ul style="list-style-type: none"> • GLNPO will begin implementing the public education strategy developed in FY 1989. • GLNPO will continue ongoing activities identified above. |
| <i>FY 1991</i> | <ul style="list-style-type: none"> • GLNPO will continue implementing the public education strategy and assess the effectiveness of completed activities. • GLNPO will continue ongoing activities identified above. |
| <i>FY 1992</i> | <ul style="list-style-type: none"> • GLNPO will evaluate the effectiveness of, and appropriate vehicles for, public participation in the renegotiation process. • GLNPO will continue ongoing activities identified above. |
| <i>FY 1993</i> | <ul style="list-style-type: none"> • GLNPO will ensure opportunities for public participation in the renegotiation of the Agreement. • GLNPO will continue ongoing activities identified above. |

As GLNPO coordinates with other Federal, State, and local programs and initiatives over the next five years and beyond, an integrated program strategy for protecting the Great Lakes resources will emerge. This integrated strategy will be founded on the common goals of the various governmental institutions entrusted with protecting and preserving the ecological integrity of the Great Lakes. GLNPO will continue to articulate and clarify this strategy throughout its evolution, and will serve as a focus for its continued development.