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POLLUTION PROBLEMS OF THE GREAT LAKES REGION

CONFERENCE PROCEEDINGS

ANN ARBOR, MI, JUNE 9-11, 1980

Report of Great Lakes Region Conference on Marine Pollution Problems

Traverse City, MI, June 9-11, 1980



Prepared for:

Interagency Committee on Ocean Pollution
Research, Development and Monitoring
Federal Coordinating Council for Science,
Engineering, and Technology

By:

Alfred Beeton, Conference Chairman
Mimi Becker, Panel Chairman
Jonathan Bulkley, Panel Chairman
James Cowden, Panel Chairman
Carlos Fetterolf, Panel Chairman
Lawrence Libby, Panel Chairman
Edwin Shannon, Panel Chairman
Russell Moll, Conference Coordinator

Edited and Produced by:

Russell Moll
Suzanne Tainter
Stephen R. Schneider

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EXECUTIVE SUMMARY

An adequate supply of fresh water is going to be a major problem for the world by the year 2010 according to the President's Global Resources study. In the United States, 95 percent of the surface fresh water is held in the Great Lakes. One fifth of the U.S. population and one fourth of American industry presently rely on Great Lakes waters. The value of this resource has not been lost on other portions of this country as evidenced by proposals, which surface with increasing frequency, to divert Great Lakes waters to water-poor regions of the U.S.

A unique and important aspect of the Great Lakes is that four out of the five lakes are international boundary waters between the United States and Canada. This international location of the lakes requires that the governments of both countries agree to maintain or improve the water quality of their joint resource. Such agreements have been made in the Water Quality Agreements of 1972 and 1978. Thus, although this document represents the results of U.S. efforts, the final research decisions and actions must be a co-operative effort between the U.S. and Canada; in fact, many steps currently taken to ensure high water quality in the Great Lakes are mandated by the 1972 and 1978 agreements.

Cognizant of the value of the fresh water in the Great Lakes, numerous federal and non-federal efforts are aimed at ensuring the future high quality of the Great Lakes. One attempt to inventory and coordinate federal efforts in Great Lakes pollution research comes from the five-year plan prepared under Public Law 95-273, the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978.

From June 9-11, 1980, representatives of federal, state, regional, and local agencies, of research institutions, and of citizen groups gathered in Traverse City, Michigan, to develop a five-year plan for federal research in Great Lakes pollution. The conference was one of five marine regional gatherings to solicit local input to the federal five-year plan. In general, the conference objectives were achieved, but the lack of several important documents somewhat inhibited progress. Initially, the research plans of federal agencies which conduct marine research were to be available to participants for their review. The participants were to analyze the intended direction of research by these federal agencies and suggest where changes should be made on the basis of conference deliberations. Unfortunately, this information was not available during the conference. Recommendations for future pollution research were made in the absence of knowledge of what type of research each agency intends to do over the next five years.

THE GREAT LAKES

There are three main characteristics of the Great Lakes which are important in considerations of pollution problems in the region. First, the lakes are fresh water. Their waters are consumed as drinking water directly by a substantial portion of the U.S. and Canadian populations. Second, the lakes are relatively closed basins. Unlike ocean embayments which are repeatedly flushed by tides, the Great Lakes system has water retention time on the order of centuries. In Lake Superior, water is totally replaced only every 500 years, thus any additions to the lakes remain in the system for a long time. Third,

many contributions of pollutants to the Great Lakes come from atmospheric input and land runoff. Another consideration is that the pollutants which enter the lakes may be generated outside the Great Lakes region. The differences between the upper (Superior, Michigan, and Huron) and the lower lakes (Ontario and Erie) must also be considered. The upper lakes are generally forested watersheds and contaminants are their main problems except in some nearshore areas and bays. Lake Erie's watershed is heavily agricultural, and the lake is shallow, thus the major problem in this lake is eutrophication.

MAJOR REGIONAL CONCERNS

Each participant at the Great Lakes conference considered the region's water quality problems as a member of one of six panels covering the major uses of the Great Lakes basin: food and fiber production; industrial; municipal; recreation and wildlife; social, economic, and institutional; and transportation. Despite the different perspectives of the panels, several common themes emerged from the discussions.

Toxic Contaminants

Concerns were raised about contaminants and toxic substances entering the lakes. These concerns covered their transport, disposal, storage, and destruction, as well as their fate and effects in the lakes and their biota. Some participants stressed human health implications while others felt the destructive effects of toxics and contaminants on the ecosystem were sufficient reason to rate this a very high priority problem. One problem that received considerable attention was the siting of hazardous waste disposal facilities.

Eutrophication

Eutrophication was another major concern raised in all panels. Eutrophication is the excessive nutrient enrichment of the waters, particularly with phosphorus. Much work in the region through the years has been devoted to sources and effects of nutrient enrichment and the development of strategies to control phosphorus loading to the lakes. But, there still remains a large amount of uncertainty concerning the causes and effects of high rates of eutrophication in the Great Lakes. Conference participants agreed that diffuse sources such as agricultural runoff as well as point sources like municipal sewage outfalls need better control.

Habitat Modifications

Alterations in the Great Lakes basin have been extensive to maintain human populations, industries, and lake commerce. All six panels raised concerns about uses and changes of the region. The function and structure of the Great Lakes ecosystems, although relatively poorly understood, have been significantly and possibly irreparably changed by human habitat modifications. The productivity of the fish stocks in the Great Lakes has been changed, as have the

predominant species found in the lakes. All of the other forms of wildlife have also been susceptible to extensive habitat modifications. The effect on wildlife has been particularly pronounced in the nearshore zone and in wetlands. Concerns were raised about effects of harbor and channel dredging, dredge disposal, nearshore landfills, and nearshore farming on the Great Lakes.

Major Discharges

The discharge of many materials to the Great Lakes in large volume can present a major pollution problem. The release of hazardous wastes and/or nutrients which exacerbate eutrophication is a major pollution problem as discussed above. But, there are many rather innocuous materials which when discharged in large quantities become a problem. Most chloride salts when discharged in small quantities are not particularly harmful. Yet, the large amount of chloride released into the Great Lakes has significantly altered the chloride concentrations of four of the five Great Lakes. The anticipated release of chlorides into the Great Lakes is expected to increase in the near future.

Runoff from heavy, rapid rainstorms can carry a variety of compounds depending on whether it comes from agricultural lands, street runoff, or combined sewers. In the case of combined sewers, these major discharges carry many pathogens which present human health hazards.

Another major discharge that affects the Great Lakes is atmospheric fallout. The heavy air pollution burden of the industrialized Great Lakes region is a major contributor to water quality problems.

Institutional Problems

Participants felt that the overlapping jurisdictions of the many political entities responsible for the Great Lakes often hampered rather than helped Great Lakes clean up efforts. Another major institutional concern was the availability and handling of information and data about the region. The perception of the attendees was that there was probably a tremendous amount of information available on Great Lakes pollution problems, but that the exchange of this information among agencies was very poor.

Risk Analysis

Risk analysis was also mentioned in several of the panel deliberations. These groups suggested that risk analysis could be an important tool, and that proposed activities for the Great Lakes region should be subject to risk analysis. Other participants called for improved techniques of risk analysis which could be used to help the public make trade-offs between safety and the cost of regulation.

An additional issue associated with risk analysis is the need for improved methods of anticipating threats to the Great Lakes. Carefully designed, long-term monitoring programs were mentioned as a means of keeping track of developing problems and evaluating proposed solutions. Conference participants pointed out that congressional and public support for monitoring programs was

not high because monitoring does not appear to address any obvious threats.

In their deliberations, participants were guided by a concern for an "ecosystem approach" to problem solving. Panel members repeatedly stressed the importance of recognizing the interaction of land, air, and organisms (including humans) in water quality issues. An important factor is that Great Lakes problems often arise outside the actual watershed of the lakes. The political corollary of the ecosystem approach is that the Great Lakes system is international - the lakes are shared with Canada - and thus effective efforts to improve water quality require Canadian cooperation.

RECOMMENDATIONS

- 1) Develop an increased understanding of how the Great Lakes ecosystems function in order to evaluate their response to various stresses and corrective measures. Such information is the basis for dealing with the majority of the problems cited in this report.
- 2) Establish an efficient monitoring program which meets the critical need for continuing data on nutrient loading, toxic substances, and the response of the biota to these pollutants. Such a program can best be developed upon a sound understanding of how the Great Lakes ecosystems function. A monitoring program capable of achieving these objectives would monitor processes in addition to occurrence and concentrations of substances and biota.
- 3) Provide specific information on present and planned federal research to any future group attempting to develop a federal plan on ocean pollution research. This information could then be used to determine if each federal pollution research program was meeting the research needs as perceived by both the public and non-federal researchers.

INTRODUCTION

The Great Lakes are certainly the prominent freshwater resource of North America, if not the world. This resource is of tremendous value both to the Canadian and U.S. economies and from an aesthetic standpoint. The daily use of Great Lakes water is overwhelming: 23 million gallons for power generation, 13 million gallons for manufacturing, 157 million gallons for agriculture, and 3,039 million gallons for domestic uses including drinking water. The Great Lakes transport 85 million tons of iron ore and 30 million tons of grain yearly. Coal, limestone, steel and other products create such a major water borne commerce that more cargo was shipped through the Locks at Sault Ste. Marie than the Panama Canal last year. The 9,500 miles of shoreline and 95,000 square miles of water provide ample recreational opportunities for the millions of tourists who contribute over \$5 billion to the region's economy each year. The region's agriculture contributes \$20 billion to the nation's economy. About one fourth of the nation's manufactured goods are produced in the region, including 70 percent of U.S. steel and 23 percent of the country's chemicals.

A heavily industrialized, heavily populated band cuts across the lower portion of the Great Lakes region from Milwaukee through Chicago, Gary, Indiana, across lower Michigan to Detroit, along the shore of Lake Erie through Cleveland to Buffalo and north to Canada's most industrialized and populated region along the shore of Lake Ontario. Yet north of this band, the region is sparsely populated and often heavily forested, with a reliance on recreation and regional natural resources to maintain the local economy.

Land uses of the region change in character as one moves south and east across the basin. The Lake Superior watershed is almost 90 percent forested and, as a consequence, is an important paper and lumber area. The port of Duluth-Superior is located on Lake Superior, and the region supplies 80% of U.S. iron ore. The Lake Huron watershed is also heavily forested. There is limestone mining and cement production in the basin, and chemical manufacturing along both the U.S. and Canadian shores of southern Lake Huron. Lake Michigan, the only Great Lake lying solely within the United States, has a watershed which is about half forested, supporting 25 percent of U.S. paper production. A quarter of the watershed is agricultural, and the area is a leading U.S. producer of fruits, vegetables, and dairy products. The southern Lake Michigan area is heavily industrialized with steel production, manufacturing, and refineries from Milwaukee to Gary. The economy of the U.S. portion of the Lake Erie watershed is based on agriculture. The region is a major producer of soybeans, vegetables, wheat, dairy products, and grapes. It is also an important manufacturing region producing steel, glass, and 66 percent of U.S. cars. The Lake Ontario watershed is largely rural. From Niagara Falls on the west to the Thousand Islands on the east, tourism is an extremely important part of this area's economy. Canada's major commercial, industrial, and population centers are located along Lake Ontario.

The convergence of people and industry in the region, coupled with the natural characteristics of the Great Lakes, has created major problems. Unlike the ocean, the Great Lakes are a relatively closed system. Each lake basin drains into the next. Even the Lake Michigan cul-de-sac eventually drains through Lakes Huron, Erie, and Ontario. Any addition of contaminants today may take centuries to be flushed out of the system. Another characteristic of the system is the significance of atmospheric contribution as a source of pollutants

to the lakes. A major source of PCBs to Lake Superior is atmospheric fallout. Thus any efforts to improve Great Lakes water quality must consider air and land issues as well.

Any threat to Great Lakes water quality is particularly significant because of one crucial fact; the Great Lakes are fresh water. Their waters are consumed directly as municipal water supplies - 3 billion gallons a day. In fact, 95 percent of the U.S.'s available fresh water is contained in the Great Lakes. Yet, as with so many of our natural resources, the environmental problems of today overshadow the value of the resource. The highly industrialized society of the Great Lakes basin has found the lakes a convenient dumping ground. The large agricultural and mining industries of the region have produced vast amounts of wastes and runoff which eventually enter the lakes. Although much of the Great Lakes could still be considered pristine, a significant portion is sufficiently polluted to pose a threat to human health as well as to ecosystem viability.

The human health problems associated with Great Lakes pollution are perhaps the most disturbing in many ways. The accumulation of toxic wastes over nearly a century of heavy industry has now become the pollution problem of the region. The disaster at Love Canal in Buffalo is likely to be repeated several times throughout the Great Lakes region. The mechanisms to introduce toxic wastes into the human population are numerous. Soluble wastes which enter the Great Lakes are likely to end up in municipal water supplies. Other toxics enter the aquatic food web and often accumulate in fish; these fish are consumed both as a result of sports fishing and commercial fishing. Air-borne particulate pollutants enter the Great Lakes by both dry and wet deposition. Many of these particulates are carcinogens, and end up in municipal water supplies. The two important factors which make Great Lakes pollution a major threat to human health are: 1) the use of these waters for drinking water, and 2) the relatively closed nature of the basins. These conditions do not exist in the marine environment.

Beyond the human health problems induced by Great Lakes pollution, there are problems which affect the overall viability of the ecosystems. Excessive nutrient enrichment has contributed to major shifts in the indigenous flora and fauna. Many species are threatened with local extinction because of the changes in their habitat. Other species are threatened by massive dredging and/or construction programs. The loss in habitat for species which require a nearshore breeding area has been large. These changes in the overall ecosystem viability are dramatic, yet relatively unquantified. The duration of these changes is totally unpredictable, as is the course they are likely to follow. The conclusion is that human-induced changes to the Great Lakes have been large, and continuous. Ecosystem viability is now threatened in many ways. Remedial actions are slow to take effect and expensive to impose. The value of the Great Lakes resource is at stake. Given this background of pollution problems, the Great Lakes Pollution Research and Monitoring Conference took on an air of certain urgency.

CONFERENCE OBJECTIVES AND APPROACH

Research needs in the field of marine pollution are constantly evolving. This evolution is caused by changes in the nature of problems which result from human activity in the nearshore aquatic environment. Although problems from aquatic pollutants rarely are completely solved, new ones arise which require more urgent attention.

The U.S. Congress recognized the complex and changing problems of pollutants in the marine environment and passed in May of 1978 Public Law 95-273: "The National Ocean Pollution Research and Development and Monitoring Planning Act of 1978." This act requires a five-year federal plan to address how federal agencies will attack problems of the marine environment. Although this is a five-year plan, it is updated every other year in recognition of the constant evolution of pollution problems.

The biennial updates are conducted in two steps. First, conferences are held in five coastal regions in the U.S. to identify important pollution problems on a region-by-region basis. Second, the results of the regional conferences are combined into one federal plan which is used to set funding priorities among the various federal agencies which support marine research. The results of the Great Lakes regional conference, which was held in Traverse City, Michigan, June 9-11, 1980, are presented in this report.

The objective of the Great Lakes conference was to identify the most important pollution problems of the Great Lakes, which are considered "marine" by congressional decree. Factors which went into the consideration of "important" problem areas were: the impact of pollutants on human health, the impact of pollutants on overall ecosystem health, the longevity or reversibility of the consequences of the pollutant, the areal extent of the pollutant, and the future magnitude of the problem. Once pollutant problems were identified, the associated research or information needs were considered; this meant that problem areas where little or no research has been conducted received special consideration beyond those areas where extensive research has been conducted. Thus, the objective of the Great Lakes regional conference was to both identify pollution problems and to determine research or information needs associated with each problem area.

The task of identifying these research needs was rather formidable and many approaches were considered. The approach used was that of individual panels. Each panel considered a specific aspect of Great Lakes pollution problems, although panel deliberations were by no means restricted to one topic area. The panels were formed along the lines of Great Lakes uses. The six panels considered: municipal water uses; food and fiber production water uses; industrial water uses; transportation water uses; recreation and wildlife water uses; and social, economic, and institutional water uses.

The attendance at the conference was by invitation. A steering committee for the Great Lakes conference, listed in Appendix A, was formed from representatives of industry, governmental agencies, public interest groups, and academia. This steering committee in turn developed an extensive invitation list for the conference; 15-20 individuals concerned with pollution problems within each of the topic areas were identified and invited. Care was taken to achieve balance along the various interest groups so, for example, industrial representatives did not vastly outnumber public interest groups. The complete invitation list is attached as Appendix B.

Conference attendees were divided into panels after the complete attendance list was available. Panel chairpersons and rapporteurs were selected several months before the conference. Attendees were assigned to panels so that each type of interest group was equally represented on each panel.

The panels deliberated for the first two days of the conference. Within each panel, problem areas were identified and information or research needs associated with those problem areas also were identified. As a final step, each panel gave some ranking of urgency of research to each problem area. The final morning of the conference was devoted to presentation of panel results to the entire body and some deliberations on possible cross-panel rankings. The consensus of the conference attendees was that cross-panel rankings were a poor representation of the findings of the conference; rather, major research or information needs which cut across all panels should be identified and presented as a suite of the most urgent problems facing the Great Lakes today. The results of the conference are presented below in two sections: 1) the major problem areas and research needs which were identified by all of the panels, and 2) the individual panel results. The individual panel results have rankings as determined within the panels, while the cross-panel results are unranked.

CONSOLIDATED RESULTS

The results of the panel deliberations from the Great Lakes regional conference are presented in this and the following section. Conference attendees were opposed, as a group, to cross-panel ranking of individual research and/or information needs. This opinion was reached after an initial unsuccessful attempt at cross-panel rankings was made by the panel chairpersons. Review of the results from the individual panels showed that six research areas and their associated information needs represent the most important pollution problems threatening the Great Lakes today.

As the panels considered the various pollution problems of the Great Lakes, a common theme emerged. This theme was that a whole-system or ecosystem approach to understanding and solving pollution problems must be adopted. This approach comes from the observation that a pollutant which enters the environment in one form often takes an unexpected course to become a problem in another form. Bioaccumulation and sorption to particles are two methods by which this transformation can take place. Thus, without considering the entire ecosystem, most pollution studies will be incomplete and may overlook the heart of many problems.

The six problem areas are presented below in alphabetical order. All six are considered equally important and no attempt at setting priorities among the six should be made.

CONTAMINANTS AND TOXICS

The Great Lakes region is a highly industrialized region with a high diversity of heavy industry along the shoreline. The volume and variety of hazardous wastes generated by these industries are overwhelming. These materials, either intentionally or unintentionally, have ended up in the Great Lakes.

Although all marine environments of the U.S. receive hazardous wastes, two factors make this problem particularly dangerous in the Great Lakes. First, the Great Lakes are relatively closed basins with long flushing times, e.g. 100 years for Lake Michigan. Even small discharges can accumulate to dangerous levels over decades. Second, Great Lakes water is used by millions as drinking water. Thus soluble hazardous wastes may be directly consumed by the Great Lakes human population. Conventional water purification techniques do not remove many of the hazardous wastes from municipal water supplies.

The information or research needs associated with this problem area are extensive. These needs fall into two categories: 1) information needs dealing with persistent and/or highly toxic materials already in the environment, and 2) information needs dealing with possible new contaminants or toxics. Many of the research programs set up to deal with these needs will be applicable to both categories of research needs. Yet, the two distinct categories should be considered. Some of the needs identified by the panels are: identification of new contaminants and their sources, development of techniques for safe storage and destruction of these materials, employment of sophisticated techniques (including mathematical modelling) to monitor the transport, fate, and effects of hazardous wastes, and development of programs to inform the public on the effects of these materials. The Industrial and Recreation and Wildlife panels considered the problem of contaminants and toxics in detail.

EUTROPHICATION

The problems of accelerated eutrophication in the Great Lakes have been identified as a major concern for over 20 years. Yet, this problem is so deeply ingrained in the Great Lakes that it is still an issue of major concern today. The fact that eutrophication continues as a major problem in the Great Lakes is not surprising; these large lakes respond slowly to remedial measures.

The recognition of the eutrophication problem in the Great Lakes over two decades ago has prompted considerable research on this problem area. This research in turn has been used in managerial decisions to reduce phosphorus and nitrogen loads to the lakes. But, these managerial decisions are often made on incomplete or inconsistent data. Simulation models from one Great Lake are usually not applicable to another Great Lake. The enormous investment by municipalities to control phosphorus levels in sewage effluent is cause enough to continue to pursue research efforts of the Great Lakes eutrophication problem. An increase or reduction of phosphorus discharge of only 0.25 mg/L (0.25 ppm) can mean billions of dollars saved or spent on sewage treatment.

The basic research needs on Great Lakes eutrophication still exist. More precise and reliable data on the sources of eutrophication are needed. Only recently have improper agricultural practices been implicated as a major polluter. Wise land use practices need to be established and enforced. The interaction of one pollutant with another, e.g. phosphorus with toxics, is a research problem which has received little consideration yet needs urgent attention both from human health and ecosystem viability standpoints.

One of the most important consequences of eutrophication is the change in the indigenous flora and fauna of the Great Lakes. Although the change has been well documented, its course can rarely be predicted. Extensive information is needed to understand more fully how Great Lakes biota respond to changing levels of eutrophication. The Recreation and Wildlife, the Municipal, and the Food and Fiber Production panels considered the eutrophication problem in detail.

HABITAT MODIFICATIONS

The Great Lakes region has undergone extensive physical and chemical changes since the beginning of colonial settlement. These changes have been most extensive and rapid during the industrial revolution. The function and structure of the Great Lakes ecosystems, although relatively poorly understood, have been significantly and possibly irreparably changed to the worse by human habitat modifications. The productivity of the fish stocks in the Great Lakes has been changed, as have the predominant species found in the lakes. All of the other forms of wildlife have also been susceptible to extensive habitat modifications. The effect on wildlife has been particularly pronounced in the nearshore zone and in wetlands. Harbor and channel dredging, dredge disposal, nearshore landfills, and nearshore farming on Great Lakes have adverse effects on wildlife habitats, but they are not fully quantified or understood.

The subtle relationships between wildlife and their habitats have been particularly difficult for study in the field of ecology. But, in cases where the life cycle of an organism is more fully understood, the rewards in species

management are large. A case in point is the sea lamprey which has invaded the Great Lakes. By more fully understanding the habitat needs of this predator during its breeding cycle, the species was kept under control by the effective use of lampricides. Similar studies are needed for other Great Lakes species both to control predator and nuisance species and to husband beneficial and desirable species.

The information or research needs in the problem area of habitat modifications include a variety of environmental and natural history problems. The complete habitat needs of many important species should be documented. These habitats should then be inventoried and their rate of loss by human activities be determined. These studies will necessitate a more complete understanding of the Great Lakes ecosystem structure and function, including species interactions. Habitat studies should be cognizant of the chemical and meteorological habitat as well as the physical environment. The problem areas of hazardous wastes and eutrophication relate strongly to habitat modification of the chemical environment. The problem area of habitat modifications was considered in detail by the Transportation, Food and Fiber Production, and the Recreation and Wildlife panels.

SOCIAL, ECONOMIC, AND INSTITUTIONAL

The issues raised in the social, economic, and institutional problem areas were not research problems per se, but rather involved the manner in which the conference attendees viewed the function of pollution regulatory agencies in the Great Lakes region. The heart of this problem is the complex tangle of local, regional, and federal agencies which is hampering efforts for effective pollution control. Many agencies are assigned the same or similar regulatory responsibility, yet these agencies seem to set contrary or conflicting regulations. Another concern in this problem area was the possibility that managerial decisions were made without considering results of previous pollution research and monitoring on the Great Lakes. The various data bases established by governmental or private research organizations, although admirable in intent, have been less than satisfactory in execution. Along with the institutional problems of government, industry has expressed concerns over the economic burden of pollution control. The cost of the many programs to control Great Lakes pollution is extremely high. The public and private enterprise are willing to pay for expensive environmental programs, but expect effective results in a reasonable amount of time. Also, although many programs and regulations were developed with the intent to protect society and its environment, the regulations are either inadequate or misdirected.

The information needs in this problem area can be addressed outside of the sphere of basic research. A major review of governmental agencies and their responsibilities is in order. More effective means of presenting hard-won research and monitoring results to both regulatory agencies and the public is needed. Mechanisms to involve more scientists in government and public information should be explored. Economic ramifications of pollution control should be considered, and economic incentives developed. The information needs of this problem area are extensive and can be found in results of all six panels and in particular in the Social, Economic, and Institutional Panel.

MAJOR DISCHARGES

The discharge of any material to the Great Lakes in large volume will present a major pollution problem. The release of hazardous wastes and/or nutrients which exacerbate eutrophication is a major pollution problem as discussed above. But, there are many rather innocuous materials which, when discharged in large quantities, become a problem. Most chloride salts when discharged in small quantities are not particularly harmful. Yet, the large amount of chloride released into the Great Lakes has significantly altered the chloride concentrations of four of the five Great Lakes. The anticipated release of chlorides into the Great Lakes is expected to increase in the near future.

There are other major discharges that also adversely affect the Great Lakes. Runoff from heavy, rapid rainstorms can carry a variety of compounds depending on whether it comes from agricultural lands, street runoff, or combined sewers. In the case of combined sewers, these major discharges carry many pathogens which present human health hazards.

Another major discharge that affects the Great Lakes is atmospheric fallout. The heavy air pollution burden of the industrialized Great Lakes region carries a high phosphorus load. This phosphorus enters the lakes by both dry and wet deposition and furthers eutrophication. Acid rain also affects the Great Lakes, but not by lowering the pH of Great Lakes water. The low pH of rainwater falling on the Great Lakes drainage basin tends to mobilize chemicals which would normally remain bound in the soil. Certain chemicals may also be formed in the atmosphere by low pH water vapor and particulate interactions. These chemicals then are washed into the Great Lakes by precipitation. Acid rain is not likely to lower the pH of Great Lakes waters because of the enormous buffering capacity of these lakes and the geologic composition of the drainage basin.

The information or research needs of this problem area are concerned with both the short- and long-term effects of major discharges. The short-term effects would include consideration of the immediate public health hazard posed by the discharge, what discharges are likely to pose health hazards, and how these discharges can be controlled. The long-term effects of major discharges have not received as much attention as the short-term effects, but these are of comparable concern. Research needs in this area include: the reduction in water quality for both human use and wildlife, the interaction of chemical species from discharges with other chemicals, and the unexpected mobility of certain chemicals from major discharges and runoff. The Municipal and Food and Fiber Production panels considered this problem area in more detail.

RISK ANALYSIS

Risk analysis was only considered explicitly by the Municipal Panel as a research area which needs further attention. But, all the other panels discussed the analysis of risks implicitly, particularly in conjunction with the consideration of energy production and consumption. Risk analysis, as perceived by the conference participants, is the consideration of the full range of risks or impacts a regulation or process is likely to encompass. The use of risk analysis as a tool in aiding the study of pollution-related problems and their remedies was considered highly useful by the conference attendees. The problem

lies in that a complete consideration of environmental risks appears to be rarely or incompletely used in many pollution-related decisions. Furthermore, the current base of information may be inadequate to permit the use of risk analysis in some areas of policy decisions on Great Lakes water quality and pollution control.

The information needs in this area include: improved techniques for use of risk analysis as applied to water quality needs, determination of the data base required for successful use of risk analysis, consideration of why risk analysis is not used more often in Great Lakes pollution problems, and the actual benefits incurred by using risk analysis. The Municipal Panel considered risk analysis directly, while the Industrial and Transportation panels considered risk analysis as part of their energy-related problem area. The Food and Fiber Panel considered risk analysis in the context of anticipating future problems in the region.

PANEL SESSION REPORTS

FOOD AND FIBER PRODUCTION WATER USES PANEL

INTRODUCTION

Food and fiber production results in the pollution of the waters of the Great Lakes through sedimentation, nutrient loading, and the introduction of toxic and hazardous substances applied as pesticides and herbicides. For the purpose of the report of this panel, food and fiber production includes all types of crops: fisheries, animal, plant crops, and forestry. The broad context of food and fiber production includes many diverse agricultural and animal husbandry practices. As a result of this diversity of practices, food and fiber production is a major cause of the eutrophication of the Great Lakes as a whole, but also results in local water quality problems in tributary water and drinking water supplies. Although urban runoff is a significant contributor of diffuse source pollution, agricultural production remains a dominant source. Further, wind erosion from agricultural lands results in air quality problems in the Great Lakes region and beyond.

PROBLEM AREAS AND INFORMATION NEEDS

Problem Area 1: Land Use Practices

Current agricultural practices in the Great Lakes region result in pollution to the lakes and their tributaries in a variety of ways. Excessive runoff from agricultural lands contributes large amounts of nutrients to the Great Lakes, exacerbating eutrophication. Inappropriate and/or excessive application of fertilizers also adds to eutrophication. Applications of herbicides and pesticides contribute large amounts of toxic and hazardous materials to the environment, all of which enter watersheds by non-point or diffuse sources which are difficult to control. The crux of this problem area is the control of diffuse sources of nutrients and hazardous materials from agricultural land uses. The information needs associated with this problem were all ranked very high.

Information Needs

The nature, location, and extent of the non-point pollution in the Great Lakes has been well documented, thus information needs primarily concern management strategies.

1. Information is needed on the economic, social, and environmental impacts of remedial erosion-reducing measures such as no-till agriculture. In particular, cost comparisons and cost distribution associated with such management strategies are required.
2. The performance of new farming management techniques will need extensive monitoring. Specific concerns would be the reduction of phosphorus loading through the use of no-till agriculture, with a distinction between total and available phosphorus. The purpose of

these measurements is to determine physical and biological changes attributable to the pollution and erosion-reducing techniques. Special monitoring strategies are needed for non-point (diffuse) pollution. In the past, most monitoring programs have focused on point sources.

3. Demonstration projects are needed to determine what effects management techniques are having on water quality. Further, we need education programs to encourage wide adoption of management practices that reduce pollution from agricultural practices.

The following is an example of an in-depth analysis which would provide some of the information required.

Comprehensive Environments Assessment. There is potential for the creation of new problems in the implementation of diffuse source control methodologies which have the greatest prospect of achieving the Great Lakes total phosphorus loading objectives. Widespread adoption of the no-tillage cropping management system will be required to achieve the phosphorus loading objectives for the lower lakes. Since herbicides replace the moldboard plow as the principal weed control method there is a potential for adverse environmental impacts. Without careful land management nitrogen transport may be increased. Crop production may be reduced if adequate technical assistance and training are not provided.

On the positive side, the eutrophication of the Great Lakes may be reversed or significantly slowed. There is potential for increased agricultural productivity. Increased soil infiltration capacity may reduce runoff peaks to such a degree that flooding will be decreased. Petroleum fuel consumption with no-till is only 20% of that with conventional farming practices.

The above discussion indicates a wide range of both positive and potentially negative impacts which may be realized in the control of pollution from food production. Before adoption of these practices becomes widespread, they should be carefully evaluated in large scale demonstration projects. The environmental assessment element of several ongoing demonstrations should be strengthened so that the full range of their impacts will be well known in advance of wide-spread implementation.

Information Needs Associated with the Comprehensive Environments Assessment

1. Transport mechanisms for pesticides
2. Management techniques to prevent increased transport of nitrogen
3. Definitions of technical assistance and educational programs
4. Potential environmental impacts of pesticides
5. Careful monitoring of demonstration projects to determine both positive and negative environmental impacts, to include biological monitoring

Problem Area 2: Prediction of Pollution Events

A significant problem affecting Great Lakes water quality is the need to improve the prediction of future pollution events. Included in this problem area is a greater facility to anticipate pollution events and respond in a timely fashion. The information needs associated with this problem are all ranked high.

Information Needs

1. Catalog sources of potential pollutants
 - a. categorize by type or character; i.e., chemical, toxic, hazardous vs. land, municipal, agricultural, etc.
 - b. categorize by modes of introduction into environment
2. Assess the probability of introduction of each pollutant into the environment
3. Assess the potential effects of each pollutant
 - a. long range - chronic effects
 - b. effects of introduction by catastrophic event
4. Identify appropriate institutional arrangements that encourage the development of predictive strategies for anticipating problems

Problem Area 3: Phosphorus Control

This problem is to achieve an integrated ecosystem approach to phosphorus control in the Great Lakes. The most environmentally effective and economically efficient water quality management program in the Great Lakes basin will involve an integrated point source/diffuse source control program. The information needs associated with this problem area are all ranked medium.

Information Needs

1. The types and quantities of phosphorus derived from all sources
2. The temporal and spatial distribution of inputs of phosphorus from each source
3. The assimilation, transport, and fate of phosphorus derived from each source, including the consequences of these on both ambient water quality in tributary streams and within the Great Lakes
4. The status of control technologies for phosphorus from each source, including the incremental costs of various levels of treatment
5. The availability of institutional frameworks for implementing alternative control programs

Problem Area 4: Beneficial Effects of Food Production

Under some circumstances, food production can be an opportunity rather than a problem with respect to Great Lakes pollution. An example is the use of agricultural land as a treatment system to handle municipal waste water and sludge. This form of treatment can often represent the most economical way to improve water quality. Approximately 65 small communities in Michigan, and many food processing firms, currently use land treatment technology. Limitations include perception by some people that land treatment is unhealthy or unattractive.

Crop residues, including forestry wastes, are increasingly valuable as energy sources. Thus, potential pollution resulting from agriculture may generate salable energy. Several industrial plants in Michigan and elsewhere have converted to bio-energy augmented power systems.

The information needs associated with this problem area were all ranked medium.

Information Needs

1. Capacity of land to absorb and process waste, specifically by type and location site
2. Data on plant use of contaminants, based on type of plant
3. Management options such as the development of rules and regulations between land owner and municipality, and examination of potential for increased application of waste water to private land
4. Economic potential of bio-energy resources - supply and demand by source of organic material, e.g. wastewood and crop residues from agriculture
5. Consideration of run-off, erosion, and other problems associated with removal of waste wood for energy

Problem Area 5: Government Regulation of Food Production

The influence of government regulations and programs on agricultural practices in the Great Lakes region is large. A major problem is seen in the conflicts between different units of government and agriculture in land use. Government actions may directly increase loss of our most productive agricultural lands. Location of public facilities, such as highways and waste treatment facilities, and lending policies of FMBA are examples. Loss of the best farmland may result in bringing less productive land into cropping. Sediment loss and non-point pollution are greater on low quality land. Thus, government actions designed to accomplish other valid purposes may contribute to non-point pollution of rivers and lakes. Local, regional, and state policies that exacerbate urban sprawl similarly affect agricultural pollution.

The interaction among agencies of government at any level, and among levels of government, may needlessly increase the costs of non-point pollution abatement policy. Effective citizen participation is difficult when the decision-making system is so complex.

The public perception of the problems and effects of pollution on food quality has been increased by recent events. The Great Lakes public has expressed concern and confusion over the safety of food and water supplies. The old faith that the "government will set standards to protect me" has been shaken by recent events. Conflicting assessments of the safety of Great Lakes fish are reaching the public. At times, the safety of water is questioned.

The information needs associated with this problem area were all ranked medium.

Information Needs

1. Document administrative costs associated with different institutional structures used by agencies to solve pollution-related resource problems
2. Identify new ways to combine agency operations and authority for a better focus on resource problems, e.g. Great Lakes pollution
3. Seek additional opportunities and mechanisms for personnel and expertise sharing (e.g., I.P.A. structure)

Problem Area 6: Pollution as a Constraint on Food Production

This problem area concerns pollution as a constraint on food production. There are no information needs listed here because the individual pollutants constraining food production are discussed elsewhere. Two major types of pollutants are envisioned as placing a major constraint on food production in the Great Lakes region.

1. Various toxics from municipal, industrial, or other sources may render water unavailable for application to crops or use in food processing. These toxics may concentrate in fish, thus reducing the value of this food source for human or other animal consumption. Examples are Mirex concentration in the Niagara River, PCBs in the Great Lakes, and mercury in Lake St. Clair.

2. Acid rain may be the most widespread pollution problem of the 1980s in the Great Lakes basin. Oxides of nitrogen and sulphur released in the atmosphere from various industrial sources may enter the soil in rain, thus affecting both quantity and quality of crop output. These pollutants directly affect food production from fish and particularly affect forest production.

Statement of Priority on Information Needs: Rationale

1. The highest need is for performance evaluation of innovative management and remedial measures on a watershed basis to deal with causes of diffuse source pollution. An accurate physical assessment of techniques such as no-till agriculture is important because without this information we cannot work these techniques into an optimal strategy for the reduction of Great Lakes eutrophication. The resources spent on non-point pollution abatement must be more efficiently spent. The results from these assessments are very important; large amounts of money are allocated to eutrophication control from point sources, yet point sources are only half the eutrophication problem. Any alternative scenarios for management of phosphorus loading to the Great Lakes will involve significant shifts in dollars, yet there is insufficient information for deciding on the proper mix of point and diffuse pollution control.
2. The second highest priority was placed on information needs for improving our ability to predict future pollution problems.
3. Loading of phosphorus to Lakes Erie and Ontario cannot be lowered to achieve objectives without diffuse source control.
4. Eutrophication control is an opportunity to achieve a great payoff from the investment in pollution control.
5. Measures such as no-till agriculture are going to be adopted by farmers because such measures save energy costs. But, the effect on a watershed of adopting no-till agriculture is unknown.

SUMMARY

The results of the Food and Fiber Production Panel deliberations show that land-use practices were the most important pollution problems of agriculture. A variety of new land-use practices are finding their way into contemporary farming practices, e.g. no-till farming. The panel strongly urged complete studies to monitor the effects of these new practices. Included in these monitoring studies should be the nutrient loading to tributaries from each

different type of land-use practice. Only by comprehensive studies can the benefits and drawbacks of each land-use practice be evaluated.

A variety of other problem areas were identified by the Food and Fiber Panel. These included: prediction of pollution events from agriculture, ecosystem phosphorus control, pollution as a constraint on agriculture, and excessive government regulations. In addition to these problem areas, this panel identified food and fiber production as a possible solution to waste-water disposal. Spray irrigation of treated sewage is a new and interesting prospect in pollution control.

FOOD AND FIBER PRODUCTION PANEL MEMBERS

Dr. Lawrence Libby, Chairman
Ms. Suzanne Tainter, Rapporteur

Mr. John Adams
Dr. David Baker
Mr. James Elder
Ms. June Janis
Mr. Phillip Janus
Dr. John Judd
Mr. James Price

INDUSTRIAL WATER USES PANEL

INTRODUCTION

The industry of the Great Lakes region is affected by pollution-related problems in many ways, both as producer of pollutants and as a user of lake water. Despite the common public image that industry only uses the lakes as dumping grounds, most industries in the Great Lakes region require abundant, high-quality water. Industry has a further concern in that it is often asked to initiate expensive pollution control practices and/or told to no longer release any wastes into the aquatic environment.

Industrial concerns in the Great Lakes region feel pressure from several directions to develop extensive pollution control mechanisms. All levels of government impose increasingly strict pollution emission standards on most industries. On the other hand, consumers who are unwilling to pay higher prices for goods because of pollution control will often buy goods made in regions with less stringent controls.

The discussions developed in the industrial panel all reflect both the concerns of industry and the concerns of the public who are impacted by industry. These concerns were expressed from members of public interest groups and industry, both of whom were represented on the panel. Four problem areas and their associated information need are presented below.

PROBLEM AREAS AND INFORMATION NEEDS

Problem Area 1: Hazardous Wastes

There is a lack of hazardous waste management facilities in the Great Lakes area.

Rationale: Hazardous wastes pose a threat to the ecosystem through direct discharges to the Great Lakes or leachate to tributaries of the lakes. Hazardous wastes are being generated, stored, and disposed of improperly in the basin. Improper disposals include midnight dumping, insecure landfills, and improper burning. There is a lack of either a method or place to dispose of many wastes which have been previously dumped improperly. All of the information needs for this problem area are ranked very high.

Information Needs

1. Develop relatively secure or "fail safe" systems for transport, storage, landfill, incineration, and deepwell injection of hazardous wastes.
2. Encourage research and information sharing on the elimination of hazardous wastes at their source.
3. Initiate studies to provide solutions to "siting problems." These should include comparisons of scale at both the regional and local levels.
4. Prioritize wastes by degree of hazard, so that the most hazardous may be given top priority for proper management.

Problem Area 2: Information

The solution to Great Lakes pollution problems is hampered because relevant information is either unavailable to or unusable by the public and managers.

Rationale: Strategies to deal with pollution problems of the Great Lakes cannot succeed without widespread public understanding and consensus on the goals these strategies are meant to achieve. This understanding does not now appear to exist. Effective communication networks could facilitate information sharing and use by a concerned public. Much of the information needed for research, development, planning, and policy purposes is not available. Even when the information exists, mechanisms for access, synthesis, and evaluation are not always satisfactory.

There is no current system to assure that data collection and storage systems are either comparable or compatible. In many cases there is limited access to existing systems and terminals. Evaluation of the quality of the information available through various computer systems is often not possible. The first information need is ranked very high, the second is high, and the last two are medium.

Information Needs

1. Many sectors of the public desire information about the Great Lakes so that (a) problems are well understood, (b) alternatives for solutions are clearly articulated, and (c) a clear delineation of advantages and disadvantages are laid out.
2. There is need for improved storage and retrieval systems adequate for addressing research and information management needs.
3. There is need for development of data systems which are more accessible to all interested users.
4. There is need to identify and develop alternatives for establishing communication networks and information sharing capabilities among those active in Great Lakes pollution management, research agencies, and the general public.

Problem Area 3: Energy

What will be the impacts of future energy and energy-related facilities?

Rationale: Changes in industrial facilities related to energy production will result in the addition of contaminants and other environmental stresses to the Great Lakes basin. For example, conversion of existing oil-fired power plants to coal and construction of new coal-burning plants will increase the levels of particulates and their associated materials in the atmosphere. Increased use of coal as a fuel will also result in lowered pH of precipitation in the basin and will increase the solid and liquid waste disposal problem. Other anticipated problems include possible disposal of wastes from dewatering of coal slurries (from coal washing or transport). Little is known about impacts of large-scale uses of biomass for energy production in the basin. The first two information needs under this problem area were ranked high, and the next two medium.

Information Needs

1. Techniques and institutional mechanisms need to be developed for siting of energy and other key industrial facilities.
2. Studies are needed to determine the regional impact of energy systems and the impact of alternative pollution control methods.
3. More information is needed about the impact of large scale conversion of biomass (especially wood) to energy in the basin.
4. There is a need for additional knowledge concerning the constituents of particulates discharged from coal-burning power plants as well as the fate and effects of these materials.

Problem Area 4: Economics

There is a growing shortage of private funds for financing pollution control.

Rationale: Industry generally allocates capital into the highest rates of return over a relatively short range. Government, by contrast, is responsible for long-range benefits to society through the legislation of pollution control requirements. How do we reconcile the allocation schemes of the public and private sectors? Also, financial analyses currently do not incorporate non-quantifiable costs and benefits and aesthetic values.

The economics of the long-range approach are difficult to quantify from both the cost and benefit sides. How do we develop new economic tools that include long-range benefits and costs?

Assuming that cost and benefit forecasts can be accurately developed, how can long-range costs be shared equitably for pollution technology development and implementation? All of the information needs were ranked medium.

Information Needs

1. Development of a means of addressing the issues of equity in determination of long-range costs/benefits is needed.
2. Development of a means of long-range forecasting of economic costs/benefits which include external factors and aesthetic values is needed.
3. Development of alternatives for sharing of long-range costs incurred for pollution abatement technology and implementation is needed.

SUMMARY

The concerns of industry in the Great Lakes region are large and encompass many aspects of aquatic pollution. The Industrial Panel identified four major problem areas that require immediate attention. Toxic materials were considered the most important problem area, which was not surprising in light of the magnitude of the problem and the consequences of this form of pollution. All phases of the problem of toxic wastes were considered of highest importance from waste generation to disposal.

The Industrial Panel also placed a high priority on the distribution of information about pollution to the public and regulatory agencies. Both of these groups must be better informed if they are to make a contribution toward solving Great lakes pollution problems. Two other problem areas were

considered. These were: changes in energy consumption in the region and the effects on pollution, and the economic burden of pollution control and accommodating pollution control in the private sector.

INDUSTRIAL WATER USES PANEL MEMBERS

Mr. Edwin Shannon, Chairman
Ms. Leslie Lin, Rapporteur

Mr. Len Aidelman
Dr. Eugene Aubert
Ms. Mimi Becker
Dr. Gordon Chesters
Mr. Phil Goodyear
Mr. Chester Gunnerson
Ms. Madonna McGrath
Mr. Joel Wesselman

MUNICIPAL WATER USES PANEL

INTRODUCTION

Before considering research needs for the Great Lakes region, it is important to establish that the Great Lakes comprise over 90% of the surface supply of fresh water for the contiguous United States. Furthermore, nearly 37 million people live within the Great Lakes basin which serves as an industrial center for both the United States and Canada. Accordingly, a primary objective of current and future research activities should be to provide the knowledge necessary to restore, preserve, and maintain the water quality of the Great Lakes as a viable resource for future generations.

Human use impacts on the Great Lakes result in problem conditions which may be classified according to location; i.e., nearshore (depth less than 20 meters) and offshore (depth greater than 20 meters). A further classification of problem conditions may be according to time; i.e., short-term and long-term. Municipal interests in Great Lakes research issues may be primarily focused upon nearshore short-term problem issues. This reflects the priorities which municipalities have in meeting current needs in delivery of services to their citizens. However, it is recognized that long-term problems in both nearshore and offshore locations are also of critical importance to municipalities. Ten problem areas and their information needs are presented below.

PROBLEM AREAS AND INFORMATION NEEDS

Problem Area 1: Long-Term Disposal of Solid Wastes

The disposal of solid wastes in the Great Lakes basin has been and will continue to be a difficult problem. Both the large volume of solid wastes and the mixture of hazardous and non-hazardous materials present a particularly difficult pollution problem for municipalities and industry. Many of the hazardous materials originally in solid wastes leach into local water supplies and watersheds. The extremely dangerous condition at Love Canal in Buffalo, N.Y., is just one example of the problem of solid waste disposal. The disposal of dried sewage sludge is another form of solid waste problem. As the impact of the Resource Conservation Recovery Act is felt and there is increased attention to the disposal process, the locations of disposal facilities, particularly landfills, will come under increased public scrutiny. All of the information needs associated with this problem were ranked high or very high.

Information Needs

1. There is a need to define credible pathways to public acceptance of solid waste disposal facility siting.
2. There is a need to define measurable and understandable regulations for solid waste disposal.
3. There is a need to develop reliable monitoring procedures and processes for disposal sites.
4. There is a need to develop a procedure for determining leachate characteristics as a function of waste types.

Problem Area 2: Demonstration Projects

Demonstration projects provide a viable means to test the application of the latest research findings to important environmental problems faced by municipalities located with the Great Lakes region. In the specific area of innovative technology for treatment of wastewater prior to discharge, the present arrangement does not encourage implementation of creative and cost-effective solutions. At present, municipalities are reluctant to undertake any new technology which has potential for failure. The information need for this problem area is ranked very high.

Information Need

1. There is a need to identify mechanisms which will link municipalities, research centers, and funding sources in effective ways to enable testing of demonstration projects.

Problem Area 3: Risk Analysis - Great Lakes Municipalities

Many decisions will be made and implemented without full knowledge beforehand of the resultant impact of the decisions upon the water resources of the Great Lakes region. The physical, chemical, and biological systems which comprise the water resources of the Great Lakes are complex and not fully understood. Accordingly, risk analysis, including risk determination and risk assessment, provides one tool to assist in the impact evaluation of both current and future policy choices. The current base of information is insufficient to allow adequate application and acceptance of risk analysis to policy issues which impact upon the long-term water quality status of the Great Lakes. The information needs for this problem area are ranked very high.

Information Needs

1. Improved techniques for risk analysis are required.
2. Application of risk analysis to water quality issues in the Great Lakes should be performed.

Problem Area 4: Major Pollution Incidents

Direct withdrawal of Great Lakes water provides the daily water supply for millions of people. Activities or incidents exist which may degrade, disrupt, or otherwise render unusable Great Lakes water as a source of supply. Examples of such incidents include but are not limited to contamination from radioactive wastes, a large volume industrial spill, a chronic discharge of a toxic pollutant, and contamination resulting from lake-bed exploration and drilling for oil and gas. The information needs associated with this problem area are ranked high.

Information Needs

1. There is a need for identification of those incidents which may degrade, disrupt, or otherwise render unusable Great Lakes water as a source of municipal water supply.
2. Appropriate models, including but not limited to dispersion, transport, assimilation, and effects of materials which may render Great Lakes water unfit for municipal water supply, should be developed.

Problem Area 5: Overall Ecosystem Viability

Aquatic organisms are sensitive to most forms of pollution. Because these organisms live in an aquatic medium, they are continuously exposed to pollutants and thus have a greater tendency to be affected than humans or their direct uses of water. In the Great Lakes there are many known and suspected cases where the abundance or types of organisms have been altered as the direct or indirect result of pollution. Thus, there is a great need to describe and understand ecosystem changes in order to protect and preserve the Great Lakes ecosystems. The first information need in this problem area is ranked very high, while the remaining needs are ranked high and medium.

Information Needs

1. There is a need to identify the properties that are the most cost-beneficial indicators of ecosystem health.
2. There is a need to determine baseline conditions from which pollution-caused changes can be detected.
3. There is a need to determine the changes and their causes that have occurred in specific areas and in the Great Lakes in general due to human activities in the Great Lakes basins.
4. There is a need to develop a means to predict the effects that projected Great Lakes pollution trends will have on the ecosystem.

Problem Area 6: Environmental Monitoring Programs

Monitoring programs are needed to identify potential pollutant problems in the water, sediments, or biota to guide existing and future research programs, to help evaluate the impact of more activities on the ecosystem, and to evaluate the effectiveness of regulatory and mitigation efforts. Current monitoring systems in the Great Lakes, although generally coordinated, frequently suffer in regard to their design, timeliness, comparability, and ultimate use. The development of improved monitoring systems that are scientifically valid and cost effective is urgently needed to aid responsible agencies in their efforts to protect the ecosystem. The information needs associated with monitoring were ranked very high, high, and medium for needs 1, 2, and 3 respectively.

Information Needs

1. There is a need to determine the sampling and analytical requirements for monitoring programs capable of accurately describing the status of pollutants at specific locations.

2. There is a need to determine the level (intensity and frequency) of monitoring necessary to meet monitoring objectives in the Great Lakes and to determine the most cost-effective approach to accomplish those objectives.
3. There is a need to develop adequate sampling storage preservation procedures for archived materials.

Problem Area 7: Total Problem Analysis

Current programs for control of municipal and other sources of nutrients and hazardous materials focus on individual polluting substances and specific sources. Although enforcement programs will continue to address pollution problems using specific water quality or effluent criteria, ultimate protection of the ecosystem requires that these criteria take into account the total array of contaminants in the ecosystem and interactions that may occur (e.g., synergistic action). Further, these programs must consider the cumulative impact of numerous sources from metropolitan areas. The information needs for problem analysis were all ranked high.

Information Needs

1. There is a need to determine the impact of multiple contaminants on the productivity of aquatic systems. A possible way to address this need is through the use of site specific field studies and/or laboratory simulation of field conditions.
2. There is a need to develop improved knowledge of interactive effects (additive, synergistic, and antagonistic) of polluting substances so that water quality criteria for specific materials may take into account the presence of additional pollutants in the ecosystem.
3. In addition to site specific studies, there is a need to describe the existing and projected sources (loading), retention, and fate of pollutants on a system-wide basis.

Problem Area 8: Atmospheric Inputs of Contaminants to the Great Lakes

Urban centers of heavy industry located in the Great Lakes basin such as Gary, Hamilton, Cleveland, Detroit, Sarnia, and Chicago contribute contaminant loads to the Great Lakes via atmospheric pathways. Moreover, the release to the atmosphere of toxic and hazardous materials derived from spills, waste disposal sites, and other contingencies pose an additional risk in such industrialized areas. Transboundary, international pollution problems are likely to result. The first information need associated with this problem area is ranked high, while all the others are ranked medium.

Information Needs

1. There is a need to develop methods to identify pollutants released to the atmosphere from municipal sources, trace their pathways, and determine their fate and effects.
2. There is a need for compilation of an inventory of source locations and identification of their polluting contents, atmospheric pathways, and fates.

3. There is a need for collection of data through monitoring programs of atmospheric masses, both upwind and downwind of the sources, to determine atmospheric contaminant loadings.
4. There is a need to determine if the data collected in the Great Lakes region can be used for development of air quality standards under an International Air Quality Treaty for the Great Lakes.

Problem Area 9: Urban Discharges

Sewage treatment processes are a source of major discharge into the Great Lakes from urban areas. Sewage treatment plants normally discharge high levels of ammonia and phosphorus into the nearshore environment. These nutrients present a variety of problems including excessive algal growth attributed to high P levels, and toxicity due to high ammonia levels.

Another major discharge from urban areas is the outflow of combined sewer overflow. During storms, large discharges of street runoff mixed with sewage present a major problem. These discharges are usually high in bacterial counts and organics, presenting a severe near shore public health hazard. All of the information needs associated with this problem area are ranked medium.

Information Needs

1. There is a need to determine the content of combined sewer overflows.
2. There is a need to determine the proportion of urban discharge attributed to combined sewer overflows.
3. There is a need to determine which type of storm events promotes large combined sewer overflows.
4. There is a need to analyze the type of mixing regimes associated with large urban discharges and to determine where these discharges have the greatest impact.
5. There is a need to determine the toxicity and oxygen demand of urban discharges.

Problem Area 10: Sediment Transport and Toxicity

Sediments which tend to accumulate in estuaries serve as a reservoir of accumulated organics, toxics, and nutrients. The impacts of accumulated sediments include severe depressions of dissolved oxygen and resuspensions of toxic materials. Impacts are primarily short-term and located in the connecting rivers and in near shore areas. The information needs associated with sediments are ranked medium or low.

Information Needs

1. There is a need to determine the volume, distribution, and content of dangerous sediments in the Great Lakes.
2. There is a need to determine a safe disposal method and disposal location for sediments.

SUMMARY

The Municipal Panel identified ten important research problem areas which impact directly upon municipalities. The critical importance of this research need is emphasized by the fact that 37 million people live in the Great Lakes Basin. Furthermore, this region serves as an industrial center for the United States and Canada. Since the Great Lakes comprise over 90% of the surface supply of freshwater for the contiguous United States, it is imperative that the research activities provide the knowledge necessary to restore, preserve, and maintain the water resources of the Great Lakes as a viable resource for future generations.

The ten problem areas requiring research activities identified by the Municipal Panel are:

1. Long-term disposal of solid wastes
2. Demonstration projects
3. Risk analysis -- Great Lakes municipalities
4. Major pollution incidents
5. Overall ecosystem viability
6. Environmental monitoring programs
7. Total problem analysis
8. Atmospheric inputs of contaminants to the Great Lakes
9. Urban discharge
10. Sediment transport and toxicity

More detailed identification of information needs associated with each of these problem areas is specified in the body of the report. It is clear that certain of these research problem areas will have findings specific to the interests of municipalities - i.e., demonstration projects, long-term disposal of solid wastes, urban discharges, and risk analysis as applied in the context of Great Lakes municipalities. Findings from the other research problem areas will have an important impact upon Great Lakes interests beyond the immediate needs of municipalities. The overall thrust of these research activities is to assure that the necessary knowledge and information is available to assure the rational management and utilization of the Great Lakes for municipal users now and in the future.

PANEL MEMBERS

Dr. Jonathan W. Bulkley, Chairman
Ms. Cheryl Baker, Rapporteur

Dr. Dorothy Brooks
Mr. Ted Ilgenfritz
Dr. William Katz
Dr. Andrew Robertson
Mr. Joe Vihtelic
Dr. Andrew Watson
Dr. Wayne Wilford

RECREATION AND WILDLIFE WATER USES PANEL

INTRODUCTION

The use of the Great Lakes for human recreation and as a suitable habitat for fish and wildlife encompasses almost all of the pollution problems of the aquatic environment. The commercial and sport fisheries had an estimated economic value of greater than \$1 billion in 1979. But the amount of contaminants in the Great Lakes has thrown these industries into turmoil. Human health may be endangered by consuming fish which are contaminated. The public is confused as to the safety of eating any Great Lakes fishes. Likewise, the public is uncertain as to the safety of swimming at many Great Lakes beaches.

The effect of pollution problems on indigenous Great Lakes flora and fauna has been extreme. Many species have been displaced and/or replaced by changes to their environments. Some of these replacements now appear to be irreversible. The concept that human-induced pollution may have permanently altered the native species of the Great Lakes is a heavy burden on society. Because the issues faced by this panel are broad in scope, the problem areas identified by the Recreation and Wildlife Panel were broken down into several sub-problems.

PROBLEM AREAS AND INFORMATION NEEDS

Problem Area 1: Contaminants and Toxics

A. New Contaminants. The extensive industrial and urban centers of the Great Lakes region produce and/or use a large number of new chemicals which are potentially hazardous to the fish, wildlife, and recreation resources of the basin. The information needs for this problem area were ranked very high.

Information Needs

1. There is a need for identification of new contaminants and their sources.
2. There is a need to quantify information on distribution, use, and occurrences.
3. There is a need for development of an effective, systematic screening process to evaluate characteristics, behavior and potential hazards of identified chemicals.
4. There is a need to improve and implement a rapid assessment of transport, fate, and effects.

B. Existing Contaminants. Persistent toxic chemicals such as DDT, Hg, and PCBs have had a serious impact on fish and wildlife resources and threatened human health in the Great Lakes region. Their effects on fish and wildlife populations are mostly unknown. Because these chemicals have a long retention time within the Great Lakes basin, they continue to exert their influence long after control measures are implemented. The information needs for this sub-problem are ranked very high.

Information Needs

1. There is a need to develop a coordinated, systematic, and sustained monitoring program for selected hazardous chemicals in selected species of recreation and food fish of the Great Lakes.
2. There is a need to develop a systematic monitoring program to identify and quantify atmospheric sources of contaminants to the Great Lakes.
3. There is a need to develop a data base concerning dynamic levels of toxic substances in all compartments of the environment (both abiotic and biotic).
4. There is a need to study human populations potentially affected by toxics or contaminants.
5. There is a need to develop public education programs to further public understanding of the effects of contaminants to assuage fear and to prevent polarization of society on these issues.
6. There is a need to develop mathematical models to predict the transport, fates, and effects of toxics and contaminants in the Great Lakes.
7. There is a need to develop reliable clinical measures of fish and wildlife health as indicators of chemical effects.
8. There is a need to develop improved, rapid procedures for population assessment and early indications of population trends.
9. There is a need to develop methods for integrating field and laboratory studies for assaying the effects of contaminants on fish and wildlife populations.
10. There is a need to establish appropriate public advisories and information concerning the recreational use of water and the consumption of fish.
11. There is a need to evaluate loading, deposition, mixing, and removal of toxic chemicals including metabolic and degradation products.

C. Additional Substances. Conservative substances such as chloride, sodium, and sulfate have shown substantial increases in the Great Lakes over the past 60 years. New processes to decrease discharge of toxic substances from steel mills will result in increased discharges of chloride and sulfates to the lakes. The impact of higher concentrations of such substances is still poorly understood. But, some brackish water diatoms and the red alga, Bangia, have now become established in and around many Great Lakes harbors where they evidently have replaced the native flora. The information needs for this sub-problem were ranked medium.

Information Needs

1. There is a need to establish the impact which increased levels of conservative ions can have on the biota.
2. There is a need to identify any cause-and-effect relationships between ion levels and changes in the algal and other community structures.

D. Water Quality and Recreational Use. Existing criteria for determining suitability of water quality for recreational use appear inadequate in light of present knowledge and conditions. The information needs for this problem are ranked medium.

Information Needs

1. Bacterial counts are the traditional criterion for determining whether a body of water should be used for swimming. The relationship between enteric infection and bathing water quality is not well understood. There is a need for increased efforts to identify more suitable organisms than the coliform bacteria as indicators of swimming water quality.
2. Increased contamination by water soluble chemical pollutants presents the need to expand the criteria to include consideration of contact toxicity and effect.

Problem Area 2: Eutrophication

Nutrient loading to the Great Lakes has resulted in deteriorated environmental quality associated with cultural eutrophication. Algal blooms and along-shore growths of Cladophora have decreased the recreational and aesthetic value of the lakes. Changes in species composition and declines in fish food organisms in such areas as Green Bay, western Lake Erie, and Saginaw Bay, and development of extensive areas of low dissolved oxygen in Green Bay and central Lake Erie, have adversely affected some stocks of fish.

A. Nutrient Loading. Loadings of nitrogen, phosphorus, and trace elements have been increasing for many years from atmospheric fallout and land runoff. Major changes in the occurrence and abundance of Great Lakes biota have occurred which have been attributed to these loadings, although a cause-and-effect relationship has not been clearly established for most of these substances. The information needs for this subproblem area are ranked very high.

Information Needs

1. There is a need to establish cause-and-effect relationships that may exist between these substances and the changes or disappearance of the Great Lakes biota.
2. There is a need to estimate the loading and cycling of major nutrients, trace elements, and toxic substances that may limit or enhance the survival and productivity of the biota.
3. There is a need to determine the sources, fates, and interactions of the various substances in order to better understand their effects, i.e. shifts in abundance and species composition of algal communities. Lakes Erie and Ontario, Saginaw Bay of Lake Huron, and Green Bay of Lake Michigan have been most seriously affected by eutrophication although all the lakes have shown the same degree of eutrophication.

B. Toxics and Eutrophication. Many of the changes in the chemical and physical characteristics of the Great Lakes and the species composition and abundance of benthic, planktonic, invertebrate, and fish communities have been attributed to cultural eutrophication. Many of these changes occurred coincident with greatly increased use of pesticides such as DDT and toxic substances such as PCBs, the introduction of exotic species, and physical changes in the basin. The cause-and-effect relationship requires further definition so past events may be better understood and the future more accurately predicted. The information need for this problem area is ranked very high.

Information Need

1. There is a need to establish the relative importance of the various stresses, individually and collectively, for bringing about the changes which have been documented in the lakes.

C. Land Use. Poor land-use practices have contributed to eutrophication of the Great Lakes. Present farming practices, i.e. improper use of fertilizers and plowing, as well as major construction projects undertaken without environmental controls, have resulted in erosion of lands and runoff laden with fertilizers and sediments. Present measures to control phosphorus loading to the Great Lakes will require control of diffuse sources. The information need for this problem area is ranked high.

Information Need

1. Demonstration projects are needed to determine the feasibility, practicality, and costs of initiating land-use practices which will reduce phosphorus loading to the Great Lakes.

D. Effects of Improved Water Quality on Various Recreational Uses. The improvement or restoration of water quality has both positive and negative ramifications. As water quality improves, nuisance algal blooms disappear and more highly prized fish stocks may be reestablished. Other organisms, such as mayflies, will be reestablished and may become so abundant as to interfere with recreational use of the water during periods of emergence. Polluted water may also form barriers to migration of some organisms such as the parasitic sea lamprey. Improved water quality in the St. Louis and Peshtigo river basins is suitable for migration and reproduction of the sea lamprey with the associated expense of control measures. The information needs for this sub-problem were ranked medium to low.

Information Needs

1. Water quality or habitat improvement programs should project probable changes in biota based on historic records.
2. There is a need to predict population imbalances when predator-prey relationships are modified and a situation results that requires further remedial measures.

Problem Area 3: Habitat Alterations

A. Ecosystem structure and function vs. habitat alterations. Since settlement of the Great Lakes region there have been large and rapid physical and chemical changes which have resulted in biological changes in what was formerly a slowly evolving ecosystem. The structure and productivity of fish and wildlife populations are dependent on the quality and quantity of habitats which support their various life history stages. Today's natural resource manager is attempting to manage fish and wildlife populations and habitats without either historical background on the former habitat types, their quality and quantity, or adequate understanding of the former habitat function which supported the productivity. Present success in fishery management is largely bio-engineered through sea lamprey control and stocking. The information needs for this subproblem area are ranked high.

Information Needs

1. There is a need for basic understanding of current and historic community structures and ecosystems.
2. There is a need for environmental mapping of historic and current habitats to serve as a basic resource and display of information for managers and decision makers. This information must be available in a usable form. The maps will also serve as a public information source.
3. There is a need for measurements of historic habitat loss caused by pollution and for measurement of the current rate of habitat loss caused by pollution, along with physical alteration or gain caused by rehabilitation efforts.
4. There is a need to establish the value of wetlands as contributors to productivity of the Great Lakes.

B. Development of Shore Zone. Construction of housing, industrial facilities, and public and private recreational facilities in the nearshore zone causes detrimental physical alteration. Housing, industrial facilities, and public and private recreational facilities (including those associated with consumptive and non-consumptive uses of fish and wildlife) attract and concentrate large numbers of people in the shore zone. Construction of those facilities, along with attendant support services, when poorly coordinated and sited, can cause permanent physical alteration and loss of habitat and its functions. The information needs of this sub-problem are ranked very high.

Information Needs

1. There is a need for identification and quantification of physical changes to the nearshore environment, e.g., filling, dredging, erosion, and sedimentation.
2. There is a need for identification of processes or situations that cause undesirable physical changes.
3. There is a need for identification and evaluation of the impact of a physical change on fisheries, wildlife, or water-related recreational activity.
4. There is a need to establish economic data bases on water-oriented recreation activities and the benefits associated with wholesome fish populations. Such information will be used by planners and decision-makers to aid in the justification of management program expenses and quantification of benefits to the public. Current estimates of the total economic impact of Great Lakes recreational and commercial fisheries (Canadian and U.S.) is \$1.16 billion/year.

C. Creation of Habitats. Over 100 harbors have been maintained by dredging. The sediments from these harbors are usually of poor quality since the harbors are settling basins for particulates and associated contaminants. In some regions of the lakes, dredged materials have been used for development of islands (Toledo, Ohio) or marsh lands (Green Bay, Wisconsin). The information need of this sub-problem is ranked medium.

Information Need

1. There is a need to evaluate the potential hazard of using contaminated materials to construct habitats for fish, wildlife, and people.

Problem Area 4: Social, Economic, and Institutional

A. Environmental Quality Impacts. There has been limited assessment of how eutrophication, contamination, toxics, and physical alterations of the Great Lakes environments affect recreation, fisheries, and wildlife. These assessments must include environmental, social, and economic considerations. The information needs of this sub-problem are ranked high.

Information Needs

1. There is a need for assessment of quantifiable and non-quantifiable values of our resources.
2. There is a need to evaluate alternative uses in order to determine optimal allocation of our resources.
3. There is a need for assessment of social, environmental, and economic impact of pollution controls such as the construction of waste treatment plants or the disposal of dredge materials.
4. There is a need for assessment of social, environmental, and economic impact of energy development such as the loss of recreational land due to strip mining or construction of power plants.
5. There is a need for re-evaluation of existing government programs for making equitable subsidies for renewable and non-renewable energy resources.
6. There is a need for evaluation of mechanisms to assure that industries, individuals, businesses, and governments include the cost of pollution control in the price of the product or service to reduce environmental impact on recreational or wildlife resources.
7. There is a need to develop mechanisms to effectively reduce, mitigate, control, administer, and fund pollution abatement problems.
8. There is a need to develop mechanisms for regional policy formulation, planning, coordination, conflict resolutions, and implementation for fisheries, wildlife, and recreation.
9. There is a need to plan for changes as fuel resources decrease. These changes will likely include the carrying capacity of existing public facilities and impacts on water quality and sports fishing as recreational pressures shift.

B. Public Awareness. There is a lack of public awareness, education, and participation in programs for fisheries, wildlife, and recreational resources. The information needs for this problem are ranked high.

Information Needs

1. There is a need to determine how to set up and implement an effective public information, education, and participation program for fisheries, wildlife, and recreational resources.
2. There is a need to improve the system of information collection, storage, and dissemination among scientists, governments, and the public. Include in this task information on the effects of human

activities on ecosystems and the importance of sustained yield since many resources are finite.

C. Hazardous Substance Legislation. State and federal laws govern the production, transport, use, and disposal of toxic and hazardous materials. In spite of these laws there are continuing problems in the above activities which adversely affect the atmospheric, terrestrial, and aquatic environments. The information needs in this area are ranked high to very high.

Information Needs

1. There is a need for review of the legislation in U.S. and Canada to compare potential adequacy to current effectiveness.
2. There is a need to identify the weaknesses in the design of the laws or their implementation.

D. Design of Monitoring and Surveillance Programs. In recent years, great emphasis has been placed on monitoring the quality of aquatic environments. Until recently, surveillance efforts were largely confined to measurements of traditional water quality variables. With the identification of important contaminants such as mercury, DDT, PCBs, and mirex the programs have been expanded to include analysis of sediments, fish, and other organisms, and the number of parameters measured has increased greatly.

The cost of monitoring the quality of the Great Lakes is very high and virtually every state and federal agency with responsibility for natural resources participates to some extent. There exists great potential for duplication of effort and excess information in some areas for some variables, while other variables and areas are inadequately covered. The information needs for this sub-problem are ranked very high.

Information Needs

1. Idealized, model programs need to be designed to produce the information needed for the least cost and effort.
2. There is a need to determine how to establish greater inter-institutional cooperation and planning.

Problem Area 5: Human Health as Related to Consumption of Fish

Public awareness and concern over chemical contaminants in fish has led to confusion concerning whether a catch can be sold and whether certain fish are safe to eat. The information needs for this problem area are ranked high.

Information Needs

1. Reporting of contaminant levels should be accompanied by statements discussing toxicological assessment of the contaminant, the extent of exposure and associated risk, and the expected contamination level in cooked fish.
2. Monitoring data should be projected as clearly as possible to indicate species and sizes of fish acceptable for sale as food.

SUMMARY

The panel clearly felt that the highest priority future research on Great Lakes pollution problems should be related to toxic materials. We concluded that mechanisms must be developed to preclude introduction of new materials of unknown potential danger and the continued introduction of materials of known danger. Understanding the behavior and the biologic, sociologic, and economic effects of existing toxics and other contaminants in the lakes is prerequisite to development and implementation of effective and knowledgeable mechanisms. The unknown effects on human health and ecosystem relationships were especially highlighted as serious handicaps to management.

The panelists were very concerned by the changes in occurrence and abundance of Great Lakes biota seemingly related to nutrient loadings, although cause-and-effect relationships have not been clearly established. We concluded that the relative importance of the combined effects of eutrophication and multiple stresses such as toxics accumulation, interspecific competition, and physical changes should be evaluated as to individual and collective influence. In connection with eutrophication, the need for changed land use practices to lower input of contaminants by run off was ranked high in importance.

In discussing habitat alterations, the panel recognized a monumental handicap in making managerial decisions in the Great Lakes because of the lack of basic understanding of current and historic biologic community and habitat structure and function within ecosystems. We concluded that development of environmental maps and resource inventories in usable form would provide a basis for more knowledgeable decision making in habitat protection.

It was agreed that the social and economic considerations had received insufficient attention in the past and that management programs based on dependable economic values and incorporating public opinion as well as scientific knowledge needed further development. Institutional and legislative handicaps were identified in the development and implementation of monitoring programs and hazardous substances laws. The necessity for development of efficient, effective, and adequate monitoring to reflect ecosystem health was stressed.

The information needs and development of strategies to address these issues were recommended as the orientation of future pollution research and monitoring on the Great Lakes.

PANEL MEMBERS

Mr. Carlos Fetterolf, Chairman
Ms. Rebecca Glover, Rapporteur

Dr. Alfred Beeton
Mr. Martin Bratzel
Ms. Edith Chase
Dr. Hal Humphries
Dr. Howard Johnson
Mr. Bruce Market
Mr. Gilbert Radonski
Dr. Wayland Swain

SOCIAL, ECONOMIC, AND INSTITUTIONAL WATER USES PANEL

INTRODUCTION

A major concern voiced by all panels of the Great Lakes regional conference was that the complex and perhaps excessive structures of government were in many instances impeding rather than promoting pollution research and control. This problem was identified as being particularly acute in the Great Lakes region. Two federal governments, one Canadian provincial government, eight state governments, and numerous local and regional governments all have a vested interest or assigned responsibility in regulating activities on and in the Great Lakes. Although all of these governments intend to protect and improve the Great Lakes environment, this panel perceived many conflicting policies, programs, and regulations among government agencies. Also, some government research agencies have become somewhat isolated from the public as well as from one another.

The general public of the Great Lakes region appears particularly confused by the multi-layered structure of the Great Lakes governments. The public does not know who to turn to for help, or who to blame for dangerous pollution problems. Although millions of dollars are spent on research each year, the public is not kept fully informed of the efforts underway to preserve the Great Lakes ecosystems. Finally, the U.S. taxpayers are becoming increasingly skeptical of expensive, long-term programs and unwilling to pay for ineffective programs from which they see few results. The topic of social, economic, and institutional problems in conducting Great Lakes research was voiced by all panels at the conference, as well as being the sole topic of concern of this panel.

Problem Area 1: Institutional Barriers

Institutional barriers limit the identification of problem areas, research needs, and implementation of remedial programs and projects. The International Joint Commission is responsible to governments for evaluating implementation of the Water Quality Agreement of 1978. Accountability, however, for response to the IJC's findings and recommendations is uncoordinated and dispersed among U.S. and Canadian governments and agencies at all levels. This makes it difficult to implement an effective monitoring program to assess progress and to provide early warning of emerging problems. The information needs for this problem area were ranked high.

Information Needs

1. Evaluate conflicting legislative or regulatory policies and priorities among US and Canadian governments with respect to technological approach for monitoring, setting of pollution programs, etc.
2. Identify the barriers to successful implementation of Great Lakes pollution prevention and control strategies.
3. Develop a coordinating mechanism to focus the efforts of U.S. federal agencies whose programs are related to Great Lakes water quality.

4. U.S. agencies concerned with 208 and NEPA programs should develop better means for identifying problems to be addressed by research activities, and better means for determining monitoring needs.
5. Information, research, and data sharing with respect to Great Lakes pollution programs should be encouraged to provide a means for better problem solving and more cost effective pollution programs.
6. Identify the most effective means for making the results obtained from the international Great Lakes surveillance program available to participating government agencies for development of future surveillance programs.

Problem Area 2: Government Management Priorities

The local, state, regional, provincial, and federal levels of governments in the Great Lakes basin are involved in similar tasks; development and dissemination of information, and implementation of Great Lakes pollution control/ecosystem management programs, monitoring, or remedial action. The many government programs, policies, and institutional levels have not been efficient in carrying out the goals of legislation that affects land, air, and water quality. The numerous and often conflicting government policies and regulations, at times tend to interfere with the solution of complex water quality problems. This problem area and the associated information needs were ranked high.

Information Needs

1. Program audits which should include identification of policies/procedures which do or do not function effectively (e.g., NPDES, fee systems).
2. Development of new and innovative management practices for administration of various water quality programs such as development of management objectives to strengthen interjurisdictional coordinating mechanisms and improve performance. These practices should include continuous review of regulations, monitoring, and legislation.
3. Assessment of the quantifiable and non-quantifiable values of the Great Lakes resources for valid cost-effective analysis.
4. Evaluation of alternative resource use in order to determine optimal allocation of our resources.
5. Assessment of the social, environmental, and economic impacts of pollution controls, e.g., construction of waste treatment plants, disposal of dredge spoils.
6. Assessment of the social, environmental, and economic impacts of energy development, e.g., loss of recreational land due to strip mining or construction of power plants.
7. Identification of various government subsidies for renewable and non-renewable energy resources and to determine how to make these equitable, e.g., loss of recreational land due to strip mining or construction of power plants.
8. Develop mechanisms to assure that individuals, businesses, industries, and governments include the cost of pollution control in the price of the product or service.

9. Determine mechanisms for regional policy formulation, planning, coordination, conflict resolution, and implementation for fisheries, wildlife, and recreational resources.
10. As fuel resources decrease, pressures on the sport fishery and recreational facilities will shift. Information is needed to plan for these changes, including the identification of the carrying capacity of existing public facilities and the potential effect of greater use on Great Lakes water quality.

Problem Area 3: Public Participation

A major factor in the failure of existing institutional arrangements and programs in the Great Lakes basin ecosystem has been the lack of effective public participation in the development of pollution prevention and abatement strategies. The public, which must make political decisions regarding allocation of fiscal resources and management strategies, has a limited understanding of the magnitude of the problem, and as a consequence has had very limited input into development of alternative strategies.

Although public participation is now mandated by law, the agencies who must develop public participation generally have an incomplete perspective as to how to develop effective programs. Some of the perceived reasons as why public participation is not a stronger component of pollution regulation are listed below:

- Agency personnel, by nature of their charges, often become defensive and "turf conscious."
- Planners and regulators have limited experience in the use of public participation as a resource to augment peer review, to develop a broader range of alternatives, and to provide a corrective mechanism to biases in agency or planner perspective.
- Many government agencies do not completely understand the difference between public information and public participation.
- The public, when not involved in a substantive and meaningful way, tends to reject plans and programs irrespective of the fact that these programs are designed to aid the public.
- Commonly, public participation in policy development is too little or too late or has little credibility in the public eye. This feeling stems from the belief that the public feels it has been unable to determine the impact of its input on agency decisions.
- The public is confused by a plethora of agencies and multiplicity of programs.

The information needs associated with this problem are all ranked high.

Information Needs

1. Develop training programs or workshops for researchers, program managers, and regulators which will help them learn to use the public as a resource to assist them in their work.
2. Analyze the effectiveness and extent of public participation programs of key agencies in the Great Lakes region in developing strategies for examining and addressing Great Lakes pollution problems. These key agencies include: EPA, Great Lakes Basin Commission, NOAA, Sea Grant, Fish and Wildlife Service, Great Lakes Fisheries Commission, Soil Conservation Service, International Joint Commission, the Corps of Engineers, Forest Service, Fish and Wildlife Service, National Park Service, and Regional and state agencies.
3. Identify and analyze successful pollution abatement programs in the Basin to determine the role of the public in achieving success.
4. There is a need for government agencies to communicate to the public how the information resources provided as a result of public participation have been used.
5. Consider alternatives to formal public hearings as a means of obtaining input into development of regulations and policy.
6. Monitor the results of public participation programs with respect to a) public acceptance of pollution prevention and abatement strategies as identified at various levels of government, and b) allocation of tax dollars to problems and solutions identified by the public.

Problem Area 4: Lack of Adequate Regional Policy Analysis Process

There is no apparent policy analysis process operating in the Great Lakes region to provide for identification and evaluation of the impact of proposed policy changes or development of new technologies on the basin's land, air, and water resources. This causes problems in assessment of costs and benefits to the bio-physical and socioeconomic resources of the basin and makes it difficult to carry out effective resource management programs which also address pollution problems. This lack of policy analysis has resulted in monofunctional planning for resource use. It has also limited development of effective monitoring and surveillance programs. The information need for this problem is ranked high.

Information Need

1. Develop a regional policy analysis process model or scenario.

Problem Area 5: Lack of Qualified Personnel

There are not enough qualified agency personnel at various levels of government to carry out effective Great Lakes pollution information, research, and monitoring programs. This results in inadequate management, public frustration, and waste of public and private dollars. The information needs from this problem were all ranked medium.

Information Needs

1. Identify information and technical training needs of personnel charged with planning and implementation of pollution programs and regulations.
2. Develop programs for training personnel and monitor the results.

SUMMARY

The Great Lakes basin ecosystem is not only a unique freshwater resource, but it is a binational resource with certain responsibilities for research and monitoring of water pollution abatement programs being jointly allocated to United States and Canadian institutions. Promulgated under the International Boundary Waters Treaty of 1909, The Water Quality Agreements of 1972 and 1978 provide a framework and set specific goals and objectives for water pollution research, monitoring, and remedial program development to be undertaken by the parties under the direction of the International Joint Commission. The goal: rehabilitation, restoration, and protection of Great Lakes water quality. The Great Lakes Fisheries Commission has devoted efforts to rehabilitation and restoration of the Great Lakes fishery. The necessity to be able to coordinate and provide some consistency in water quality research, monitoring, and remedial or enforcement programs was seen by the Social, Economic, and Institutional Panel as being essential to achieving protection of this resource. Because of the international location of the resource, institutional coordination at many levels of government on both sides of the border is of paramount importance.

A major concern raised by panel, is that the existing framework of institutions operating on both sides of the Great Lakes basin is too complex and is impeding resolution of Great Lakes pollution problems. Two international commissions, eight states, two provinces, two federal governments, regional governments, and hundreds of townships, municipalities, counties, and special purpose districts such as port authorities, conservation authorities and park districts have various responsibilities for water quality and pollution management.

The panel found that responsibilities or policies often overlapped or were in conflict with each other. It identified specific needs with respect to research relative to government management, international cooperation and coordination, public information and public participation, and the development of a regional policy analysis process adequate to identify the impact of proposed policy change or technology on the land, air, and water resources of the basin. The panel also identified the need to obtain qualified and trained personnel to administer monitoring and pollution control programs. It recommended that the need for research in these areas was high because the effectiveness of expending tax dollars in pollution control technologies or management programs is in jeopardy due to the identified problems.

PANEL MEMBERS

Ms. Mimi Becker, Chairperson

Dr. Dorothy Brooks

Ms. Edith Chase

Mr. Chester Gunnerson

TRANSPORTATION WATER USES PANEL

INTRODUCTION

The transportation panel felt somewhat constrained by the charge to consider only transportation-caused pollution. Major economic, technical, and institutional problems that will directly affect the future character of transportation in the region, and indirectly effect the potential pollution contribution, were not discussed. The lack of regional transportation goals and credible transportation planning in the Great Lakes basin was evident throughout the panel discussions. Issues such as the economics of commercial navigation, the optimization of vessel sizing, the significance of export-import trade, uncoordinated development activities, and underutilization of all modes of transport underscore this lack of planning. Currently there is a limited capability to achieve coordination and management of transportation in relation to regional needs and goals, as opposed to the functional goals of individual and competing modes. Policy analysis mechanisms appear lacking.

The Transportation Panel began its problem identification using eight categories, including vessel navigation, ports and harbors, channel maintenance and development, potential system changes, other transportation modes, energy, institutions, and other future considerations.

During further consideration of information needs, the panel chose to reduce the number of categories by combining research requirements under fewer headings. The consideration of transportation included not only commercial navigation and recreational boating, rail, highway and pipeline modes (particularly where these modes parallel or cross lakes or tributaries), but port and harbor facilities, sewers and interchanges. The transportation facilities in the region are significantly greater in proportion than the 13% of U.S. land area in the Great Lakes states would suggest. This in turn is associated with the concentration of population and industry in the Great Lakes basin.

PROBLEM AREAS AND INFORMATION NEEDS

Problem Area 1: Vessel Navigation

The potential effects of vessel passage and operation include oil and hazardous substance spills, and pollution from both commercial and recreational vessels. Problems such as the invasion of oceanic algae previously unknown in the Great Lakes, caused by the release of bilge water, and the problem of oil spills were considered. Although many minor oil spills occur, larger ones are associated with tank barges. Coast Guard studies indicate that loss of oil from barges generally results from hull damage. Lack of power on these barges contributes to the hazard.

There is a serious lack of information regarding behavior of hazardous materials when spilled in quantity, as well as information on the behavior, fate, and effects of oil products in a cold, freshwater environment. Research is needed on the relative differences in effects compared to ocean spills. Overall oil loading to the Great Lakes may be 10-40 times the loading per unit of ocean area. This is not primarily a transportation problem, but rather

originates from sources such as steel runoff, waste oil disposal, industrial areas, marinas, etc. Quantification of spills from various sources and relative risk is needed to determine where effort should be placed.

Oil and gas drilling in the lakes, while not a transportation problem except for piping to the shore, requires some examination, since experience gained in salt water operations may not be applicable to fresh water. A greater hazard than oil spills may be the release of brines from drilling, depending on the geochemical makeup of the drilling area. Salt concentration in the Great Lakes is increasing and will pose a hazard unless controlled. The sources are primarily industrial and domestic treatment systems and transportation-related highway salting. The information needs associated with this problem are ranked high.

Information Needs

1. There is a need to quantify input of contaminants to lakes from sources related to transportation, such as oil spills, toxic chemical releases, increased coal shipment, etc. (Includes navigation, terminal activities, and ancillary land transportation.)
2. There is a need to determine the fate and effects of contaminants which enter the Great Lakes from transportation activities.

Problem Area 2: Ports and Harbors

The dredging of ports and harbors is required to maintain adequate draft for Great Lakes commercial shipping and recreational ships as well. Dredging and the disposal of dredged material constitute one of the largest volume waste generation and disposal problems in the basin. The need for dredging is primarily caused by upland erosion, producing sediments that are carried by tributaries to deposition in harbor areas.

When pollutants are added to natural sediments by industrial or municipal discharges, they create not only environmental problems, but barriers to dredging and disposal. Dredging to remove those sediments will resuspend the sediments and may redistribute the associated pollutants. A critical issue is the problem of safely dealing with sediments containing toxic materials, nutrients, and other contaminants. There are major problems with disposal, not only because of the contaminants but also because of conflicts in jurisdiction, standards, and regulatory requirements among federal and state governments. Some harbors may have to shut down operations unless this problem is resolved. Dredging of contaminated sediments and their deposition in the lake environment will cause a variety of problems including increase of turbidity, release of contaminants, blanketing of nearby areas with sediment, and change of biological habitats and sediment characteristics.

A potential new source of dredge materials will be the development activities proposed incident to the expansion of the regional harbor concept. The information needs for this problem are ranked high to medium.

Information Needs

1. There is a need for information regarding the uptake and release of sedimental nutrients as a result of resuspension and bioturbation.
2. There is a need to determine the effect of upstream land management on harbor dredging (source reduction).

Problem Area 3: Channels

The potential for water level changes that might result from ongoing studies such as the Lake Erie Levels Regulation Study, the Lake Ontario Shoreline Protection Study, and the Connecting Channels and Harbors Study were discussed. If water levels were reduced, the consequences for shoreline uses, for riparian property both upstream and downstream in the system, and for such functions as habitats and wetlands would be significant. Lower water levels may create additional need for channel dredging to maintain navigation depths, with resulting dredge and dredge spoil disposal problems.

The problem of shoreline disturbance created by vessel movement in confined channels and in ice environments was discussed. Both commercial navigation and recreational boating were included. The localized physical effects of shock waves under ice, produced by passing vessels, is a major reason for opposition to season extension. The relative importance of this factor is unknown. The information need for this problem area is ranked medium.

Information Need

1. There is a need to determine the relative significance of shoreline disturbances, particularly in connecting channels, caused by both commercial and recreational vessels movements.

Problem Area 4: Other Transportation Elements

While pollution from lake shipping was characterized as limited, the identification of dispersed transportation activities that affect lake pollution is needed. Spills and other losses from other transportation modes exist, but the quantities are unknown. Rail, highway, and pipeline modes serving port areas and paralleling or crossing waterways, as well as submerged pipelines and utility structures in harbor waters, are potential sources for spills. Runoff from terminal areas and storage piles forms a more diffuse problem. There is a need for quantification of these sources and a comparative assessment of risk. The information needs for this problem area were ranked medium.

Information Needs

1. There is a need for quantification of additional transportation modes (rail, highway, pipelines) to pollution and spills in the Great Lakes. There is a need to analyse the nature of contributions and comparative assessment of risk of these spills.
2. There is a need to quantify the relative risk from transportation sources of pollution compared to non-transportation sources.

Problem Area 5: Energy

One of the major increases in lake shipping may come from increased transportation of western coal. Pollution problems are seen in the increased potential for airborne particulates, leaching from coal storage areas, and escape of fine coal particles during loading/unloading operations. The question of water requirements for new synthetic fuels resulting from coal gasification and liquification was examined. The water consumption for this purpose in the basin was not seen as significant because of the expectation that the processes would take place closer to the source of coal. Energy shortages in the basin were seen as more likely to affect life style factors leading to, for instance, the increased use of local recreation facilities. A need for characterization of these changes and their relationship to water quality was seen. No new information needs were identified beyond those already assigned to other problem areas in this panel.

Problem Area 6: Institutions

A major institutional problem was seen in the failure to achieve a national approach to the problems engendered by dredging and dredge spoil disposal. There is a need to resolve both technical and jurisdictional conflicts which now may prevent any action at all. For instance, Indiana has a ban on dredging because it has no disposal sites for polluted dredge spoil. Lake disposal is not allowed. Harbors may close if a resolution is not obtained. A socio-economic analysis of the conflicting factors is required, together with analyses of federal and state policy on movement of solid materials for harbor and channel maintenance and development.

Present institutional arrangements in the Great Lakes are fragmented and tend to deal with uses and pollution problems in a somewhat mono-functional way. Since this ignores the system interrelationships, the problem is to seek a strategy that will encourage Great Lakes institutions to integrate their problem solving with a total ecosystem concept. The information need for this problem area is ranked high.

Information Need

1. There is a need for analysis of a policy on the movement of solid materials in relation to harbor and channel maintenance and development. There is a need to investigate state-federal jurisdictional inconsistencies.

SUMMARY

While the transportation industry is highly concentrated in the Great Lakes basin, the effects of that concentration are not adequately characterized. Commercial navigation, recreational boating, rail, highway, and pipeline modes, ports, harbors, and ancillary facilities all contribute pollutants in one form or another. Oil and gas drilling, coal transportation, and other development incident to the energy situation constitute a threat whose dimensions are unknown.

There is an urgent need for identification and quantification of

contaminants to the lakes from transportation-related sources such as oil spills, chemical releases, dredging, and the non-point contributions from land-based facilities. Of particular importance is information on the behavior, fate, and environmental effects of pollutants such as oil products in cold, fresh-water environments. Lake navigation depends on established channel and harbor depths which require dredging to maintain. The dredging and disposal of dredge spoil, particularly those contaminated by pollutants, requires close examination. The behavior and impacts of sedimental pollutants and ways to reduce the upland erosion that creates the necessity for dredging need examination.

Related to the problems of dredging are the technical and jurisdictional conflicts that have created an impasse in certain areas of the basin. Socio-economic analysis of the conflicting factors and a policy resolution are urgently required, not only for this problem but for other pollution problems exacerbated by the fragmented institutional arrangements and the lack of a system-oriented strategy for the Great Lakes basin.

PANEL MEMBERS

Dr. James Cowden, Chairman
Ms. Diane Baldwin, Rapporteur

Dr. David Edgington
Mr. Thomas Gruss
Dr. Loren Habegger
Mr. William Newstrand
Ms. Barbara Pijanowski
Dr. Robert Ragotzki
Dr. John Reynolds
Dr. William Sonzogni

APPENDIX A

STEERING COMMITTEE MEMBERS

Dr. Eugene Aubert	Great Lakes Environmental Research Laboratory/NOAA
Ms. Mimi Becker	Great Lakes Tomorrow
Dr. Alfred Beeton	Michigan Sea Grant Program
Mr. Ted Ilgenfritz	Environmental Services
Dr. Howard Johnson	Institute of Water Research
Dr. Joseph Kutkuhn	U.S. Fish and Wildlife Service
Dr. Robert Ragotzkie	Univ. of Wisconsin Sea Grant College Program
Dr. W. Sonzogni	Great Lakes Basin Commission
Dr. W. Swain	USEPA Large Lakes Research Station

Technical Advisors:

Dr. Russell Moll	Great Lakes Research Division, University of Michigan
Dr. A. Robertson	Great Lakes Environmental Research Laboratory/NOAA

NOAA Representative:

Ms. Barbara Pijanowski	National Marine Pollution Program Office, NOAA
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APPENDIX B

CONFERENCE INVITEES

Dr. George W. Saunders
Ecological Research Division
Office of Health and Environmental Research
Office of Environment
Department of Energy
Washington, DC 20545

Dr. L. John Hoover
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Dr. Clifford Mortimer, Director
Center for Great Lakes Studies
University of Wisconsin
Milwaukee, WI 53201

Mr. Kenneth Oakley, Director
International Joint Commission
100 Ouellette Avenue
Windsor, Ontario N9A 6T3

Mr. Thomas Gruss
Cement Division, National Gypsum Co.
Box 887
Southfield, MI 48037

Mr. William M. Nolan
Environmental Coordination Division of Marathon Oil Co.
539 South Main
Findley, OH 45840

Mr. John Reynolds, Director
Environmental Services Dept. of Consumers Power Co.
1945 Parnall Road
Jackson, MI 49201

Mr. David Gubanc
Republic Steel Corp.
Box 6778
Cleveland, OH 44101

Dr. Alan W. Maki
Environmental Safety Department
Proctor and Gamble Company
301 E. 6th St.
Cincinnati, OH 45202

Dr. Douglas Dougal
Director, Environmental Sciences
Institute of Paper Chemistry
Appleton, WI 54911

Mr. Robert Mallinger
Sherwin-Williams Research Center
10909 S. Cottage Grove
Chicago, IL 60628

Mr. Timothy Saylor
Hammermill Paper Co.
P.O. Box 1440
Erie, PA 16533

Dr. Paul J. Eisele
Environmental Affairs Dept. of Detroit Edison
2000 2nd Ave.
Detroit, MI 48226

Mr. Bud Shannon
Government Affairs
47 Bldg.
Dow Chemical Corp.
Midland, MI 48604

Mr. James Howell, Director
Environmental Control
Great Lakes Steel Division
National Steel Corp.
Detroit, MI 48229

Mr. Victor Sussman
Director of Stationary Environmental Control
Ford Motor Co.
625 Parklane Towers West
Dearborn, MI 48126

Mr. John Horton
Cleveland-Cliffs Iron Co.
1460 Union Commerce Bldg.
Cleveland, OH 44115

Dr. James Fish, Director
Great Lakes Commission
University of Michigan
Ann Arbor, MI 48109

Mr. David C. N. Robb
St. Lawrence Seaway Development Corporation
800 Independence Avenue, S.W.
Washington, DC 20591

Dr. Francis Ogilvie, Chairman
Dept. of Naval Architecture and Marine Engineering
University of Michigan
Ann Arbor, MI 48109

Ms. Lee Botts, Chairman
Great Lakes Basin Commission
Box 999
Ann Arbor, MI 48106

Rear Admin. Roy Hoffmann, Port Director
Port of Milwaukee
500 N. Harbor Dr.
Milwaukee, WI 53202

Admiral Paul Trimble, President
Lake Carrier's Assoc.
1411 Rockefeller Bldg.
Cleveland, OH 44113

Mr. John A. McWilliams, President
Toledo-Lucas County Port Authority
241 Superior St.
Toledo, OH 43604

Mr. William Newstrand
Manager of Ports, Waterways and Pipelines
Minnesota Dept. of Transportation
Room 820, Transportation Bldg.
St. Paul, MN 55155

Mr. Wayne Schmidt
Michigan United Conservation Clubs
2102 Wood St.
P.O. Box 30235
Lansing, MI 48909

Dr. James W. Cowden
Hiram College
P.O. Box 1934
Hiram, OH 44234

Mr. Carlos M. Fetterolf, Jr., Executive Secretary
Great Lakes Fishery Commission
1451 Green Road
Ann Arbor, MI 48105

Ms. Mary Lee Strang
League of Women Voters
1831 Balmoral Lane
Glenview, IL 60025

Ms. Helen Bieker
Lake Michigan Federation
1154 Ridge Road
Munster, IN 46321

Mr. Jonathan Ela
Sierra Club
142 W. Gorham St.
Madison, WI 53703

Dr. John Magnuson
Laboratory of Limnology
University of Wisconsin
Madison, WI 53706

Dr. Niles Kevern
Dept. of Fisheries and Wildlife
Michigan State University
East Lansing, MI 48824

Dr. Joseph Delfino
University of Wisconsin
Laboratory of Hygiene, 465 Henry Mall
Madison, WI 53706

Dr. Wayne Willford
U.S. Fish and Wildlife Service
1451 Green Rd.
Ann Arbor, MI 48107

Dr. Andrew Robertson
Great Lakes Environmental Research Laboratory
2300 Washtenaw Ave.
Ann Arbor, MI 48104

Mr. John Scott
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909

Mr. Eugene F. Dice
334 Natural Resources Bldg.
Michigan State University
East Lansing, MI 48824

Mr. Brian Doyle, Advisory Service Agent
Morgan III
State University College
Brockport, NY 14420

Dr. Thomas Brown
Dept. of Natural Resources
Cornell University
Ithaca, NY 14850

Mr. Thomas Inglehart
Save-the-River
425 Riverside Drive
Clayton, NY 13624

Dr. Alden Lind
Save-Lake-Superior
4130 McCullough
Duluth, MN 55804

Dr. Jonathan Bulkley
Dept. of Civil Engineering
University of Michigan
Ann Arbor, MI 48109

Ms. Madonna F. McGrath
U.S. Environmental Protection Agency, Region V
536 South Clark Street
Chicago, IL 60605

Dr. Donald I. Mount
U.S. Environmental Protection Agency
6201 Congdon Blvd.
Duluth, MN 55804

Dr. John Moser, Research & Development
Milwaukee Metropolitan Sewerage District
735 North Water Street
Milwaukee, WI 53202

Dr. William Katz, Chief Engineer
Milwaukee Metropolitan Sewerage District
735 North Water Street
Milwaukee, WI 53202

Dr. Herbert Allen
Dept. of Environmental Engineering
Illinois Institute of Technology
Chicago, IL 60616

Mr. Randy Frykberg
Northeast MI Council of Governments
P.O. Box 457
Gaylord, MI 49735

Prof. Steven Born
Dept. of Urban & Regional Planning
University of Wisconsin
925 Lathrop Drive
Madison, WI 53706

Mr. Dolloff F. Bishop
Chief, Technology Dev. Support Branch
USEPA Wastewater Laboratory
26 W. St. Clair St.
Cincinnati, OH 45268

Dr. Gilbert Levine, Director
Center for Environmental Research
Cornell University
Ithaca, NY 14853

Dr. John Frey
Institute for Research on Land and Water Resources
Pennsylvania State University
University Park, PA 16802

Mr. Joe Moore
Detroit Water Treatment Center
735 Randolph
Detroit, MI 48226

Mr. Tony Grano
U.S. Department of Agriculture
1405 South Harrison Road
East Lansing, MI 48823

Dr. Lawrence W. Libby
Department of Agricultural Economics
Michigan State University
East Lansing, MI 48824

Dr. John Rankin, Chairman
Preventive Medicine
University of Wisconsin
504 N. Walnut St.
Madison, WI 53706

Ms. Barbara Clark
Mich. Forest Association
914 Fir Street
Hancock, MI 49930

Mr. John Fry
Michigan Farm Bureau
Rt. 1
Charlevoix, MI 49720

Dr. Jacob Hoefer
109 Agriculture Hall
Michigan State University
East Lansing, MI 48823

Dr. James Price
Dept. of Food Science and Human Nutrition
4563 Nakoma Drive
Michigan State University
Okemos, MI 48864

Dr. Gilbert Laveille, Chairman
Dept. of Food Science and Human Nutrition
204 Food Science Bldg.
Michigan State Univ.
East Lansing, MI 48823

Mr. Claude VerDuin
The Fisherman
623 Washington Ave.
Grand Haven, MI 49417

Dr. David Baker
Water Quality Laboratory
Heidelberg College
Tiffin, OH 44883

Dr. Harold Humphrey
Michigan Dept. of Public Health
P.O. Box 30035
3500 N. Logan St.
Lansing, MI 48909

Mr. J. Welch
Soil Conservation Service
1405 South Harrison Road, Rm. 101
East Lansing, MI 48823

Mr. Alan Ames
Maritime Administration
666 Euclid Ave., Rm. 576
Cleveland, OH 44114

Mr. Gary Failor
Toledo-Lucas County Port Authority
241 Superior St.
Toledo, OH 43604

Mr. Davis Helberg, Port Director
Seaway Port Authority of Duluth
P.O. Box 6877
1200 Port Terminal Rd.
Duluth, MN 55802

Dr. John Hazard
Marketing & Transportation Administration
332 Eppley Center
Michigan State University
East Lansing, MI 48823

Dr. Norbert A. Jaworski, Deputy Director
Industrial Environmental Research Lab.
U.S. EPA
Research Triangle Park, NC 27709

Admiral Fugaro
9th Coast Guard District
2053 Federal Bldg.
1240 E. Ninth St.
Cleveland, OH 44199

Mr. Carl Cable
U.S. Army Corps of Engineers
536 South Clark St.
Chicago, IL 60605

Dr. Ken Hoover
National Power Plant Team
2929 Plymouth Road, Rm. 206
Ann Arbor, MI 48105

Dr. Gregory Hedden
Sea Grant Institute
1315 University Ave.
Madison, WI 53706

Dr. J. H. Judd
Michigan Sea Grant Program
University of Michigan
Ann Arbor, MI 48109

Mr. Peter Howe
Environmental Affairs, Commonwealth Edison
72 West Adams, Room 1700
P.O. Box 767
Chicago, IL 60690

Dr. E. Aubert, Director
Great Lakes Environmental Research Laboratory
NOAA
2300 Washtenaw Ave.
Ann Arbor, MI 48104

Ms. M. Becker
Great Lakes Tomorrow
Box 1935
Hiram, OH 44234

Dr. A. M. Beeton, Director, Chairman
Michigan Sea Grant Program
University of Michigan
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

Mr. Larry HiiPakka
U.S. Army Corps of Engineers
North Central Division
536 South Clark St.
Chicago, IL 60605

Mr. Ted Ilgenfritz
628 Bldg.
Environmental Services
Dow Chemical Corporation
Midland, MI 48640

Dr. Howard Johnson
Room 334, Natural Resource Bldg.
Institute of Water Research
Michigan State University
East Lansing, MI 48824

Dr. J. Kutkuhn, Director
U.S. Fish & Wildlife Service
1451 Green Rd.
Ann Arbor, MI 48105

Dr. R. Ragotzkie, Director
Sea Grant College Program
University of Wisconsin
1800 University Avenue
Madison, WI 53706

Dr. T. Sheffy
Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707

Dr. W. Sonzogni
Great Lakes Basin Commission
P.O. Box 999
Ann Arbor, MI 48106

Dr. W. Swain
Large Lakes Research Station
U.S. Environmental Protection Agency
9311 Groh Rd.
Grosse Ile, MI 48138

Mr. Lowell Martin, Associate Director
National Marine Pollution Program Office
NOAA, Office of Administrator
Washington, DC 20230

Mr. G. Robert Adams, Administrator
Michigan Dept. of State Highways and Transportation
State Highway Bldg.
425 W. Ottawa St.
Lansing, MI 48933

Mr. Robert Hanson, Director
Coastal Zone Management
Department of State
162 Washington Ave.
Albany, NY 12231

Mr. Robert Johnson
Buffalo District Corps of Engineers
1776 Niagara St.
Buffalo, NY 14207

Mr. Wayne Nichols, Deputy Director
Ohio Dept. of Natural Resources
Fountain Square
Columbus, OH 43224

Ms. Edith Chase, Director of Natural Resources
Natural Resources Committee
5731 Caranor
Kent, OH 14207

Dr. Martin Bratzel, Research Scientist, Toxicology
Great Lakes Regional Office
International Joint Commission
100 Ouellette Ave.
Windsor, Ontario N9A 6T3

Sister Loretta Shimondle
c/o Soil Testing Services
540 Lambeau Road
Green Bay, WI 54303

Mr. F. Brandt Richardson
State of Minnesota Water Planning Board
600 American Center Building
150 E. Kellogg Blvd.
St. Paul, MN 55101

Ms. Nancy Huang
Great Lakes Information
P.O. Box 999
Ann Arbor, MI 48106

Ms. Diane Baldwin
Great Lakes Information
P.O. Box 999
Ann Arbor, MI 48106

Dr. Gordon Chesters, Director
Univ. of Wisconsin - Water Resources Center
1975 Willow Drive
Madison, WI 53706

Ms. Barbara Pijanowski, Associate Director
National Marine Pollution Program Office
NOAA, Office of Administrator
Washington, DC 20230

Mr. Phillip Janus
Office of the Science Advisor, OASH
Department of Health, Education and Welfare
Parklawn Bldg., Room 9A55 -- 5600 Fishers Lane
Rockville, MD 20857

Mr. Chester Gunnerson, Environmental Engineering Advisor
Office of Marine Pollution Assessment
Environmental Research Laboratory, NOAA
Boulder, CO 80303

Mr. Chris A. Shafer
Coastal Zone Management Program
Michigan Dept. of Natural Resources
P.O. Box 30023
Lansing, MI 48909

Dr. Charles E. Herdendorf
Ohio Sea Grant Program
Ohio State University
484 West 12th Avenue
Columbus, OH 43210

Dr. Robert Sweeney, Director
Great Lakes Laboratory
State Univ. College at Buffalo
1300 Elmwood Ave.
Buffalo, NY 14222

Mr. William D. Marks, Asst. to the Bureau Chief
Bureau of Environmental Protection
Michigan Dept. of Natural Resources
P.O. Box 30023
Lansing, MI 48909

Mr. William B. Mann, Water Resources District Chief
U.S. Geological Survey, Water Resources Center
1815 University Avenue
Madison, WI 53706

Mr. G. Robert Adams, Administrator
Bureau of Transportation Planning
State Highway Building
425 W. Ottawa
Lansing, MI 48933

Mr. William Pearce, Station Director
N.Y. Dept. of Environmental Conservation
Box 292
Cape Vincent, NY 13618

Mr. Roger Kenyon
Pennsylvania Fish Commission
Box 531
Fairview, PA 16415

Mr. Russell Scholl
Ohio Dept. of Natural Resources
Fountain Square
Columbus, OH 43224

Mr. Ron Poff
Wisconsin Dept. of Natural Resources
Box 7921
Madison, WI 53707

Mr. Gerald Lowry
Assistant Regional Director - Environment
U.S. Fish & Wildlife Service
Federal Building, Fort Snelling
Twin Cities, MN 55111

Mr. Gilbert Radonski, Executive Secretary
Sport Fishing Institute
Suite 301, 608 13th St., N.W.
Washington, DC 20005

Mr. Robert Roda
Environmental Activities Staff
General Motors Technical Center
Warren, MI 48090

Mr. John Suffrun
White Pine Copper Company
White Pine, MI 49971

Mr. Richard L. Black
Champion Timberlands
405 Norway Street
Norway, MI 49870

Mr. Jack Druckemiller
Indiana-Michigan Electric Company
P.O. Box 60
Ft. Wayne, IN 46801

Mr. George Kiba
150 Michigan Avenue
Detroit, MI 48226

Mr. Cleamon Lay
Amway Corporation
7575 Fulton Road
Ada, MI 49301

Mr. Charles Worthylake
Monsanto Company
Trenton Resin Plant
5100 W. Jefferson Avenue
Trenton, MI 48183

Mr. Stanley Andrie, President
Bultema Marine Transportation
P.O. Box 728
559 E. Western Avenue
Muskegon, MI 49445

Mr. Frank Fauver, V.P. of Operations
Great Lakes Towing
1800 Terminal Tower
Cleveland, OH 44113

Mr. Don Hanna
Hanna Inland Waterways
P.O. Box 189
Lemont, IL 60439

Mr. Stockton Sikes
American Steamship
3250 Midland Marine
Buffalo, NY 14203

Mr. David Ritchie, V.P.
Cleveland Tankers
1 Erieview Plaza
Cleveland, OH 44114

Mr. Charles Beckham, Director
Detroit Water and Sewer Department
Water Board Building
735 Randolph
Detroit, MI 48226

Mr. William E. Muno, Chemical Engineer
Region V - U.S. Environmental Protection Agency
230 South Dearborn Street
Chicago, IL 60604

Mr. William Shaw
Washtenaw Engineering Section
Environmental Protection Bureau, Michigan Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909

Mr. Richard Lanyon, Assistant Director for Research
Metropolitan Sanitary District
100 East Erie Street
Chicago, IL 60611

Dr. Al Gailauskas
Lake Erie Research Station - Whiskey Island
Cleveland Division of Water
c/o 1201 Lakeside
Cleveland, OH 44114

Mrs. Peter Williams
416 Sixth Street
Traverse City, MI 49684

Dr. Frederick L. Brown
488 West Ashby Road
Route #5
Midland, MI 48640

Dr. William Cooper
Department of Biology
Michigan State University
East Lansing, MI 48824

Prof. J. Sax
Law School
The University of Michigan
Ann Arbor, MI 48109

Mr. Ira Markwood, Manager
Public Water Supplies Division - Illinois EPA
2200 Churchill Road
Springfield, IL 62706

Ms. Christina Carlson
1445 Meadow Lane
Yellow Springs, OH 45387

Mr. Dean Rhodes
District Extension Office
2143 S. Airport Road
Traverse City, MI 49684

Mr. James A. Newton
Conrail
610 Center Plaza
Philadelphia, PA 19003

Commanding Officer
U.S. Coast Guard Research and Development Center
Avery Point
Groton, CT 06340

APPENDIX C

CONFERENCE ATTENDEES

John R. Adams
U.S. Army Engineering District
1776 Niagara Street
Buffalo, NY 14207

Len Adelman
Decisions and Designs, Inc.
c/o National Marine Pollution Program Office
NOAA, Office of the Administrator
Washington, DC 20230

Eugene Aubert
Great Lakes Environmental Research Laboratory
NOAA
2300 Washtenaw Ave.
Ann Arbor, MI 48104

Cheryl Baker
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

David Baker
Water Quality Laboratory
Heidelberg College
Tiffin, OH 44883

Diane Baldwin
Great Lakes Information
P.O. Box 999
Ann Arbor, MI 48106

Mimi Becker
Great Lakes Tomorrow
Box 1935
Hiram, OH 44234

Alfred Beeton
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

Martin Bratzel
Great Lakes Regional Office
International Joint Commission
100 Ouellette Ave.
Windsor, Ontario N9A 6T3

Dorothy Brooks
Lake Michigan Inter-League Group
Watervale
Arcadia, MI 49613

Jonathan Bulkley
Dept. of Civil Engineering
University of Michigan
Ann Arbor, MI 48109

Edith Chase
Director of Natural Resources
Natural Resources Committee
5731 Caranor
Kent, OH 14207

Gordon Chesters, Director
University of Wisconsin - Water Resources Ctr.
1975 Willow Dr.
Madison, WI 53706

James W. Cowden
Hiram College
P.O. Box 1934
Hiram, OH 44234

David Edgington
Center for Great Lakes Studies
University of Wisconsin
P.O. Box 413
Milwaukee, MI 53201

James B. Elder
Environmental Contaminants Evaluation Prog.
U.S. Fish & Wildlife Service
Federal Building, Fort Snelling
Twin Cities, MN 55111

Carlos Fetterolf, Jr.
Great Lakes Fishery Commission
1451 Green Rd.
Ann Arbor, MI 48105

Becky Glover
Michigan Sea Grant Program
1020 I.S.T. Building
University of Michigan
Ann Arbor, MI 48109

Phil Goodyear
National Power Plant Team
2929 Plymouth Rd.
Ann Arbor, MI 48105

Tom Gruss
Cement Division
National Gypsum Corporation
Box 887
Southfield, MI 48037

Chester Gunnerson
Office of Marine Pollution Assessment
Environmental Research Laboratory
NOAA
Boulder, CO 80303

Loren Habegger
Argonne National Laboratory
9700 South Cass Ave.
Argonne, IL 60439

Harold Humphrey
Michigan Dept. of Public Health
P.O. Box 30035
Lansing, MI 48909

Ted Ilgenfritz
628 Bldg.
Environmental Services
Dow Chemical Corporation
Midland, MI 48640

June Janis
League of Women Voters
9219 Fairview Ave.
Williamsburg, MI 49690

Phillip Janus
Office of the Science Advisor, OASH
Department of Health, Education & Welfare
Parklawn Bldg., Room 9A55 -- 5600 Fishers Lane
Rockville, MD 20857

Howard Johnson
Institute of Water Research
Michigan State University
East Lansing, MI 48824

John Judd
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

Niles Kavern
Dept. of Fisheries & Wildlife
Natural Resources Bldg.
Michigan State University
East Lansing, MI 48824

William Katz, Chief Engineer
Milwaukee Metropolitan Sewerage District
735 North Water Street
Milwaukee, WI 53202

Lawrence W. Libby
Department of Agricultural Economics
Michigan State University
East Lansing, MI 48824

Leslie Lin
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

Bruce Markert
Institute of Paper Chemistry
P.O. Box 1039
Appleton, WI 54912

Russell Moll
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

William Newstrand
Manager of Ports, Waterways and Pipelines
Minnesota Dept. of Transportation
Room 920, Transportation Bldg.
St. Paul, MN 55155

Madonna F. McGrath
U.S. Environmental Protection Agency, Region V
536 South Clark St.
Chicago, IL 60605

Kenneth Oakley, Director
International Joint Commission
100 Ouellette Ave.
Windsor, Ontario N9A 6T3

Barbara Pijanowski, Associate Director
National Marine Pollution Program Office
NOAA, Office of Administrator
Washington, D.C. 20230

James Price
Dept. of Food Science & Human Nutrition
4563 Nakoma Dr.
Michigan State University
Okemos, MI 48864

Gilbert Radonski, Executive Secretary
Sport Fishing Institute
Suite 801, 603 13th St., N.W.
Washington, DC 20005

R. Ragotzkie, Director
Sea Grant College Program
University of Wisconsin
1800 University Ave.
Madison, WI 53706

John Reynolds, Director
Environmental Services Dept. of
Consumers Power Co.
1945 Parnall Rd.
Jackson, MI 49201

Andrew Robertson
Great Lakes Environmental Research Laboratory
2300 Washtenaw Ave.
Ann Arbor, MI 48104

Edwin Shannon
Government Affairs
47 Bldg.
Dow Chemical Corporation
Midland, MI 48604

W. Sonzogni
Great Lakes Basin Commission
P.O. Box 999
Ann Arbor, MI 48106

Wayland Swain
Large Lakes Research Station
U.S. Environmental Protection Agency
9311 Groh Rd.
Grosse Ile, MI 48138

Suzanne Tainter
Michigan Sea Grant Program
2200 Bonisteel Blvd.
Ann Arbor, MI 48109

Joe Vihtelick
Environmental Services Division
Michigan Department of Natural Resources
Mason Bldg. - Box 30023
Lansing, MI 48909

Andrew Watson
International Joint Commission
100 Ouellette Ave.
Windsor, Ontario N9A 6T3

Joel Wesselman
Milwaukee Metropolitan Sewerage District
735 North Water St.
Milwaukee, WI 53202

Wayne Wilford
U.S. Fish & Wildlife Service
1451 Green Rd.
Ann Arbor, MI 48107