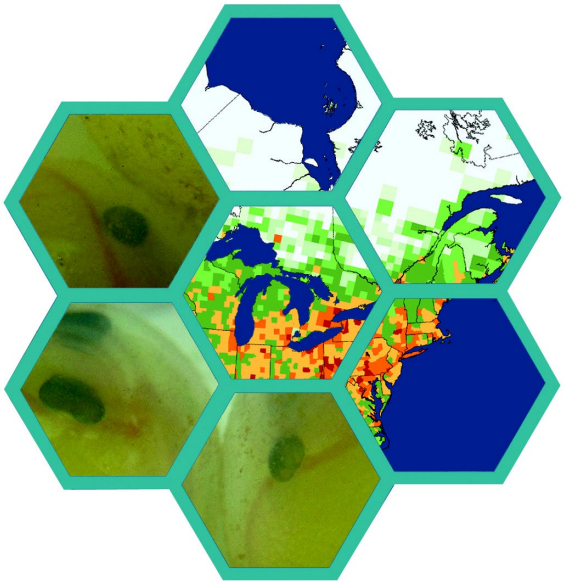

2001-2003
Priorities Report
Chapter 5

EMERGING GREAT LAKES ISSUES IN THE 21ST CENTURY

CHAPTER FIVE Emerging Great Lakes Issues in the 21st Century

Contents

Report of the Great Lakes Science Advisory Board

5.1 INTRODUCTION

The scope of the Great Lakes Science Advisory Board's (SAB) work also extends to the scientific dimensions of "emerging issues"; a term that includes issues that are new arrivals on the public policy agenda as well as those that are established, but changing in substance, scope or significance. The centerpiece of this priority activity in the 2001-2003 biennium was the conduct of an "expert consultation" in partnership with other *Great Lakes Water Quality Agreement* institutions of the IJC (the Great Lakes Water Quality Board, Council of Great Lakes Research Managers, and International Air Quality Advisory Board), Environment Canada, the U.S. Environmental Protection Agency, and The Johnson Foundation. Objectives included a scoping exercise to identify issues of importance under the *Great Lakes Water Quality Agreement* over the next 25 years; binational discourse among eminent U.S. and Canadian scientists; and the identification of specific initiatives to ensure progress under the *Great Lakes Water Quality Agreement*. Topics to guide discussion included new non-chemical stressors, new chemicals, new effects, changing ecology of the Great Lakes, and new policies.

Toward that end, several overarching recommendations were generated that are of critical importance if a science-based approach to implementation of the *Great Lakes Water Quality Agreement* is desired. The *Great Lakes Water Quality Agreement* must be reviewed in a comprehensive manner and with an eye toward revisions that will allow it to reflect a current vision of goals, priorities and institutional arrangements.

A significant outcome of the expert consultation was recognition of the policy and institutional dimensions of emerging issues. Research, monitoring and data analysis needs associated with the identification of emerging issues were documented, but it also was noted that science can only be effective when conducted via institutional arrangements that encouraged its application in the decision-making process. **Toward that end, several overarching recommendations were generated that are of critical importance if a science-based approach to implementation of the *Great Lakes Water Quality Agreement* is desired. The *Great Lakes Water Quality Agreement* must be reviewed in a comprehensive manner and with an eye toward revisions that will allow it to reflect a current vision of goals, priorities and institutional arrangements.**

Great Lakes Water Quality Agreement implementation requires a greater degree of accountability, benchmarks for measuring progress and an aggressive implementation schedule that reflects the urgency of basin ecosystem restoration and protection efforts. As well, the need for a binational, science-based decision support system with requisite monitoring and information/data management components; and new/revised institutional mechanisms that move the notion of an "ecosystem approach" to water quality from concept to reality by integrating governance responsibilities for air, land and water management across all relevant levels of government.

5.2 EXPERT CONSULTATION ON EMERGING ISSUES IN THE GREAT LAKES IN THE 21ST CENTURY

5.2.1 Background

In its 1999-2001 Priorities Report, the SAB recommended that the IJC support a specific initiative related to emerging issues in order to comprehensively identify and review emerging issues as a priority activity. The biennial priorities approved by the Commission for 2001-2003 included a provision to hold such a meeting. The substantial interest of other IJC advisory groups lead to a collaborative planning effort involving the Great Lakes Water Quality Board, International Air Quality Advisory Board and Council of Great Lakes Research Managers. These IJC advisory boards then formed a partnership with Environment Canada, U.S. EPA and the Johnson Foundation to convene an expert consultation at Wingspread, February 5 - 7, 2003. The planning committee identified three principle objectives to be achieved in the consultation process:

- to conduct a scoping exercise to identify issues of importance for the Great Lakes over the next 25 years as part of the advisory roles of the IJC boards;
- to facilitate binational discourse on an interdisciplinary basis among eminent scientists and policy makers; and
- to identify specific initiatives that represent the most promising future opportunities for sustaining progress under the *Great Lakes Water Quality Agreement*.

The format chosen for the Expert Consultation was carefully crafted to maximize discussion and interaction. A set of six themes was selected to explore a range of future issues and challenges for the Great Lakes. The presentations associated with each theme were deliberately kept to a combined total of 30 minutes so that there were would be significant discussion time, which was managed by a professional facilitator.

The Wingspread facility proved to be highly conducive for both informal and formal discourse, and allowed participants to more easily put aside any biases from their day-to-day environments. The participants were carefully chosen to provide diversity of both experience and expertise, and included scientists and decision makers from federal agencies, academia, industry, and consulting, as well as with interests both within and outside the Great Lakes basin.

It is anticipated that the full proceedings of the Expert Consultation will be published in a peer-reviewed journal in due course.

5.2.2 Themes of discussion

Visioning Statement: State of the Great Lakes 2025

There are many different processes that can be used to develop a vision of the future and create a workshop atmosphere conducive to sharing new thoughts. The introductory session used the metaphor “Retreat of the Industrial Glacier” to capture the impact of contemporary urban philosophy and design that is connecting the built and natural environments in cities throughout North America. The abandonment of industrial waterfront sites is providing a unique opportunity to provide natural areas and amenities, often in the very heart of the central core of the urban area. These efforts are being supported by other related concepts, such as “green design principles” and “green building construction” that taken together represent a new development paradigm having a major positive impact for Great Lakes cities over the next 25 years and beyond.

If the prospects for greater coexistence for city and nature are to be beneficial in terms of maintaining and restoring the integrity of Great Lakes waters, it will be critical to include Great Lakes goals within an intergovernmental framework that encompasses the basin ecosystem in the decision-making process at all levels of government.

To ensure that costly restoration efforts in urban areas are sustainable, new investments of research in aquatic science need to be made to provide a greater understanding of ecosystem function. In terms of the impact of development, the effects of imperviousness, both in terms of habitat fragmentation and increased runoff, merit special research focus. There is also a need for greater political awareness that the watershed is not merely a section of shoreline with aesthetic value, but is an extensive biodiverse environment that has fundamental requirements for maintenance and health.

New Non-Chemical Stressors

The major non-chemical stressors currently known to be impinging on the Great Lakes basin ecosystem -- invasive species, climate variability, nutrient enrichment, habitat loss, and food web dynamics -- will continue to affect Great Lakes water quality in the future. The relevance of these ongoing issues underscores their intractability and the

inventories and evaluation of substances using models based on Quantitative Structure Activity Relationships.

Ongoing fish and wildlife research and ambient monitoring also has been effective in identifying new chemical classes in the Great Lakes. Polybrominated diphenyl ethers (PBDEs), perfluorosulfonates (PFOS) and carboxylates, chlorinated paraffins and naphthalenes, various pharmaceuticals and personal care products, phenolic substances and approximately 20 current-use pesticides have been identified.

scientific challenge of addressing them. For example, the issue of invasive species is not new, but it has been accelerating in recent years because of globalization and the vulnerability of the Great Lakes to invasions. The current number of known invaders stands at 162, with many more "surprises" anticipated as long as effective action is not taken. The ultimate non-chemical stressor is the economy, since all stressors result from human economic activity.

In terms of ecosystem science, the most critical factors dominating ecological processes in the Great Lakes originate from offshore in the open waters. Understanding the interconnections between physical, biological and chemical processes is the key to implementing a science-based approach to decision-making to achieve long-term management goals for large complex systems. A major challenge is the limitations imposed by the current institutional structures to implement the *Great Lakes Water Quality Agreement*, and to provide integrative management and oversight based on its goals.

New Chemicals

Substantial progress has been made over the past few decades in reducing or eliminating releases of critical pollutants identified under the *Great Lakes Water Quality Agreement* and achieving reductions in the ecosystem. While these trends are encouraging, other classes of chemicals are emerging as potential pollutants in the basin. The Existing Substance Inventories of the United States and Canada are approximately 80,000 and 25,000 substances, respectively, many of which have had no formal assessment of risk to human health and the environment and may be present in very low levels in both environmental media and biota. There are two major activities relevant to the identification of new chemicals of interest -- release

New Effects

In the past, the identification of effects was largely based on a combination of field observation and scientific judgement by resource managers and biologists. New effects can be observed at different levels of biological organization ranging from the cellular to the ecosystem level, though most are first seen at the organism level. Systematic surveys are currently being undertaken in a limited way in the Great Lakes. They are limited in the sense that the studies are short term and selective in terms of species and localities. In the future, new techniques, such as toxicogenomics that combine disciplines - in this case Quantitative Structure Activity Relationships and toxicology potential - to enable predictive capabilities to be developed that will allow scientists to anticipate new effects on a more comprehensive basis.

The large surface area of the lakes makes them vulnerable to atmospheric deposition of chemical stressors, and the large volumes of the lakes may result in long residence times for these substances.

The Existing Substance Inventories of the United States and Canada are approximately 80,000 and 25,000 substances, respectively, many of which have had no formal assessment of risk to human health and the environment and may be present in very low levels in both environmental media and biota.

Two central questions emerged from the discussions related to "how does one get ahead of the curve" with respect to effects? These can be summarized as:

- What is the appropriate balance between efforts to anticipate new effects and the further development of the knowledge and understanding of what is already known?
- What is the nature of the scientific commitment and program necessary to ensure that both countries are diligent in the identification of potential new effects as part of their overall goal of Great Lakes protection?

Changing Ecology of the Great Lakes

Ecosystems generally exhibit a resistance to change in the face of external perturbations – homeostasis. Yet, the Great Lakes have undergone tremendous ecological change in the past 200 years of human development within the basin and now scientists have come to "expect the unexpected." Human population growth and its impact have led to a great increase in the range and magnitude of stressors. These stressors include: nutrient loads, sediment loads, synthetic chemical loads, wetland destruction, microbial inputs, modification of thermal regimes, exotic species introductions, fish stocking and harvesting practices, and water withdrawals/diversions, among others. Despite their initial impact, reductions of the severity of these past stressors may explain the recovery conditions generally thought to prevail in the lakes.

Notwithstanding this recovery, the basin ecosystem has evolved well beyond its historic natural state. If the Great Lakes will never be returned to their pre-industrial state, what state or condition is achievable and acceptable? How will the *Great Lakes Water Quality Agreement* purpose to protect and maintain biological integrity be determined, if that condition is undefined? To answer these questions the U.S. and Canada needs a shared vision for the lakes that is supported by long-term management objectives. For example, more integrated binational approaches to water quality management, addressing such primary topics as nutrients, contaminants and land use, could be identified that would enable the ecosystem approach as perceived in the 1978 *Great Lakes Water Quality Agreement* to be fully realized. An example of a long-term management objective might be the reestablishment of locally extirpated top predators, as a prime indicator of sustainability.

New Policies

Policy approaches since the 1972 Great Lakes Water Quality Agreement have followed three distinct iterative approaches: the 1970s marked the adoption of the regulatory system, the 1980s introduced the concept of pollution prevention, and the 1990s was characterized by the integration of economy and environment decision making and the development of global protocols. Beginning in the late 1990s and continuing today, the emergence of the precautionary principle heralded a new policy approach, to address those instances where decision making cannot be supported by scientific certainty.

The areas of binational opportunity and importance for the Great Lakes region to be a policy leader are numerous. Several of the most prominent include: agricultural policy focusing on manure management and pesticide controls, control of alien invasive species, improved nutrient control, chemical emissions releases and landscape restoration. Yet despite this list, and the emerging importance of multilateral policies that are global in scope that have impact on the Great Lakes, there is no one institutional mechanism for policy development or consensus that is effective on a binational basis to address policy opportunities for the Great Lakes.

5.2.3 Future Challenges

One interesting outcome of the discussions was that no truly new, previously unidentified, threats to the Great Lakes emerged, perhaps suggesting that there are current mechanisms in place to adequately identify emerging issues, and that future problems of the Great Lakes will be continuations or permutations of those issues that we are already aware of. This could be primarily a result of our inability to adequately address these issues currently, or in the past.

While these topics are not new, there are some interesting "twists" to them that indeed make them important considerations for the future. The list of contaminants in the Great Lakes is a dynamic one, and not simply the IJC list of critical pollutants or the Tier I and Tier II substances from the Binational Toxics Strategy (Canada and U.S., 1997). Several new classes of chemicals have been identified by researchers to be present and persisting in the Great Lakes. As commerce changes, so do the chemicals in our environment. It is anticipated that we will continue to see new chemicals in the Great Lakes. It is noted that both Parties have programs in place to identify substances that may be released into the environment and that show persistent, bioaccumulative or toxic properties singly, or in combination.

Present chemicals as well as these new chemicals may exert new kinds of deleterious effects on fish, wildlife, and potentially also on humans. Researchers are reporting that many chemicals that were associated with the endpoints of mortality and population extirpations are now exhibiting

subtle sub-lethal effects that are insidious and difficult to assess. For example, many compounds can impair or disrupt the endocrine system, interfering with proper development, reproduction and growth of certain species. Even more disconcerting is that fact that many of these effects do not exhibit a linear dose-response, so that declining concentrations of current chemicals may not always result in a decline of adverse effects. On the contrary, what is observed in some cases is the emergence of a new endpoint that was masked by a more evident effect caused by higher concentrations.

Inputs of nitrogen and phosphorus from point sources have been regulated for decades, but the loadings of nutrients from nonpoint sources still results in excess ambient water concentrations. Major sources of these nonpoint inputs are agricultural operations, both crop-based and animal-based. Runoff and animal manure disposal and treatment are not well regulated or controlled. In addition, nutrient cycling is not fully understood, as evidenced by the recent hypoxia trends in the Lake Erie central basin.

The majority of scientific opinion supports the concern that anthropogenic-induced climate change is affecting chemical, biological and physical aspects of the Great Lakes. Future effects that have been identified include the impact on lake levels. Another significant effect will be the impact of warming on biological community structure. Changes in either fish predator species or algal assemblages will further impact other trophic levels through top-down and bottom-up effects. Finally, warming of the Great Lakes will result in greater evaporation of semi-volatile compounds from the water column, which will accelerate the rate of leaching from sediment reservoirs to the water column.

The control of exotic species that have been introduced to the Great Lakes ecosystem have been and will continue to be a major challenge for resource managers and for Great Lakes communities. The current efforts to prevent further introductions have not been effective, however, as the current rate of new introductions is about two species per year.

Exotic species introductions often lead to changes in the biological community structure, and changes within the entire food web. These changes can cause instability in the overall ecosystem. Some changes have no clearly understood cause, such as the decline of *Diporeia* in all of the Great Lakes, with the exception of Lake Superior. Such stresses are anticipated in the future and may be due to combinations of stressors.

Finally, the impact of future increases in population and the growth of urban areas within the basin will inevitably lead to continued shoreline development, increased runoff, increased air pollution from increased vehicle distance traveled, energy demands, etc., and increased loss of fish and wildlife habitat including wetlands.

These future challenges are summarized below in terms of findings, which reflect important insights and discussion, and recommendations, which reflect specific initiatives and approaches.

5.2.4 Findings

Long-term objectives for recovery are necessary to achieve future progress in restoring and maintaining the chemical, physical and biological integrity of the waters of the Great Lakes basin ecosystem. The *Great Lakes Water Quality Agreement* should be reexamined in light of these objectives. The reestablishment of some native species could be one such objective - recognizing that many native species will have to be introduced and that restoring the Great Lakes to an historical natural ecosystem will not be possible.

Institutional effectiveness is impeded by a multitude of agencies and organizations fulfilling their own objectives with insufficient coordination, in the absence of shared long-term goals and strategies, and according to disparate visions.

A renewed sense of shared purpose is needed that delineates the image of the basin as a total system, that people accept collectively, and that has personal relevancy. No one vision of the Great Lakes may be attainable, or practical, because of the importance of this vast resource among many users. The challenge for the future will be to develop a process, or a forum, where shared values can be discussed, and decisions made to protect and maintain the high natural amenities that sustain the use and enjoyment of the resource. If expressed as a key question, it is "how do we organize ourselves to deliver an ecosystem approach?"

Greater integration is needed to address the tendency of the current practice of science and policy to be over-compartmentalized, with policy frequently lagging behind current scientific understanding. The goals and purpose of the *Great Lakes Water Quality Agreement* cannot be achieved until greater integration occurs, for example, in relation to policy decisions that affect the interface of land and water, or in the case of the environment and the economy.

A*dditional formal binational programs* are necessary to contribute greater inter-operability to the institutional framework, building on examples such as International Air

Deposition Network and the Binational Toxics Strategy (Canada and U.S., 1997).

Greater institutional capacity to coordinate and integrate roles, responsibilities and decision making to provide greater accountability among all levels of government is required. Policy making in the future will increasingly depend upon on a hierarchy of global, continental, national and local initiatives employing a wide variety of principles, instruments, methodologies and processes.

Major reinvestments in scientific infrastructure for the basin are required to provide improved monitoring and more importantly, to develop a *capability for ecosystem forecasting*. Decisions that impinge on Great Lakes water quality cannot be made wisely on the basis of current information, especially due to its lack of integration. New technologies have the potential to attain forecasting capability through the innovation of continuous real time monitoring employing integrated observation and monitoring systems. Such capabilities hold major promise for managers and decision makers to "get ahead of the problem curve" and to be truly proactive. The identification of new effects requires *greatly enhanced monitoring, data sharing and ecosystem forecasting*. Greater access to data; better basin wide data management; and detailed basin-wide, *binational scientific assessments* are needed to interpret and coordinate effects based research that encompasses an ecosystem approach.

Superior data management to inform decision making and reduce scientific uncertainty of a decision will be required for future policy making. The model for this capability exists with Statistics Canada, whose singular role is to provide high quality information and interpreting the data for decision makers, while maintaining confidentiality. There is considerable merit in developing a binational institution to collect, store and manage high quality Great Lakes information to support agency policies and programs, as well as *Great Lakes Water Quality Agreement* activities.

Superior data management to inform decision making and reduce scientific uncertainty of a decision will be required for future policy making. The model for this capability exists with Statistics Canada, whose singular role is to provide high quality information and interpreting the data for decision makers, while maintaining confidentiality. There is considerable merit in developing a binational institution to collect, store and manage high quality Great Lakes information to support agency policies and programs, as well as *Great Lakes Water Quality Agreement* activities.

New chemicals of concern are being identified through the development of screening assessments using Quantitative Structure Activity Relationships, the use of release inventories to identify high production volume chemicals and advancements in analytical methodology and equipment have resulted in improved capabilities to identify new classes of chemicals of concern in the Great Lakes. However, exposure assessment and effective monitoring is still needed to evaluate the significance in terms of Great Lakes water quality. Analytical method development needs to keep pace with the identification of new substances.

An urban renaissance is underway based, in part, on the value of the water resource to impart the qualities of the natural environment within the developed area. A fundamental tenet of that renaissance is creating the conditions for the natural environment to reestablish itself in harmony with the built environment. Developed waterfronts present unique opportunities for this to occur, and especially to bring natural amenities into the core of the city. Encouragement and innovation at the site level is evident through the *adoption of green design concepts*, such as the Leadership in Energy and Design principles, which could comprise further opportunities for extension into broader policy principles at the basin level.

Three key Great Lakes policy challenges will be increasingly relevant over the next 25 years: *agricultural policy* will need to move beyond developing "farm nutrient management plans" to consider manure, primarily, as a waste to be managed rather than as a source of nutrients; *treated waste water* will need to be reused and recycled; and, finally, *environmental and economic considerations* must be better integrated into policy decisions.

Broader ecosystem based management strategies are needed in order to manage resources, such as the fishery, to maintain biodiversity and to support land-use decision making. Centers of biological organization such as the Biodiversity Investment Areas identified by State of the Lakes Ecosystem Conference, need to be vigorously protected and maintained. It is theorized that *the future ecology of the Great Lakes may be unpredictable because it is unstable*, based on the scientific understanding that a well-functioning ecosystem hierarchy has few surprises. Biological integrity, and how to achieve it, is not scientifically well defined or understood, however the importance

of higher levels of organization to impart a stability and regulatory constraint on the entire system was further theorized. It was speculated that the loss of biological integrity of the Great Lakes was a critical aspect of a lack of ecosystem integrity and stability.

Introductions of alien invasive species urgently require the development of better science and technology *to identify and treat pathways to the lakes,* such as ballast water, and to manage undesirable introduced species. Invasive species are a characteristic of disturbed systems, with accessible aquatic environments such as the Great Lakes most vulnerable. Once introduced, invaders permanently change the ecosystem, and defy management.

5.2.5 Recommendations

The SAB recommends the following to the IJC.

- **Recommend that the Parties conduct a comprehensive review of the operation and effectiveness of the *Great Lakes Water Quality Agreement*, and seek public input, with a view to substantially revising it to reflect a current vision of water quality goals, priorities and institutional arrangements. Such a review should also consider greater accountability for implementation and for measuring progress, including a schedule of priority actions deemed essential to achieve important water quality goals.**

- **Recommend that the Parties develop an ecosystem forecasting capability within the auspices of a coherent binational monitoring, information and data management policy and infrastructure for the Great Lakes to inform management and decision making, and to provide for greater public accountability in reporting progress.**

- **Recommend that the Parties establish a binational Integrated Great Lakes Observing System as a key element of major reinvestment in Great Lakes scientific infrastructure and to provide high quality scientific information for policy decisions.**

- **Recommend that the Parties establish an "International Field Year for Great Lakes Research" as a special five-year program to improve the knowledge and understanding of the Great Lakes basin ecosystem.**

- **Ensure that the Parties:**
  - **provide for adequate bilateral mechanisms to identify and monitor previously undetected chemicals in the environment.**
  - **develop and implement strategies that use Quantitative Structure Activity Relationships to assist in the earlier identification of potential chemicals of concern.**
  - **increase their support of the development and validation of Quantitative Structure Activity Relationships to promote the cost effective use of chemical testing resources.**
  - **establish early notification processes between researchers and regulatory officials to minimize the possible injury to health and property as a result of the presence of new chemicals.**

- **Recommend that the Parties further develop binational institutional mechanisms to enhance bilateral cooperation and coordination for air, land and water management in order to implement a truly ecosystem approach for water quality management that involves local, state/provincial and federal governments.**