PRIORITIES
2003-2005
Priorities and Progress under the Great Lakes
Water Quality Agreement
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Report to the International Joint Commission by the
Council of Great Lakes Research Managers

CHAPTER INDEX Council of Great Lakes Research Managers

INTRODUCTION

The Council of Great Lakes Research Managers (Council) advises the International Joint Commission (IJC) on matters related to Great Lakes research programs and needs. Created by the IJC more than 20 years ago, the Council serves to enhance the ability of the IJC to provide effective leadership, guidance, support and evaluation of Great Lakes research. In particular, how research within the Great Lakes satisfies the requirements and intent of the Great Lakes Water Quality Agreement (Agreement). The responsibilities of the Council include:

- promoting effective communications, collaboration and coordination between researchers and agencies in Canada and the United States;
- encouraging researchers to share their findings, through common reporting mechanisms, with basin policymakers, resource managers and the public;
- stressing the policy implications of research findings;
- compiling and summarizing current and planned research programs related to the Agreement; in particular those required by Annex 17 – Research and Development;
- identifying and prioritizing research needs to encourage the U.S. and Canadian governments to shift funding towards studies directly relevant to the Agreement's purpose; and
- reviewing the impact of research recommendations made by itself, the Great Lakes Science Advisory Board, the Great Lakes Water Quality Board and the IJC.

Council membership consists of individuals that manage federal, state and provincial research programs in the United States and Canada, as well as representatives from academic institutions and private industry. Representatives of the Great Lakes Fisheries Commission and the International Association for Great Lakes Research also participate. All of these individuals serve in their personal and professional capacity at the pleasure of the IJC, usually for terms of three years.

During the 2003 to 2005 IJC priority cycle, the Council focused much of its effort on two activities that directly relate to Annex 17 of the Great Lakes Water Quality Agreement – Research and Development and Annex 11 – Surveillance and Monitoring. These were the development of a strategy to coordinate Great Lakes research and the formation of an integrated Great Lakes observing system. During this same period, the Council also continued its collaborative efforts with the Science Advisory Board and the Water Quality Board to identify new priorities and to identify areas of the Agreement affected by advances in science and the understanding of the Great Lakes ecosystem. In addition, the Council further developed the Great Lakes – St. Lawrence Research Inventory, promoted coordination of science vessel operations and organized workshops at the State of the Lakes Ecosystem Conference and the 2005 Great Lakes Conference and Biennial Meeting in Kingston, Ontario.

Two major workshops on the research coordination strategy and the future of open water observation technology resulted in excellent advice and guidance from Council members

and participants. Proceedings from those workshops are provided in separate publications by the Council; however summaries of both are included in this report. These two workshops provided excellent advice and direction to inform the Council's advice to the IJC; however much remains to be done to refine the vision, implement recommendations and to unify efforts on these two activities. The success of these two initiatives will greatly improve our ability to effectively focus monitoring and research efforts to address critical scientific questions leading to a better understanding of the Great Lakes environment. A fully integrated network of sensors to "take the pulse" of the Great Lakes will alert us to changing conditions, better inform management and policy decisions and eventually enable scientists to forecast the impact of human activities, climate change and emerging stressors on the ecosystem.

The Council of Great Lakes Research Managers wishes to acknowledge the efforts of all those who lent their support to the Council during the past two years. The USEPA support staff at GLNPO especially Pranas Pranckevicius; Amber Lahti and Angie Wagner from the Upper Lakes Environmental Research Network, the support staff of GLERL and the IJC Great Lakes Regional Office, in particular Ms. Laura Newlin, Giovanna Stasiuk, and Jill Mailloux for their technical support and efforts to coordinate workshop logistics, the Great Lakes Commission in particular Roger Gauthier and Jon Dettling, Dr. Tom Johengen with the Alliance for Coastal Technologies and Dr. Guy Meadows with the University of Michigan. The efforts of all of these individuals, along with the Council members who volunteered many hours to help to plan, lead and document the proceedings of workshop sessions. All contributed to the success of Council activities and to the content of this report. Their assistance is greatly appreciated.

DEFINING A RESEARCH COORDINATION STRATEGY FOR THE GREAT LAKES

The Great Lakes Research Coordination Strategy workshop was held at the U.S. Environmental Protection Agency's Great Lakes National Program Office in Chicago from April 28 through the 30th, 2004. There were 33 attendees representing both U.S. and Canadian organizations throughout the Great Lakes basin. This included 14 members of the Council of Great Lakes Research Managers (CGLRM).

The need for improving overall coordination of Great Lakes, Coastal and Ocean activities has been emphasized repeatedly during the past few years in reports from the IJC, the U.S. Government Accountability Office, the Canadian Auditor General, the Pew Oceans Commission and the U.S. Commission on Ocean Policy. The CGLRM chose this issue as a priority activity for the 2003 -2005 reporting period, recognizing the opportunity for the two governments to address improved research coordination during the upcoming review of the Great Lakes Water Quality Agreement.

The purpose of the workshop was to address the need for a binational Great Lakes research coordination strategy. This was defined as an overarching framework for Great Lakes research management and a mechanism for international cooperation to describe

how the region will collaborate, organize and coordinate large scale research projects. The workshop provided a basis for Council advice and recommendations to the International Joint Commission.

The workshop was organized in two sessions. The first day and a half public session consisted of U.S. and Canadian perspectives on regional coordination. Presentations were made about lessons learned from regional or problem driven coordination efforts, lake-wide coordination efforts and collaborative approaches. During the two half-day sessions that followed, members of the CGLRM and other advisors met to identify the elements of the research strategy and how to move forward with the initiative.

Findings:
The goals of the strategy should include: promoting effective collaboration, avoiding duplication, applying a holistic ecosystem approach and effectively communicating science with a consistent message throughout the basin. The strategy will promote and facilitate collaborative research proposals and provide for an informed research funding process that can address all categories of research in a strategic, effective and flexible manner.

An effective research strategy should include the following attributes:

- Guiding principles
- Clearly defined terms, roles and processes, including a list of cooperating agencies and organizational chart(s).
- A role for a key coordinating body
- A communications plan or sub-plan regarding how agency plans will be communicated to all participating agencies around the basin and how urgent issues/needs will be communicated to the public and decision makers.

The plan should address requirements for effectively carrying out both long term projects and short term thematic or problem driven research involving rapid response and pooling of resources. The strategy should take advantage of existing organizations and avoid reinventing things that are working well. It should also address the process of setting research priorities; providing some basic principles, structure, and mechanics of how priorities are looked at and set.

Three sources of research should be addressed:

- Management driven research (focused on recognized needs);
- Thematic issues (not yet recognized by managers);
- Emerging issues (the surprises)

The workshop participants used a process employed by the Lake Erie Millennium Network (LEMN) to identify specific activities that should be incorporated in the research coordination strategy. The LEMN process is defined by addressing a series of questions regarding the origin and fate of ideas about areas of research to be pursued in the Great Lakes basin.

LEMN Process Questions:

1. Where will the ideas come from?
2. Where will the issues come from?
3. Who will synthesize the ideas into a theme?
4. Who will promote the theme?
5. Who will advertise the theme and get participants?
6. Who will organize the logistics of the theme?
7. Who will coordinate the resources?
8. Who will coordinate the reporting/databases, etc?

Session Results

1. Where will the ideas come from?

Three sources of research typically drive activity in the region. Management driven research ideas come from well recognized needs such as fisheries management and control of lamprey. Thematic research ideas come from issues such as chemicals, pathogens, invasive species, habitat loss and anthropogenic effects that are not fully understood. Emerging issues are surprises, such as unexpected bird and fish kills that need to be studied in order to answer public concerns and to inform management decisions. Recommendations from participants included:

- Consulting with Science Advisory Groups (expert consultations);
- Developing a stable funding source for Great Lakes research workshops;
- Coordinating with existing workshops/conferences such as those sponsored by the International Association for Great Lakes Research (IAGLR); Sponsoring new research oriented thematic workshops;
- Using the internet to gather input from “Cyber Seminars”.

2. Where will the issues come from?

An effective communications plan should be used to ensure rapid and effective communication at all levels. Researchers in touch with what is happening in the field need to be assured that new ideas will receive the attention and full consideration of decision makers. It was recommended that the strategy include developing a well known forum where people know they can bring an idea that will be discussed through the entire Great Lakes community.

3. Who will synthesize the ideas into a theme?

The outcome of the workshops, cyber seminars and teleconferences would be a recommended research theme that could be considered for funding.

4. Who will promote the theme?

Participants suggested this as a possible role for the CGLRM, as well as facilitating peer review, media events and other public promotions.

5. Who will advertise the theme and get participants?

It was recommended that the CGLRM serve as a “Clearing House” where Requests for Proposals (RFP's) from agencies could be easily accessed and publicized using the Council website. The CGLRM list server could be used to advertise when and how

RFPS would be released; early pre-award planning information. Partnerships would be formed with existing research consortiums, academic institutions, the Great Lakes Commission, the Council of Great Lakes Governors, individual government agencies and non-governmental organizations to gain broad support.

6. Who will organize the logistics of the theme?
Recommendations included: contracting with experts from the scientific community, designating a separate coordinating entity at the choice of partnering agencies that would be structured to receive funding, partnering with private industry and equipment suppliers. It was also suggested that existing agency logistics personnel and database managers be utilized as much as possible, with well-defined work plans, timelines and funding.

7. Who will coordinate the resources?
Recommendations for resource coordination included the CGLRM as a workshop sponsor, forming a committee to coordinate Great Lakes Resources and a coalition of agency heads. It was suggested that the Council consider the National Oceanographic Partnership Program as a model interagency working group for this purpose.

8. Who will coordinate the reporting/databases, etc.?
It was recommended that a portal for data housed at other agencies be provided and that the strategy align with the data management plan for the Great Lakes Observing System (GLOS). In addition, it was recommended that the CGLRM or a reformulated research coordination council be established where issues & themes (for example from a workshop) could be reported. The coordinating body would discuss the pros and cons of the workshop recommendations; obtain a consensus; identify agencies that wish to contribute and funding sources. The result would be a truly coordinated research project that could be of substantial scale.

Future Plans
The Council members decided to incorporate the attributes described above in a draft research coordination strategy. Further collaboration with the Great Lakes Fisheries Commission in finalizing and implementing the strategy will be explored. Workshops and further meetings will be organized to gather input on the draft strategy, examine how efforts should mesh with those of the Great Lakes Regional Collaboration and to address a test case project will be carried out during the upcoming year.

Recommendation
Rather than providing a “laundry list” of research topics as currently found in Annex 17 of the Agreement, potential revisions to the Agreement should mandate a process aimed at identifying and addressing key scientific questions as well as informing management and policy decisions. A clearly identified coordinating body should also be designated in the agreement with a responsibility to provide an open forum for communication between scientists and granting agencies, to maximize collaboration and effective use of resources.

The Council recommends the following to the IJC:

- Recommend to the Parties that the U.S. and Canadian governments consider including a research coordination process with a role for a central coordinating body as part of a revised Great Lakes Water Quality Agreement as the two governments proceed with the review of the agreement.

THE FUTURE OF OPEN WATER OBSERVATION TECHNOLOGY FOR GREAT LAKES RESEARCH

After extensive planning, the Council, in partnership with the NOAA Great Lakes Environmental Research Lab hosted The Future of Open Water Observation Technology for Great Lakes Research workshop in December 2004. More than 60 participants convened at the workshop in Ann Arbor, Michigan to discuss the potential of recent developments in open water observation technology to impact the way scientific research is conducted in and about the Great Lakes. Over the course of this four-day event, participants shared new ideas and developments; discussed challenges and opportunities; and brainstormed ideas regarding collective actions and future directions.

In numerous presentations, leading experts on open water research—from both the Great Lakes and other regions—discussed the current state of monitoring technologies for open water systems and the promise of several emerging technologies. Considerable attention was given to the relative costs and benefits of implementing each of these technologies on a wider scale in the Great Lakes. Such technologies included a wide variety of monitoring options, including moored buoy systems, autonomous vehicles, ship-based observations, satellite/aerial imagery, and many others. The workshop presentations resulted in a clear view of what observations are currently being conducted over the Great Lakes, what research questions are being addressed, what additional options exist and what opportunities are emerging for enhancing over water observation systems in this region.

During a breakout session, the participants divided into sub-groups focusing on the physical, biological and chemical aspects of open water observing technologies. Each of these sessions focused on identifying fundamental research questions, required observation data, gaps in current monitoring systems, and the adequacy of current technology to fill those gaps. New sensor technology to gather additional data was recommended and areas were identified where new sensor technology needs to be developed. In addition, the participants brainstormed as a group on the ability of enhanced open water monitoring to fulfill the needs of restoration goals identified by the Council of Great Lakes Governors.

The results of the three breakout group discussions are presented below:

Physical Sciences

The physical sciences group identified the following key questions to be answered by a Great Lakes observing system. These were:

- How well are over-the-lake meteorological conditions measured and predicted by the current shore-based systems and National Data Buoy Center (NDBC) buoys?

- What are the dominant physical processes responsible for lateral and vertical transport on various spatial and temporal scales?
    - Seasonal overturn
    - Episodic events (e.g., eddies, passing storms)
    - Turbulence, internal waves
    - Effects of ice

- What are the impacts of changing ice cover on the thermal and hydrological budgets of the lakes? How will these change through time?

- Are we seeing long-term changes in the thermal structure and circulation dynamics of the lakes?

- What is the relationship of Great Lakes physical conditions to global climate dynamics (e.g., El Niño/Southern Oscillation (ENSO), North Atlantic Oscillation, etc.)?

- Are the sediment dynamics and budgets of the lakes changing?
    - Lakewide sediment budgets
    - Nearshore processes
    - River loadings

- How do nearshore sediment dynamics respond to meteorological conditions? What are the linkages to turbidity, light availability and substrate composition?

The group also discussed what physical data need to be collected by a Great Lakes open water observing system to answer these questions. The major types of physical data that must be collected include:

- Meteorological data
    - standard NDBC suite of sensors (also for waves)
    - precipitation and evaporation at offshore moorings
    - upward and downward radiation
- Temperature loggers
- Acoustic Doppler Current Profilers (ADCP)
- Pressure
- Light and turbidity
- Time-series sediment traps

The group agreed that there is an ongoing need to improve the standardization and comparability of physical parameter data in the Great Lakes. For many of the data types mentioned, it was agreed that a combination of spatially distributed and fixed-point data collection methods are needed.

Gaps in the current open water observing infrastructure were identified. Major gaps relative to the physical science needs identified above include:

- Lacking or insufficient wintertime observations; few, if any; measurements are taken when lakes are iced over.
- Lack of long-term moorings for water column measurements to be taken synoptically in all the Great Lakes.
- Lack of Autonomous Underwater Vehicles / Gliders, and the monitoring benefits these units provide
- Very few ship observations except for occasional regional initiatives
- No (or few) drifters or autonomous profilers
- No CODAR (coastal radar) measurements are being taken

The group identified a need for a more thorough and scientific analysis of current and potential monitoring systems. Through such an assessment, numerical models should be used to determine how many moorings, vehicles, etc. are needed in each lake to fulfill the identified needs.

There was consensus among the group that for the most part, current technology—if adequately implemented—is sufficient to achieve the scientific goals identified by the group. Some exceptions where technological advances are needed include:

- Evaporation and precipitation measurements on buoys are needed to ground truth remote sensing data.
- Higher frequency measurements of wind, relative humidity, and certain gases (e.g., CO_2) are needed in order to calculate fluxes at the air-lake interface.
- Instrumentation is needed that can measure suspended sediment concentrations in the water column, such as by acoustic techniques.
- Improved capabilities of CODAR systems are needed for freshwater, possibly involving use of higher power. Bi-static CODAR systems that include transmitters on buoys as well as on shore are another possibility.
- Operational hyper spectral satellite and Synthetic Aperture Radar (SAR) measurements are needed to measure ice cover, among other things.
- ADCP measurements are needed at the benthic boundary layer on a fine scale.
- Atmospheric deposition measurements need to be taken over the lakes.

Chemical Sciences

The chemical sciences breakout group began by describing the fundamental scientific questions related to lake chemistry that are to be addressed by an open water observing system. The prominent questions that were identified include the following:

- There is a need for a better understanding of the fluxes of chemicals across media, including air-water, sediment-water, and land-water. This is necessary for quantification of chemical mass budgets for the lakes and applies to wide range of Persistent Bioaccumulative and Toxic chemicals (PBTs), nutrients, microorganisms, carbon, etc. Quantifying these fluxes requires measurements at higher resolution.
- There is a need for better understanding of nearshore-offshore coupling and how it is influenced by physical processes.
- There is a need for better understanding of uptake pathways (pathways by which chemicals are taken up by biota). Identification is needed of the most important emerging chemicals on the basis of their in-lake effects. This also requires ability to measure chemicals in multiple phases, providing full speciation of congeners or enantiomers.
- The role of atmospheric inputs of nutrients on the trophic state of the lake needs to be better determined.
- Improved evaluations are needed of the temporal and spatial variation of atmospheric deposition of chemicals to the lakes.
- A better understanding is needed of the coupling of physical processes to chemical and biological processes. Quantification is needed of the spatial and temporal gradients in chemicals and how these are affected by physical processes.
- There is a need to quantify long-term trends in chemical concentrations in the lakes. The ability to elucidate long-term trends by measuring and understanding inter-annual variability is needed.
- Measurements are needed of the effects of short-term (potentially episodic) fluctuations in forcing functions (e.g., loads, solar radiation inputs, heat transfer, circulation, etc.) on system response variables (e.g., primary production, larval fish survival, etc.). A capability must be developed for these measurements to validate high resolution forecasting models.
- Mass balances of nutrients and toxic chemicals need to be determined, as do recovery trajectories and the long-term response of the system to historic loadings. Determining ultimate sources of chemicals to the lakes is needed, including proximate sources versus long-rage transport, and urban sources versus rural/background.

Following identification of the prominent chemical questions to be answered, the group developed a conceptualization of an open water observing system to address these issues. The major characteristics of this observing system identified by the group include:

- An integrated system of buoys, towers, shore installations, AUVs and Remotely Operated Vehicles (ROVs), bottom resting structures, sensor chains to capture vertical profiles, and sediment traps

- Installations able to capture three-dimensional gradients in both water and air above water, including measurements at various heights and depths
- System that provides high temporal resolution – from continuous to daily scales
- Systems might be laid along transects perpendicular to the shoreline (especially off major urban or tributary sources) that can capture signals of chemicals from these sources (both in air and water) and how they dissipate over distance from the source
- Measurements of tributaries to complement open water measurements in assessing mass budgets
- Sequential sediment traps to monitor sediment-water exchange
- Passive samplers for chemicals in air and water

The major chemical parameters to be measured by the open water observing system include:

- Nutrients: NO_3 by sensor; TP and PO_4, NH_4^+ and Si by Flow Injection Analyzers (FIA)
- Dissolved oxygen by sensor
- Fluorometric methods for chlorophyll and Dissolved Organic Carbon
- Carbon dioxide
- Persistent, bioaccumulative, and/or toxic substances (including hydrophobic organics, heavy metals, and pesticides (e.g., atrazine) using discrete sampling and passive samplers in both air and water
- Particulate matter by continuous measurement (turbidity, transmissivity) and discrete sampling
- Sediment traps (sequenced to capture temporal variability)
- Light (hyperspectral measurements) – depth profiles to assess vertical light extinction
- Three-dimensional wind profiles (sonic anemometer) with motion correction
- Relaxed Eddy Accumulation (REA); however this needs research and development

It was noted that for many of the parameters mentioned, sensors are available. However, many other parameters do not currently have sensors available. Therefore, sampling of water and other media for laboratory analysis will be required for the foreseeable future. Major technological advances that are needed to improve the capabilities for open water observing of chemical parameters include further development of:

- Relaxed Eddy Accumulation (REA)
- Fine-scale measurements without continuous sensors (e.g., FIA)
- Biological sensors (e.g., DNA probes, immunoassay techniques, gene expression arrays)
- For nutrients, nitrate sensors are available, but no sensors are currently available for phosphorous or silicon.
- Automated, miniaturized measurement systems with reduced power demands and reduced servicing needs (e.g., reduce fouling)

- Increased sensitivity and speed of analytical technologies

Biological Sciences

The biological sciences group discussed several major themes for the use of an open water observing system to answer questions concerning Great Lakes biological science. Major issues that were discussed during the session are the need for improved temporal and spatial scales, identification of the forcing functions in the system, and research into biocomplexity in the Great Lakes. Among major scientific topics that an advanced open water observing system could help improve human understanding of are: fish life cycles, fish production and relationships between habitat and water levels. An observing system will have important implications for connecting information across spatial and temporal scales.

Gaps that the group identified in current Great Lakes open lake monitoring systems include monitoring of nearshore areas (i.e., to 5 meter depth). These areas are sensitive and can be difficult to instrument. Remote sensing, aircraft imaging or LiDAR (Light Detection And Ranging) may be possible solutions. Remotely controlled devices could potentially be used to take fine scale water levels, vegetation, substrate conditions and temperature.

There is a need to relate physical-chemical structure (forcing) to biological community structure, such as through habitat-mediated affects.

It was noted that each of the Great Lakes represent different systems and processes may differ in each lake.

There is a need to connect physiology with ecology. An example is developing a better understanding about how fish and other aquatic organisms 'see' or sense their environment.

A thorough understanding needs to be gained of food web dynamics and well-functioning ecosystems (as opposed to non-functioning systems due to invasive species or disease). Trophic signatures can be used to determine if each system is gaining ground toward becoming self-sustaining. Characteristic signatures or indicators must be developed for each lake to determine lake health. For example, an indicator could be based on zooplankton size frequency and monitoring results could be compared to typical patterns to detect shifts toward larger or smaller populations. In this regard, a broad suite of indicators of ecosystem change must be identified. Addition important parameters include fish concentration and distribution at any time, fish movement around a lake, size of broodstock, and others.

An open lake observing system will be essential for detection of episodic events and the conditions leading up to it. The system will also allow better characterization of spatial

heterogeneity and patchiness of the system and relationships of heterogeneity to forcing factors.

There is potential for using spectroscopy for classification of plants and phytoplankton (species, physiological state) based on spectral signatures. Flow cytometry is an additional potentially useful tool for characterizing phytoplankton.

Open water observing also has considerable potential for improving understanding and prediction of harmful algal blooms. For example, sensors can be deployed to measure species composition, toxicity, and environmental conditions to determine ecosystem function signals (e.g., a shift to blue-green algae) and form predictive links to other forcing functions. Plankton counters would be particularly beneficial in this regard.

An open water observing system would also provide valuable information for determining interactions between the lakes. Intensive instrumentation in the connecting channels would provide necessary information on the boundary conditions, nearshore, river mouths, and nutrient loading/concentrations.

With the exception of satellite imagery, there is no biological data being collected at the same time, using the same technique, uniformly across all the lakes. Although it is clear that biological data is under-sampled, it has not been determined what the appropriate sampling rate is. Sampling needs to be more consistent. More samples over broader time-scales are needed to generate hypotheses. Wherever possible, the ability to view data in real-time presents a large advantage, and should be the preferred option. Obtaining sensor data in real-time allows the data to guide more intense (i.e., fine-scale, episodic) research.

The group agreed that current sensor technology is capable of achieving the majority of the needs identified. However, much of the current technology requires attended operations. There is a need for work on unattended, reliable, low-maintenance tools. Although these are being developed, their operational feasibility is untested. There are a host of new technologies in various stages of development.

Measurement of survivorship and recruitment of fish larvae are needed to predict year class strength. The variables needed to make this prediction must be determined. The observing system will provide valuable information for studying trophic transfer and parasite dynamics.

Additional biological questions that an observing system could help answer include:

- Why are perch populations thriving in one place and not in another?
- Why are salmon moving from Lake Huron to Lake Michigan?
- What are the essential driving forces for ecosystem change (e.g., climate change, land use, invasive species)?
- What is the primary production in each lake?
- What is the carrying capacity of each lake?

A preliminary list was compiled of technologies and characteristics that should be incorporated into a Great Lakes open water observing system to obtain adequate biological data. Identified components include:

- CTD, fluorometer, light, transmissometer, multi-frequency acoustics, in situ spectrophotometers
- Sensors in the offshore, nearshore, tributaries, and connecting channels
- Deployment patterns should vary by lake and be issue-driven (e.g., anoxia). For example, monitoring of sediment interface exchange is more important in Lake Erie and less in Lake Superior
- Benthic habitat mapping

Monitoring of benthic macroinvertebrates, such as through imaging or acoustics

How a Great Lakes Observing System will Help to Address Restoration Priorities

There has been an increasing amount of momentum across the Great Lakes region toward establishing a basin-wide restoration initiative. Draft legislation was introduced in Congress proposing to invest large amounts of money in a series of well coordinated efforts to overcome many of the basin's environmental challenges. To guide the process of establishing such an initiative, the Council of Great Lakes Governors established a Restoration Priorities Task Force, which issued a list of nine basin-wide restoration priorities in October 2003. During the afternoon of the workshop's third day, a group discussion session was held to identify the role of an open water observing system in implementing a large-scale restoration plan. In particular the group discussed the Council of Great Lakes Governors priorities and how each might be affected by an open water system. Each priority will require monitoring of baseline conditions and progress toward identified goals. Expansive and consistent measurements in the open water will be essential in this goal setting and tracking process. One of the Council of Great Lakes Governor's nine priorities, "Standardize and enhance the methods by which information is collected, recorded and shared within the region," is central to the observing system itself and was not discussed explicitly. The remaining eight priorities are:

- Ensure the sustainable use of our water resources while confirming that the States retain authority over water use and diversions of Great Lakes waters.

- Promote programs to protect human health against adverse effects of pollution in the Great Lakes ecosystem.

- Control pollution from diffuse sources into water, land and air.

- Continue to reduce the introduction of persistent bioaccumulative toxics into the Great Lakes ecosystem.

- Stop the introduction and spread of non-native aquatic invasive species.

- Enhance fish and wildlife by restoring and protecting coastal wetlands, fish and wildlife habitats.

- Restore to environmental health the Areas of Concern identified by the International Joint Commission as needing remediation.

- Adopt sustainable use practices that protect environmental resources and may enhance the recreational and commercial value of our Great Lakes.

For each of these priorities, the group identified the role of an open-water observing system in implementing actions to address the priority and specific measurements to be taken or characteristics of the observing system that will be required.

Water Diversions

An observation system would significantly improve estimates and understanding of the water budget within the Great Lakes. Cumulative withdrawals, inflows and outflows could be more thoroughly monitored and linked to water levels. Ecological impacts could be monitored and/or predicted from significant changes in water levels due to changes in natural cycles or as a result of withdrawals. The Great Lakes Charter Annex 2001 states that water use and diversions should have no detrimental impact on the ecology or waters of the Great Lakes. It is difficult to justify disallowing diversions without demonstrating that there is an ecological effect on the system. An observing system could identify ecological impacts of water withdrawal in the basin.

A recent study of biology-hydrology interactions in the Great Lakes examined the impacts of water withdrawals on the open lakes. It was identified that the largest amount of uncertainty in estimating impacts is in the nearshore and head-waters. An emphasis should be placed on changes in the nearshore zone, although implications can also be extended to offshore zones, such as deep water species that use near-shore areas for breeding.

Although there is currently a poor understanding of the major errors in the factors used in estimating evaporation, a thorough system of open water observations could improve this. Similarly, estimates of precipitation over the lakes are currently inadequate and could be greatly improved by enhanced over-water monitoring. Flow measurements can provide a more accurate baseline measure to gauge cumulative effects. Additional questions that might be answered include:

- What is the manifestation of water loss on offshore ecology?
- What is the impact of global climate change on water levels?
- Are there strategic times or places where impacts of withdrawals or diversions would be minimized?

Human Health

An advanced observing system would have significant implications for protection of the region's human health. Monitoring of drinking water sources for both accidental and purposeful contamination would be valuable. Monitoring and prediction of bacterial contamination at beaches is essential for providing accurate beach closures and warnings. Bacterial monitoring, offshore circulation and meteorology are essential for this purpose. In addition, improved identification of various E. coli strains and other coliform bacteria will lead to better predictions of human health impacts from beach bathing.

A better understanding of the air/water interface and atmospheric transport and deposition processes will provide more accurate contaminant loading estimates. Tracking harmful algal blooms will be possible with open water observations and models might be developed to better predict when these events might occur. Open water observations are also highly important for maritime safety, emergency response, and search and rescue operations, all of which relate to human health.

Developing a good open water observing infrastructure will provide a platform for the next generation of sensor technology to be developed. Additional technological developments that may emerge in coming years include the ability to identify and trace biological indicators of water quality. Developing a better understanding of open water ecosystems will allow detection of subtle changes in critical indicators caused by pollutants, pathogens and/or introduced toxins. Maintaining a healthy fishery is vital to enhancing human health in the region. Knowledge of fish location and migration can help improve prediction of fish contamination. This may be particularly important if aquaculture in the lakes becomes popular.

Non-Point Source Pollution

An open water observing system would increase measurements of material fluxes into and out of the lakes. This information could be used to better identify and pinpoint sources of runoff pollution, as well as to evaluate the effectiveness of control strategies. Identification of sources and source regions is an essential first step in pollution prevention programs. Monitoring information combined with improved tributary loadings would provide a better understanding of tributary and atmospheric loadings to the lakes. In addition to open water systems, it was recognized that thorough tributary monitoring would be required. In addition, high quality open water monitoring data could be used to integrate and evaluate the impacts of large scale land use decisions on water quality and to make predictions concerning long term impacts and recoveries.

Persistent Bioaccumulative Toxics

Consistent open water and over-water sampling for toxic substances would provide a baseline to assess the progress made by control measures. Measurements of the benthic flux of toxics (i.e., resuspension) by both biological and non-biological processes would provide essential information for understanding the cycling of toxic substances.

Improved understanding of trophic structures will greatly improve bioaccumulation models for these substances.

Recently developed technologies have great potential to improve persistent bioaccumulative toxic monitoring, both in the lakes and in the air above them. A spill detection system has been implemented on the St. Clair River (Sarnia-Lambton Environmental Association EARS system). Similar systems in numerous other parts of the Great Lakes at high risk of chemical spills would be valuable. Passive samplers have also begun to be used to monitor PBTs in ambient air. These have the potential to be adapted to buoys for over-water monitoring.

Habitat

To effectively protect, preserve and restore Great Lakes basin habitat, there is a need to categorize baseline information and to develop a scale to measure changes and evaluate the effectiveness of control measures. Remote observatories should be designed to assess habitats under restoration. Open water observations and satellite/airborne imagery could be used for habitat mapping and to determine the response of wetlands to water level changes. Such systems could also be used to measure the impact of restoration activities, such as the effects of new sources of clean water entering the system and benefits to the lake as a whole. Acoustic monitoring could be used to track fish populations. Improved understanding of habitat and ecosystem processes could have far-reaching benefits, such as the possibility of understanding and predicting situations that leads to botulism outbreaks and harmful algal blooms.

Restoring Areas of Concern

Although all Areas of Concern are in coastal or tributary areas, an open water observing system has several important implications for these areas. Predicting and measuring the impacts of restoration projects on open lake water quality is important. Measuring routine sediment disturbance and dredging disturbance will enhance understanding of contaminant cycling in Areas of Concern. There is currently poor monitoring of Area of Concern restoration after cleanup projects are concluded. Components of an open water observing system could partially make up for this shortfall.

Aquatic Invasive Species

Tracking the spread and quantifying the effects of aquatic invasive species can be greatly improved by open water observing systems. A system of open water observations would be an important management tool for assessing conditions, likelihood of invasion and survival of invasive species in specific sites. In addition, the system would provide a baseline and long-term understanding of the system. Routine monitoring is essential for early detection based on subtle ecosystem changes. Improved understanding of ecosystem structures might also reveal areas that are particularly sensitive to introduction and spread of invasives. In addition to monitoring in the Great Lakes, better global monitoring for invasive species is important.

Sustainable Use / Recreational and Commercial Value of the Great Lakes

Assessing the long-term sustainability of the Great Lakes ecosystem requires the types of monitoring data being discussed for the open water observing system. The system will provide both baseline data and data for measuring success of restoration action or further deteriorations. The system would provide long-term trends in biological inventories, and a large-scale, integrated and accurate assessment of the impacts of various Great Lakes uses. Modeling and analysis tools to support management decisions can also be implemented. The Great Lakes Observing System (GLOS) is fundamental to creating the capacity to forecast potential changes in the system resulting from use (and/or misuse) and changes to use patterns. This system will enable advanced forecasting capability. Distribution of data to the public in a productive and engaging way will help decision makers and the public understand the impacts of actions. The system must provide improved nearshore observations and forecasts. There could be a substantial spin-off of new products with commercial value from the system.

It was recognized that the Governors priorities are focused on ecological restoration and although they make reference to socio-economic aspects of the lakes, there are several Great Lakes issues that may be obscured or neglected by focusing discussion only on this set of priorities. Additional frameworks that may benefit from discussion include the seven societal goals recognized by the Global Earth Observing System of Systems (GEOSS) initiative and the Commission on Ocean Policy's recent report. Navigation is one area that could be critically improved by open water observing but is not directly reflected in the priorities discussion. Commercial shipping interests would benefit from near-term forecasts of water levels and meteorological data. Additionally, homeland security issues should be addressed. Sensors could be incorporated to detect bioterrorism and to track cleanup efforts, providing an incredibly useful tool for emergency responders.

Recommendations

The Council of Great Lakes Research Managers recommends that:

- The IJC recommend that the Parties consider inserting language into any proposed revision of the Great Lakes Water Quality Agreement that would provide for coordination of United States and Canadian participation in the Great Lakes portion of the Global Earth Observation System of Systems.

- The IJC actively support and participate in the implementation of the Great Lakes portion of the Global Earth Observation System of Systems and promote widespread binational participation from all agencies and organizations.

GREAT LAKES – ST. LAWRENCE RESEARCH INVENTORY

The Great Lakes – St. Lawrence Research Inventory (http://ri.ijc.org) is an ongoing responsibility of the Council. The Research Inventory is a web-accessible database of research projects conducted in the Great Lakes region that contains a brief descriptive

summary of each project. The data can be sorted in a wide variety of ways to identify studies of interest and contact information is provided to facilitate networking between Great Lakes researchers. A number of summary charts may be produced from the site to help characterize the distribution of projects and areas of focus. Registered users may enter data about their research project from anywhere using the internet. Each project is screened and validated by the CGLRM secretary; at that point sections of the Great Lakes Water Quality Agreement that relate to the project are noted and entered into the database. This enables the program to sort the data by sections of the Agreement. Together with summary data about the number of projects, geographic distribution and funding the Research Inventory can provide users with an indication of research emphasis in the region.
The Council is constantly striving to improve the user interface and utility of the Research inventory web site and to promote participation. The site currently houses summaries of over 740 current and past projects. During the past two years the program was enhanced with new user help features, access to individual project descriptions from summary charts, and new administrative functions to maintain data integrity. In addition, new program subroutines were developed that enable the CGLRM to modify and update inventory tables and to facilitate streamlined loading of projects from agency/university databases. These tools are intended to help provide the flexibility needed to accommodate changing needs.

Keeping pace with the growing number of project databases, building awareness of the Inventory and encouraging participation has been an ongoing challenge. In October 2004 in Toronto October the Council teamed up with representatives from Environment Canada to organize and coordinate a workshop at the State of the Lakes Ecosystem Conference (SOLEC) entitled “Monitoring Coordination and Information Management.” Participants were briefed on Canadian and U.S. Federal and provincial initiatives that are currently underway to inventory Great Lakes monitoring programs, archive and make data available on the internet. These efforts support several different programs including the Canada - Ontario Agreement, Lakewide Management Plans, the Great Lakes Binational Toxics Strategy and SOLEC. In 2004 the Binational Executive Committee launched the Great Lakes Monitoring Inventory on www.binational.net, and has adopted a basin wide rotational cycle for cooperative monitoring to address key information needs; to facilitate access and sharing of Great Lakes data.

The workshop reviewed the status and possible means of integrating these initiatives and prompted improved collaboration between agencies. In line with this effort, the Research Inventory has exchanged data with the Lake Erie Millennium Network and has agreed to exchange data with the Great Lakes Monitoring Inventory.

Other efforts underway include a project to collect and verify the aquatic invasive species projects in the inventory. The project will report on the temporal patterns of funding for work on aquatic invasive species in the Great Lakes basin over the past five years. A “Marketing Plan” has been created for the Research Inventory and outreach efforts were conducted at the IAGLR conference in May 2005.

Recommendation

Since the Council's September 2003 Priorities Report, the number of projects in the inventory has grown from approximately 570 to 740, however the voluntary nature of the inventory, the lack of incentives and resource limitations continue to limit participation. Accordingly, the Council recommends the following to the IJC:

- Recommend to the Parties that organizations granting funds for Great Lakes research be encouraged to routinely utilize the Great Lakes – St. Lawrence Research Inventory as a tool to help target research dollars and that researchers and managers be given incentives to participate with the inventory.

SCIENCE VESSEL COORDINATION

Background

Science vessels are used throughout the Great Lakes and in the St. Lawrence Seaway for research, training and outreach by public agencies, academic institutions and private industry. They are a critical part of Canadian and U.S. research and monitoring programs targeted at protecting the quality of the Great Lakes ecosystem. There are currently 68 science vessels active in the Great Lakes and St. Lawrence. These vessels come in a wide variety of shapes and sizes, but average around 60 feet in length. The average vessel is more than 30 years old, much older than typical commercial fleets. The 40 different agencies, universities, other organizations and the crews operating these ships should be praised for their ability to maintain such a long service life. Even with the best care, ships eventually need to be replaced; however only a few new or rebuilt ships have been launched in recent years. Maintaining existing ships typically places the biggest demands on research budgets and therefore significant cost savings may be achieved through measures to share resources and more efficiently carry out shipboard operations.

To promote better coordination of efforts, annual science vessel coordination workshops have been held since 1997. These workshops have been organized by a steering committee comprised of members from the Great Lakes Commission, USGS Great Lakes Science Center, NOAA Great Lakes Environmental Research Lab, Ontario Ministry of Natural Resources, U.S. Environmental Protection Agency's Great Lakes National Program Office, Department of Fisheries and Oceans, Buffalo State College Great Lakes Center, Grand Valley State University, the University of Wisconsin Milwaukee Great Lakes Water Institute, the Canadian Coast Guard and the Council.

An action plan created in 1997 has served as a guide throughout the process. The workshops have provided an excellent forum for the exchange of ideas and over the years have focused improvement efforts in three areas: advocacy, standards development; and marine personnel requirements. This effort has evolved into the Great Lakes Association of Science Ships (GLASS) and work groups have formed to address administrative needs, vessel utilization, standards development and personnel issues. In addition, a

science vessel web page has been established (www.CanAmGLASS.org), which hosts an interactive science vessel database containing comprehensive information on each science vessel in the Great Lakes.

Workshops

The Eighth and Ninth Annual Great Lakes Science Vessel Coordination Workshops were both held in Traverse City, Michigan in partnership with the Great Lakes Maritime Academy (GLMA). This enabled the workshop organizers to act on recommendations from previous workshops by taking advantage of the excellent training facilities made available at the academy. Participants were first offered a choice of marine engineering training sessions at the GLMA during the Eighth annual workshop and this aspect of the program was so popular, it was decided to repeat the same type of program in 2005. The workshops also provided an opportunity for participants to discuss recent successes, such as the Teacher Education Initiative, the use of new technology, like Remotely Operated Vehicles; and opportunities for collaboration. The roles of the NOAA and Environment Canada scientific support coordinators were discussed as well as public outreach activities carried out by university sponsored vessels. Partnership opportunities with Chicago's Shedd Aquarium, the new Great Lakes Maritime Heritage Center, and a unique research program being carried out on the sea cadet vessel, Pride of Michigan were also highlighted during these workshops.

Partnerships & Outreach

The 2005 workshop made a concerted effort to draw in support from the Great Lakes Captain's Association (GLCA) by coordinating the workshop with the GLCA Industry Days program. This initiative, as well as the high quality training opportunities available at the Great Lakes Maritime Academy has increased workshop participation. Future plans call for a workshop session to be held in conjunction with the 2006 International Association for Great Lakes Research conference scheduled in Windsor, Ontario as well as another joint GLASS/GLCA event in Traverse City. Outreach activities include production of a Great Lakes science vessel brochure, and a professional-quality display that can be used at conferences to raise awareness about science ship coordination efforts. This display was produced in cooperation with NOAA GLERL staff and first used at the 2005 IAGLR Conference. The web site continues to attract public attention with an average of more than 350 hits per month and over 7000 hits in the past 18 months.

Recommendations

The Council recommends the following to the IJC:

- The International Joint Commission maintain their support for improved communication, coordination and utilization of science vessels through continued funding for coordination workshops sponsored by the IJC's Council of Great Lakes Research Managers.

- The IJC urge the governments of Canada and the United States to significantly increase their investment in Great Lakes research, scientific technology and research vessel fleet modernization to support the goals of the Great Lakes Water Quality Agreement.

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