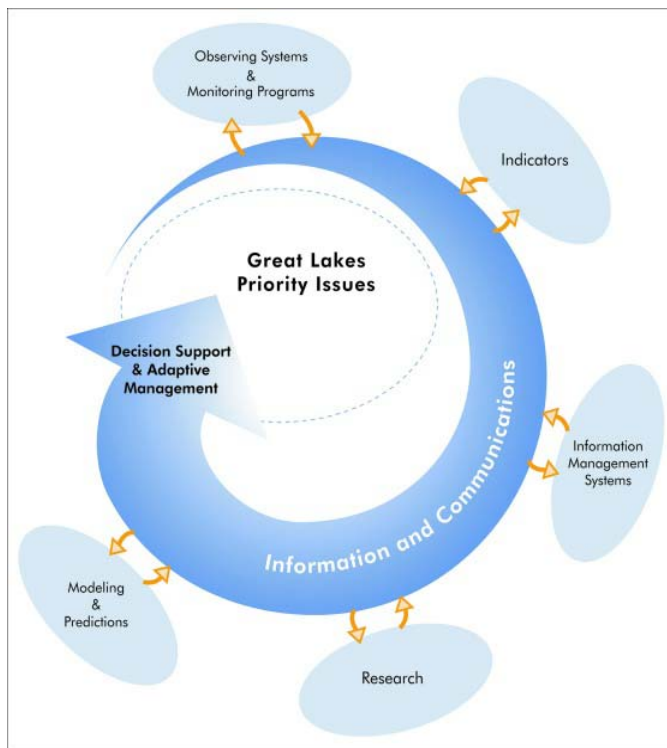


Great Lakes Regional Collaboration Indicators and Information

Problem Statement

Management, protection and restoration of the Great Lakes ecosystem require coordinated decisions and actions that are based on the best obtainable scientific and supporting environmental information. Unfortunately, ecosystem monitoring, observation, research, indicator development and modeling efforts in the Great Lakes region are currently underfunded, lack comprehensive ecosystem approaches and often exist as piecemeal programs. The information and communications systems currently in place are not sufficiently integrated and coordinated to support regional decision-making in a timely, cost-effective manner. The volume of data collected for the Great Lakes and their tributary watersheds has expanded considerably in recent years. This situation has affected each of the other seven issue areas (non-point source pollution, toxic pollutants, aquatic invasive species, habitat and species, areas of concern, sustainable development, and coastal health). The complexity in making management decisions has increased because all of the seven priority issues are interrelated.

Data are not adequately organized, standardized and integrated to produce concise and accurate information. All too often this information is not easily accessible or understandable by differing stakeholder audiences within the region. The lack of integrated information and communication within the region limits decision-making ability and application of adaptive management principles to protecting and restoring ecological resources. Adaptive management is based on identifying priority issues, gathering of information, establishing metrics, formulating options, implementing actions, tracking progress, reevaluating actions based on observed responses, communicating results and adjusting both management and monitoring based upon revised management decisions.



Not all decision-makers and stakeholders approach a problem with the same needs and goals to achieve the desired results. Decisions made on one issue frequently affect other issues. Development of information and communication approaches should accommodate these diverse needs.

For this discussion, information and communication needs are addressed as components in an integrated process focused on priority issues. These components include observing systems, monitoring programs, indicators, modeling and analysis, information management and communication. Additional needs for research to improve each of these components are critical. The adjacent figure depicts these relationships. The information and communication components are not distinct, but interact significantly and build upon each other to provide a basis for scientifically defensible decisions, actions and accountability for Great Lakes management.

Observing components, including sensors, stations and networks, are the primary means for gathering information on the chemical, biological and physical characteristics of the Great Lakes ecosystem. These observations are used in a host of monitoring programs to take the pulse of the Great Lakes, assess natural variability, drive ecosystem forecasting models, and assess the progress of restorations efforts. Current challenges facing observing and monitoring include: incomplete inventories of federal, state/provincial and municipal observation and monitoring activities; insufficient spatial density of basic observations across the system; incomplete coverage over varying time scales (real-time to historic) and over space (site-specific, watershed, and region-wide); a lack of reliable and consistent monitoring protocols; and, a lack of long-term financial commitments from partnering organizations. Additional observation and monitoring are particularly needed for the open lakes.

A comprehensive system of indicators is essential to provide information on the state of the Great Lakes, variations over time, and the progress toward achieving goals. A consensus opinion has not yet been fully achieved on clear, achievable and understandable endpoints for some sectors where indicators have been defined. Nevertheless, considerable progress has been made in developing a small yet comprehensive and scientifically-based set of indicators through the State of the Lakes Ecosystem Conference (SOLEC) process. Yet, often for indicators that do exist, there are multiple explanations to explain observed changes. This frustrates the ability to make indicator-based management decisions. Needs for additional indicators have been identified by other strategy teams, which require additional work to develop realistic endpoints, appropriate metrics and monitoring protocols. Securing financial commitments from organizations to undertake the scientific development, measurement, evaluation and reporting of indicators is a major limitation. Finally, stakeholders do not currently have easy access to indicator reports and findings, thus limiting their ability to participate in decision processes.

Integration and management of Great Lakes information is prevented by many technological, procedural, and policy constraints. It is often difficult to identify the existence, location and characteristics of data that are issue specific. Data quality is often not documented or communicated to data users, with new visualization techniques often providing a false impression of data accuracy. As a result, many critical environmental and resource planning decisions may be made using poor quality data. Universal implementation of standards for metadata (information about data) would resolve these problems, but production and maintenance of metadata is rare across agencies throughout the region. There is considerable variability in data formats and computing environments, which limits the interoperability of otherwise complementary datasets. Many institutions do not have the technological tools to implement data sharing protocols and applications such as Geographic Information Systems (GIS). Legal and institutional constraints, such as proprietary data and security provisions, can adversely affect information sharing. A lack of strong, formal data exchange partnerships among Great Lakes organizations underlies many of these constraints. The lack of a coordinated approach to multijurisdictional information management and sharing results in significant duplication of time, money and effort.

Various methods are used to communicate information developed from observing systems, monitoring programs, indicator development and testing and research, but these are not well integrated and coordinated. The lack of a coordinated message can make it difficult for audience groups to find and access needed information. The audiences that require information are also diverse, requiring that complex information needs to be sufficiently repackaged to meet their needs. The sheer breadth of information collected over the region further complicates the communication process. Some information, such as lake conditions and beach closings, also require rapid delivery. In addition, communications need to be two-way; the needs of users must be conveyed to those producing the information. A comprehensive, two-way communication strategy has not been developed to address all of these needs.

Great Lakes research provides the understanding necessary to make sound, scientifically supportable decisions and actions, to assess the associated risks, expectations and timelines of management actions, to

plan for effective observation and monitoring programs and to identify sensitive and meaningful indicators of ecosystem status. The current funding level for Great Lakes research does not sufficiently support the level of research and development needed to address the host of ecological issues currently affecting the system. Research has traditionally been focused on single issues. This focus must transition to an ecosystem approach with greater emphasis on predictive forecasting and adaptive management. Improvements in predictive capabilities are needed, particularly regarding the impacts of chemical, biological and physical changes on ecosystem structure and function. Improved observations within the system, enhanced monitoring programs, and new multidisciplinary approach to research would spur advances in adaptive management. Development of such capabilities is hampered by lack of a comprehensive research coordination strategy across agencies and partnering institutions.

Desired State

Strengthening our decision-support capabilities is the ultimate goal of the information and indicator tasks supporting the overall Great Lakes strategy. Management, protection and restoration of the Great Lakes ecosystem require coordinated actions and decisions based on the best obtainable scientific information. Chemical, biological and physical stresses on the Great Lakes ecosystem determine the need to make management decisions and implement actions. In the desired state, ecosystem monitoring, assessment, communication and research capabilities are fully funded and developed. Decision makers have access to and use this information to make sound scientific decisions from an ecosystem perspective. An integrated decision-support capability is in place to support movement towards consensus endpoints for ecosystem protection and restoration.

The desired state is likely a generation into the future, although progress can be made towards this end over the next five years. Substantial progress can be made in identifying priorities, gathering information, developing ecosystem understanding, assessing risks, establishing metrics and indicators, formulating and implementing actions, tracking progress, reevaluating actions based on the observed response, and communicating results. Decisions can be made more efficiently, cost-effectively, systematically and comprehensively if better information is readily available through a variety of communication mechanisms including distributed information architecture (i.e., network of interoperable servers). Such an approach would be more flexible and would not constrain the viewpoint of the user. It could offer enhanced abilities for multi-participant decision making, in which the needs and goals of diverse user groups can be assessed simultaneously to derive the most agreeable solution. Decisions could be improved to accommodate decisions both in real-time applications and long-term planning for sustainable use of the ecosystem.

A more spatially intensive observing network using state-of-the-art technology of Great Lakes physical, chemical and biological conditions could be deployed and information could be transmitted to receiving stations quickly and accurately. A comprehensive observation network for the Great Lakes would include the monitoring of all relevant ecosystem components at spatial-temporal scales needed to make decisions and track progress. Associated monitoring programs would have better defined protocols and standardized information for assessing changes over time. The observing systems and monitoring programs would need to be continuously improved to adapt to technological advancements and informational needs of Great Lakes resource management.

An effective, scientifically-validated system of indicators for the Great Lakes Basin could be further implemented to meet the needs of more user groups for accuracy, resolution and relevance to key concerns. A scientifically-validated system of indicators for the Great Lakes Basin would include a formalized approach for incorporation of new indicators and refinement of previously developed indicators. The indicator process would be supported by formal agency commitments. The indicator suite should be more accepted by user groups. Indicators would be organized and reported through a flexible

and accessible framework. In a truly adaptive management environment, changes in the status of an indicator should elicit an appropriate management response.

Substantial progress also can be achieved in advancing information management across the region. Specific activities include: implementation of common data standards for formatting and content; promotion of metadata production and distribution to facilitate data discovery; development of policies to share information across institutional and jurisdictional boundaries; implementation of distributed web services that facilitate access, query, analysis, and decision support; and development of an information technology infrastructure that will ensure future growth and sustainability. These activities would involve a coordinated, stakeholder-based approach to the design of a regional distributed information system.

Communication efforts in the Great Lakes would be focused on the delivery of accurate scientific and technical Great Lakes information to fulfill the needs of a wide variety of audiences, ranging from decision makers to stakeholder groups and the general public. Such information would be easily discovered and accessible for all audience groups and available in forms suitable to technical and non-technical audiences. Communications efforts would take maximum advantage of technologies to deliver information rapidly and via multiple media. Communication activities would be two-way, allowing information users to communicate their needs to potential information producers.

Great Lakes research programs need to be fully funded and strategic and comprehensive enough to meet user needs. Ideally, an effective research coordination strategy would be developed to ensure that research is targeted at ecosystem level predictions. The research plan would guide research in a pro-active fashion, yet remain flexible enough to accommodate new needs. Scientific results would be effectively communicated to stakeholders.

Recommended Actions

The following five recommended actions are provided based upon the collective input of members of the strategy team. These actions recognize the complexity of other strategy team recommendations. These recommended actions are equal parts of a comprehensive strategy for improvement. As such, no one recommendation is more important than any other. However, all recommended actions call for greater coordination to be exercised by stakeholders within the Great Lakes region and identification of a specific, existing or new body to accomplish this integration. As such, an overall recommendation is that: **Observations, information management, indicators, research and communications need to be coordinated under a Great Lakes Council or similar entity, composed of lead representatives with appropriate technical, scientific and managerial backgrounds from each of the five interdependent recommended groups identified below.** The Council would need to meet often (at least four times per year) to insure continuity between elements. Canadian participation, representing Federal, provincial, municipal and First Nation interests, should be invited to participate. Readers are encouraged to explore the detailed basis of these recommended actions contained in the Indicators and Information appendix.

- **The Great Lakes Interagency Task Force and other stakeholders need to implement the U.S. contribution to the Global Earth Observing System of Systems (GEOSS).**

Initial activities should be focused on implementing the Great Lakes Observing System (GLOS) business plan and establishing a Great Lakes node under the Integrated Ocean Observing System (IOOS) and the National Ecological Observatory Network (NEON). Work needs to be expanded by U.S. agencies to coordinate ecosystem-based and issue focused monitoring program activities including protocols, scientific rationale, testing and integration of indicators, and program planning and implementation. [\$32 million over 5 years]

- **Legislation needs to be enacted and funded to scientifically develop, test and implement a set of science-based indicators of the status of Great Lakes ecosystem components, associated stresses, and human response actions.**

Key, management-relevant indicators need to be scientifically developed and tested. Initial focus would be to validate selected SOLEC indicators and add additional indicators specific to the priorities of the strategy teams. A searchable online system needs to be developed to provide access to indicator descriptions, data, interpreted information, reports and summaries, maps and charts and related metrics of protection/restoration progress. The coordinating function of SOLEC should be maintained but broadened beyond water quality issues and enhanced to draw in more stakeholder and scientific involvement. [\$28 million over the next five years]

- **A regional information management infrastructure needs to be established to facilitate access to information resources across the region.**

A workgroup of information management professionals need to be constituted to implement a distributed network of servers and databases to support this infrastructure. The workgroup should include representatives from key stakeholder organizations with recognized data stewardship expertise and would coordinate interagency and interjurisdictional partnerships and mitigate institutional and legal barriers. The workgroup would promulgate data standards, quality assurance protocols, metadata production and region-wide multi-server search and access capabilities. The workgroup should manage a grants program to provide necessary funding to partnering agencies to cover costs for data management, servers, networks and database infrastructure development. The information management infrastructure should build upon the proven success of the Great Lakes Information Network (GLIN) and provide for funding for its long-term sustainability as an independent regional asset. The distributed or decentralized network of servers should be designed to exploit the advent of the Internet2 backbone. [\$8 million over five-years]

- **A permanent Great Lakes Communications Workgroup needs to be established to coordinate communication strategies and manage communication of scientific and technical information.**

Communications professionals from government agencies, environmental groups, regional organizations, Native American interests and relevant industry associations would make up the workgroup and provide the oversight for the development, and implementation of a comprehensive regional communications plan with assistance from staff or consultants. The communication plan would include periodic reviews of user needs and assess optimal methods of information delivery to decision-makers and the public. [\$4 million over five years]

- **Funding should be provided to establish a Great Lakes Research Office as authorized in the 1987 Clean Water Act Amendments (33 U.S.C. 1268).**

The Great Lakes Research Office would work in conjunction with existing institutional entities to coordinate a comprehensive Great Lakes Research Strategy with an emphasis on predictive ecosystem-based research organized to address existing and emerging ecological issues. Great Lakes research programs need to be funded in accordance with an established research strategy, emphasizing research integration in the decision making process. The Great Lakes Research Office should closely coordinate all activities with the International Joint Commission's Council of Great Lakes Research Managers. [\$40 million over five-years]