

INDICATORS AND INFORMATION

I. Problem Statement

The issues facing the Great Lakes were well described by the U.S. Commission on Ocean Policy which highlighted the need for “unbiased, credible and up-to-date scientific information” to properly manage the human activities that effect the nation’s oceans coasts and Great Lakes. The Commission found that new scientific findings demonstrate the complexity and interconnectedness of natural systems and that management approaches have not been updated to reflect this complexity with responsibilities remaining dispersed among a confusing array of agencies at the federal, state, and local levels. Managers, decision makers, and the public require timely access to reliable data and solid scientific information that have been translated into meaningful products. The Commission also stated: “sustained investments will be required to: support research and exploration; provide an adequate infrastructure for data collection, science, and management; and translate new scientific findings into useful and timely information products for managers, educators, and the public. This is especially true as we move toward an ecosystem-based management approach that imposes new responsibilities on managers and requires improved understanding of physical, biological, social and economic forces.” The Commission urged Congress to double the federal research budget over the next five years and to fund and adopt an integrated observing system on a regional basis.

Clearly, 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 under-funded, lack comprehensive ecosystem approaches and often exist as piecemeal programs. The volume of data collected for the Great Lakes and their tributary watersheds and the complexity of management issues have also expanded considerably in recent years.

The lack of accessible integrated information limits decision-making ability and application of adaptive management principles for the protection and restoration of ecological resources. Adaptive management requires one to identify priority issues, gather information, establish metrics, evaluate options, implement actions, track progress, reevaluate actions based on observed responses, communicate results and adjust both management approaches and monitoring activities. Also, decisions made on one issue often affect other issues. Observing systems, monitoring programs, indicators, research, modeling and analysis, information management and communication must be integrated into a holistic decision-making process.

Observing systems, including sensors, stations and networks and field data collection, 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 comparable monitoring protocols; and a lack of long-term financial commitments. Additional observation and monitoring are needed across the Great Lakes basin, including the open waters, coastal areas, tributaries and watersheds. Needed data collection effort reach beyond measurements of the Great Lakes components and include such things as socio-economic data, inventories of pollutant releases or hazard potential, and satellite remote sensing.

Comment [JD1]: Added in response to Comment #37

Deleted: Additional observation and monitoring are particularly needed for the open lakes.¶

Formatted: Font: (Default) Times New Roman, 11 pt

Comment [JD2]: Changed in response to comments 23-25

Formatted: Font: (Default) Times New Roman, 11 pt

Comment [JD3]: Changed in response to comments 71, 53-55, 59

Formatted: Font: (Default) Times New Roman, 11 pt

Some of the observations required are essential as indicators that provide information on the state of the Great Lakes and progress toward achieving goals. Continued efforts are needed to ensure the viability of a small yet comprehensive and scientifically-based set of indicators (e.g., the State of the Lakes Ecosystem Conference (SOLEC) indicator suite) that are useful for management decisions and public perception. The complexity and continual changes of the ecosystem often result in multiple explanations for observed changes. In addition, indicators must be flexible to account for the unique conditions of each Great Lake, including differences in temperature, trophic status, native biota, and so on. Although the comprehensiveness of the current indicator suite has continually expanded, needs for additional indicators have been identified by other strategy teams. These require additional research to develop realistic endpoints, cause-effect relationships, appropriate metrics and monitoring protocols.

Comment [JD4]: Changed in response to comment #72
Deleted: .

Great Lakes research provides the understanding necessary to make informed, 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 to meet present-day demands. Any new restoration efforts will require coupled research and observations programs. 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. Development of such capabilities requires a comprehensive research coordination strategy across partnering institutions.

Comment [JD5]: Changed in response to comment #42
Deleted: sound

Information produced by research and observations must be made readily available to managers, decision-makers and the public. This will require information integration, management and communication. Integration and management of information are hampered by parochial management approaches and policy constraints that restrict a user's ability to find out about the existence, location and characteristics of Great Lakes data. Data quality is often not documented or communicated to data users. Coordination needs to be improved to ensure that critical decisions are made using the best available data. Standards for metadata (information about data) are required. 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 also adversely affect information sharing. A lack of strong, formal data exchange partnerships among Great Lakes organizations underlies many of these constraints.

Deleted: technological, procedural,
Deleted: mask the

Various methods are used to communicate information to those that require it, but coordination needs strengthening for the sheer breadth of information collected over the region. 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. Some information, such as lake conditions and beach closings, requires rapid delivery. In addition, two-way communication needs to be promoted so that user needs are conveyed to those producing the information. A comprehensive, two-way communication strategy has not been developed to address these needs.

II. Goals and Milestones

Goals:

- The importance of reliable data and high-quality science must be widely recognized and physical, chemical, biological, socio-economic research and scientific technology must be strongly supported.

Comment [JD6]: Changed in response to comment #42
Deleted: sound
Comment [JD7]: Added in response to comment #22
Deleted: al and

- A widespread network of observing systems should provide a steady stream of data, and scientific findings that are translated into practical information and products for decision makers, educators, and the public. This network must be continually improved to adapt to technological advances and emerging informational needs of Great Lakes managers and stakeholders.
- Robust information gathering and integration tools must be available to support scientifically informed decisions. Decision-support tools must be flexible, not constrain the user's viewpoint, and offer enhanced abilities for multi-participant decision making. Predictive modeling tools need to be applied to critical ecological problems and be integrated across local areas to provide lake-wide assessments.
- Great Lakes research programs must be comprehensive, strategically coordinated and meet user needs. Research should be targeted at ecosystem level predictions.
- Progress achieved in the design of scientifically-validated set of indicators for the Great Lakes ecosystem must be fully realized through their implementation. Indicators must be implemented to meet the needs of all user groups for accuracy, resolution and relevance to key concerns. We must have a formalized approach for incorporation of new indicators and refinement of existing indicators in response to evolving science, user needs, and ecosystem conditions.
- Standardized information management systems must be implemented within regional organizations and connected through an integrated network of Great Lakes information systems. This must include application of appropriate information technology infrastructure, and development of policies to share information across institutional and jurisdictional boundaries.
- Communication efforts in the Great Lakes must deliver accurate scientific and technical Great Lakes information to fulfill the needs of the decision makers, stakeholder groups, and the general public. Communication avenues must be two-way, conveying user needs to information providers.
- Enhanced coordination mechanisms are required to provide common direction among partnering Great Lakes organizations. Coordinative bodies must engage the region's technical experts and be closely integrated with existing senior-level Great Lakes management groups.

Deleted: and monitoring station

Deleted: A

Deleted: developed and

Deleted: ed

Deleted: across

Deleted: committed development of

Deleted: ,

Interim Milestones:

- By 2007, establish a coordinating Great Lakes Information Coordination Council
- By 2007, develop and implement a Great Lakes research strategy covering all issue areas.
- By 2007, initiate an annual (or biennial?) Great Lakes Monitoring Conference
- By 2008, develop and implement a Great Lakes communication strategy covering all issue areas.
- By 2008, fully implement IOOS/IEOS within the Great Lakes region.
- By 2010, adopt comparable information management protocols and data standards across the region
- By 2008, develop and implement high-priority indicators and refine current indicators, building upon SOLEC.

Comment [JD8]: Added in response to comment #86

Formatted: Bullets and Numbering

Deleted: the GLOS Business Plan and I

Comment [JD9]: Changed in response to comment #86

Deleted: agreements

Deleted: 11

Deleted: new

Comment [JD10]: Changed in response to comments #35, #80 and #82

III. Recommend Actions

The following recommended actions are equal parts of a comprehensive strategy for improvement. All recommended actions call for greater coordination within the Great Lakes region and identify of a specific, existing or new body to accomplish this integration. All recommendations require participation of numerous partners at the federal, state, local/municipal, Native American, and binational levels as well as partners from industry, academia, public interest groups and the public to be effective.

Recommendation 1: Observations and monitoring, information management, indicators, research and communications need to be coordinated under a Great Lakes Information Coordination Council (GLICC), composed of lead representatives with appropriate technical, scientific and managerial backgrounds.

Rationale: Ecosystem monitoring, observation, research, indicator development and modeling efforts in the Great Lakes Region currently exist as piecemeal programs. A coordinating body is needed to provide common direction among partnering Great Lakes organizations. The region’s technical experts need to be engaged and be closely integrated with existing senior-level Great Lakes management groups. This new Council should be comprised of representatives from existing structures and recognize the binational nature of the Great Lakes resource.

Cost: \$2 million per year for five years

Recommendation 2: 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) and the Integrated Ocean Observing System (IOOS). The Task Force should promote monitoring program coordination and support the continued development and implementation of science-based indicators through the existing SOLEC process.

Rationale: Observing systems and monitoring programs are the primary means for gathering information on the chemical, biological and physical characteristics of the Great Lakes ecosystem. These programs are needed to take the pulse of the Great Lakes, assess natural variability, drive ecosystem forecasting models, and assess the progress of restorations efforts. Monitoring and observing systems require continued improvements to adapt to changing technologies and informational needs of Great Lakes resource management. Initial activities should be focused on implementing the Great Lakes Observing System (GLOS) business plan.

U.S. agencies **must expand efforts** to coordinate ecosystem-based and issue-focused monitoring programs including protocols, scientific rationale, and integration of indicators. **As an established and successful binational effort, the SOLEC process must receive increased support and participation to accomplish this.** High-priority, management-relevant indicators **must be identified, scientifically developed and tested for each issue area of this report.** Current indicators need to be broadened beyond water quality issues and enhanced to draw in more stakeholder and scientific involvement.

Cost: \$20 million per year for five years

Recommendation 3: The overall federal research budget to the Great Lakes should be doubled over the next 5 years. For all new appropriations to support Great Lakes restoration activities, at least 10% of these funds should be dedicated to independent research. Finally, adequate funds should be made available to support a Great Lakes Research Office as authorized in the 1987 Clean Water Act Amendments (33 U.S.C. 1268) to coordinate these research efforts.

Rationale: Great Lakes research provides the understanding necessary to make informed, scientifically supportable decisions and actions, to assess the associated risks, expectations and timelines of management actions, to plan effective monitoring and observation systems and to identify sensitive and meaningful indicators of ecosystem status. Current research programs do not offer sufficient support to address all current research needs nor to fully employ ecosystem management. In addition to explaining the current state of the lakes, research is needed to improve predictive capabilities regarding the lakes, particularly regarding the impacts of chemical, biological and physical changes on ecosystem structure and function. Research is required to a) set management goals and expectations, b) identify the most cost-effective restoration strategies, c) evaluate connectedness to other components of the ecosystem and d) evaluate progress in achieving management goals and expectations. Overall, as per the U.S. Commission on Ocean Policy, overall research funding should be doubled over the next five years to fix the observation that “Chronic under-investment has also left much of our...infrastructure in woefully poor condition” and that this funding needed since the nation’s current needs are well below the level

Deleted: ,

Deleted: , test and

Comment [JD11]: Changed in response to 31-35

Deleted: of the status of Great Lakes ecosystem components, associated stresses, and human response actions

Deleted: as the regional node under IOOS and the National Ecological Observatory Network (NEON). A sustained, national IOOS will provide invaluable economic, societal, and environmental benefits, including improved warnings of coastal and health hazards, more efficient use of living and nonliving resources, human safety, and ecosystem management.

Deleted: Work needs to be expanded by

Deleted: testing

Deleted: , and program planning and implementation

Deleted: Key

Deleted: need to

Deleted: . Initial focus would be to validate selected SOLEC indicators and add additional indicators specific to the priorities of the strategy teams

Comment [JD12]: Changed in response to 31-35

Comment [JD13]: Changed in response to comment #42

Deleted: sound

Comment [JD14]: Changed in response to comment #73

Deleted: the success or failure of the restoration in achieving this

necessary to adequately meet the nation’s need for Great Lakes Information. Research should also be a fundamental and integral part of any restoration or management decision. The research should be objective and done through agencies independent of those doing the restoration. Ten percent of the restoration funding should be devoted to the effort. The Great Lakes Research Office (GLRO) 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 GLRO would closely coordinate all activities with the IJC’s Council of Great Lakes Research Managers. Increased support of university-based Great Lakes science is needed to support independent and localized research, such as through a NSF Science of Freshwater Inland Seas (SoFIS) program.

Comment [JD15]: Added in response to comments 12,13,14

Cost: \$3 million annually to support the research office or \$15 million over five years. Overall doubling of current research in 5 years (20% increase per year to an approx. total of \$15 million per year), plus 10% of any new restoration efforts

Recommendation 4: The Great Lakes Interagency Task Force should establish a regional information management infrastructure (i.e. network of networks) to facilitate easy and accessible information exchange among all regional partners. Regional partners must adopt standardized data management protocols and commit to open data availability to create a consistent and comprehensive repository of Great Lakes data.

Deleted: between Great Lakes ecosystem investigations (monitoring, observing, research and modeling), and inform decision-making

Rationale: The U.S. Commission on Ocean Policy recognized that: “The data generated from increased research, enhanced monitoring networks, and new observing systems will be essential in improving our management of ocean and coastal resources. However, two major challenges face today’s data managers: the sheer volume of incoming data, which strains storage and assimilation capabilities, and the demand for timely access to the data in a variety of formats by user communities. Meeting these challenges will require a concerted effort to modernize the current data management system and will require greatly improved interagency planning and coordination.”

In the Great Lakes, infrastructure is required to help turn data into useful information. Integrated and coordinated scientific and technical information is needed to adequately share results of ecosystem investigations with stakeholders. Long-term funding of an information management infrastructure to acquire and exchange timely, objective and accurate information is needed. The infrastructure will facilitate two-way communication between scientists and stakeholders, also allowing stakeholder needs to inform the investigations. The information management infrastructure should mesh with and augment existing infrastructure, such as the Great Lakes Information Network (GLIN) and provide for sustainability of such a network as an independent regional asset.

Deleted: both

A workgroup of information management professionals is also needed to implement the distributed network of servers and databases to support this infrastructure. The workgroup should include representatives from key stakeholders with recognized data stewardship expertise and would coordinate interagency and inter-jurisdictional 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.

Deleted: The information management infrastructure should mesh with the existing Great Lakes Information Network (GLIN) and provide for sustainability of such a network as an independent regional asset.

Cost: \$2 million per year for five years

Recommendation 5: The Great Lakes Interagency Task Force should establish a permanent Great Lakes Communications Workgroup to strategically coordinate and manage communication of scientific and technical information.

Rationale: Communications professionals from federal and state governmental agencies, environmental groups, regional and local organizations, Native American interests, relevant industry associations and academia would participate in the workgroup and provide oversight for the development and implementation of a comprehensive regional communications plan. The communication plan would include periodic reviews of audience needs and assess optimal methods of information delivery to decision-makers and the public. By sharing experience, tools and workloads, the Workgroup would facilitate efficient and consistent delivery of Great Lakes information to disparate audiences and oversee small grants to regional and local organizations to enhance communications efforts. The workgroup would be led by the Great Lakes Sea Grant Network, who would encourage broad participation and report on progress to the GLICC and the Binational Executive Committee (BEC).

Deleted: and

Deleted:

Deleted: make up the

Deleted: the

Deleted: ,

Deleted: user

Comment [JD16]: Revised / added in response to comments 66,74, and 87

Cost: \$1 million per year for five years