

# First Draft

## Strategic Plan for Great Lakes Restoration and Protection: Indicators and Information

The Indicators and Information Strategy Team (I&IST) includes five work groups, each tasked with developing a separate yet interrelated section of the teams' portion of the overall Strategic Plan for Great Lakes Restoration and Protection. These five work groups are:

- Indicators
- Data and Information Management
- Research and Monitoring
- Decision Support, and
- Communication.

Each of the work groups were directed to conduct their tasks within the following scope:

- Describe existing programs and activities to collect observations, operate monitoring networks, define indicators, model complex physical and ecological systems, assess progress towards consensus goals and communicate information between stakeholders;
- Evaluate options for addressing identified needs; and
- Recommend actions to implement needed improvements.

Each of the work groups were requested to provide their input for the overall strategic plan according to the standard report format outlined for each strategy team as follows:

- Problem Statement (including ecosystem impacts, causes, geographic extent and environmental, social and economic implications of no action)
- Desire State (including performance-based goals, ultimate restoration endpoints, priority formulation, and expected benefits from results)
- Assessment of Ongoing Efforts (including actions underway, responsible parties, costs of activities and sufficiency of activities with respect to performance objectives)
- Evaluation of Alternate Approaches (including costs, feasibility and benefits)
- Recommended Actions (including timeframe, projected benefits/costs, responsible entities, and metrics toward desired state.)

The work groups also were tasked to also address specific overarching considerations outlined by the GLRC Executive Committee including human health impacts and priorities, tribal interests and perspectives, and research and monitoring. To a large degree this is being addressed by identification of liaisons between the I&IST and the rest of the strategy teams under the GLRC. It is expected that the I&IST input to the overall strategy team report will be updated regularly as the other Strategy Teams define their priorities and recommendations.

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The information generated by the five work groups has been consolidated into the following first draft of the I&IST report. Some of the work groups (e.g., Indicators, Research and Monitoring, Communications) have had access to a large amount of pre-existing information while other work groups (Data and Information Management, Decision Support) have needed to define innovative strategies for addressing their topic area. As such, this first draft reflects substantial differences between work groups in terms of length, detail and to a lesser degree, long-term vision. In addition, significant reformatting of this material is expected to occur over the next month as further comments are received on this first draft. In particular, the Glossary of Terms and Reference Sections will be combined for the overall I&IST report and not reflect specific interest areas addressed by the working groups.

The final version of the I&IST portion of the overall Strategic Plan will only be 4-5 pages in length, based upon the directives of the GLRC Executive Committee. This first draft is much longer and will likely constitute an appendix to the final GLRC strategy report. In the interim, this first draft is expected to promote discussion for each topic area, identify areas requiring further investigation, and initiate efforts for attaining consensus on priority actions from a broad section of the Great Lakes community.

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## Indicators

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Restoration and protection of the Great Lakes ecosystem can be and is defined in many ways. The Great Lakes Water Quality Agreement sets an overall vision that we will “restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes basin ecosystem.” The Agreement also sets goals and lists specific objectives for certain water quality parameters such as phosphorus loadings. But that only tells part of the story. To draw a clear picture of the health of the ecosystem, we must collect information on a wide array of variables that allow us to assess progress toward achieving those goals and specific objectives. Indicators are the gauges that provide us information about conditions at a particular point in time and allow us to monitor changes over time. They give an objective assessment of environmental conditions and can be used to track progress towards achieving goals and objectives.

## Problem Statement

The 1987 protocol to the GLWQA called for the development of such indicators of ecosystem health. As a result, the State of the Lakes Ecosystem Conference (SOLEC) was created. Through biannual conferences hosted by the United States and Canada, a suite of indicators was developed to report on the state of various components of the ecosystem focusing primarily on chemical, physical, and biological parameters. The Great Lakes indicators that have been developed and implemented through the SOLEC process provide an umbrella or overarching set, which give a general system wide overview. They draw upon and complement indicators used for more specific purposes such as Lakewide Management Plans or Remedial Action Plans for geographic Areas of Concern.

While essential to measuring progress towards environmental improvement, the Great Lakes indicators assess the state of the ecosystem from a basin-wide perspective. Overall the community of regulators, industry, and non-government groups that use them for their own assessments considers these indicators reasonably acceptable. Improvements, however, are needed to adapt to new information needs and address the changing management of the Great Lakes resources. A comprehensive set of indicators is needed to support and monitor the progress of activities developed in the Regional Collaboration Strategic Plan. These indicators must answer both complex and simple questions regarding the health of the ecosystem and its components. In developing the indicators, five critical issues need to be addressed:

- **Scale.** The existing suite of Great Lakes indicators provides a very broad measure of environmental improvements at the basin level. Most decisions impacting the health of the ecosystem are made at a local or watershed level. Indicators must be able to measure conditions and trends from both the basin-wide and individual watershed level.
- **Monitoring Protocols.** The information feeding into the indicators must be reliable and consistent. Currently, conflicts and incompatibility between data exists because

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Agencies monitor different parameters to answer the same questions. There needs to be uniform monitoring and reporting requirements to ensure that comparable data and information are being used across the basin.

- Agency Commitments. Agencies must commit to routine and consistent monitoring and reporting. Indicators are only as useful and reliable as the data used to evaluate them. A long term schedule and commitment to monitoring must be made by the responsible Agencies.
- Data Accessibility. Many Agencies and organizations collect data yet it is not readily available for inclusion in the indicators. Data must be accessible, understandable, and retrievable.
- Additional Indicators. While a comprehensive suite of Great Lakes indicators does exist, additional indicators and information may be needed to support the strategic plan. It is important to build on the existing indicators. We need to identify ways to aggregate and interpret multiple indicators in order to clearly and effectively communicate the findings.

Indicators are crucial to the success of any Great Lakes ecosystem restoration and protection strategy. Information from a comprehensive suite of indicators will demonstrate where past actions have been successful and which future programs will result in measurable environmental improvement.

## Evaluation of Alternate Approaches

There are few, if any, viable alternate approaches to the development and implementation of a comprehensive suite of Great Lakes indicators. Several variations on a theme may be proposed and/or established, but in general, the process for the restoration and maintenance of the Great Lakes Basin ecosystem remains the same:

1. Identify the problem (or issue, or pressure, or threat)
2. Create a plan of goals, objectives, and actions
3. Implement the plan
4. Monitor for results (environmental status, pressures, and/or program actions), and
5. Adapt and repeat the cycle as needed.

An effective, comprehensive system of indicators for the Great Lakes Basin requires the characteristics described below. These include:

- Incorporation and refinement of previously developed indicators
- Recognition of multiple spatial and temporal scales
- Organization into a flexible framework
- Selection through a formal process
- Indicators are broadly accepted
- Monitoring protocols defined
- Agency commitments
- Accessibility

For each of these characteristics, the desired state is identified, ongoing efforts are assessed, and actions to achieve the desired state are recommended.

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## Incorporation and refinement of previously developed indicators

### **Desired State (Goals)**

There has been much effort in the Great Lakes Basin to develop and implement systems of indicators, for example through the LaMPs and the SOLEC process. This body of work and knowledge will provide the foundation for further development, testing and implementation of indicators.

### **Assessment of Ongoing Efforts**

ONGOING. The current suite of Great Lakes indicators has been developed and refined from a much larger group of candidate indicators. A description of the initial indicator selection process can be found in the report, Selection of Indicators for Great Lakes Basin Ecosystem Health (Version 2, 1998).

Over the years, the list of indicators has expanded and the descriptions revised or clarified. Recently, a major rearrangement of the organization of the suite into bundles or groups of indicators was also proposed. The bundling or grouping of indicators allows us to make a simplified statement regarding the state of the ecosystem based on very complex indicators.

Indicators supporting other Strategy Teams may or may not be already developed.

### **Recommended Actions**

ONGOING. Wherever possible, existing indicators and indicator development activities should be used to avoid duplication of effort. An evaluation against the screening criteria should be done for any additional indicators needed to support the Strategy activities as well as existing indicators from the LaMPs, SOLEC, EPA STAR grants or other processes.

**Cost: Not available at present**

## Recognition of multiple spatial and temporal scales

### **Desired State (Goals)**

Multiple stakeholders and decision-makers in the Great Lakes basin require information focused at different scales. For example, RAPs for AOCs reflect local conditions at river mouths and nearshore embayments. LaMPs, however, are largely concerned with watershed-level conditions and processes. Many aspects of the GLWQA apply to the Great Lakes basin as a whole. Further, some environmental processes and/or issues may require time scales of years to decades for resolution. The suite of indicators would include those of most relevance to the space and time scales appropriate for the given issue or decision to be made.

### **Assessment of Ongoing Efforts**

SPACE SCALES SHORTCOMING. The current suite of indicators is focused on the whole Great Lakes basin or on individual lakes or sub-basins. The Great Lakes

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Collaboration recognizes a need to also inform local decision-makers, and to identify indicators and/or measures relevant to local areas. Local areas would include municipalities, regional planning commissions, and Areas of Concern, among others. Most “nearshore” and/or coastal areas should be assessed at smaller scales than sub-basins.

**TIME SCALES SHORTCOMING.** Most Great Lakes monitoring programs are designed primarily to track trends over the scale of years to decades. Environmental Management may be impatient to identify restoration improvements over that extended time. Additional interim features of Great Lakes ecosystem components may need to be identified to infer improvements (or not) over shorter time periods.

## **Recommended Actions**

Action: Develop and implement a suite of indicators for the Great Lakes nearshore and coastal areas. This suite should be scaled to local conditions, providing information to municipalities and other planning organizations who would conduct specific actions based on the information.

Action: Identify characteristics of the Great Lakes basin ecosystem that are of interest to environmental management and which have time scales of interest less than annual. These elements are expected to be associated with more local features, e.g. AOCs, than lake-basin features.

Action: Explore options like remote buoy system(s) to provide high frequency data collection about a few parameters.

**Cost: Not available at present**

## **Organization into a flexible framework**

### **Desired State (Goals)**

Indicators increase in value if they can serve as measures of the effectiveness of strategies that address specific threats to ecosystem health. If we can measure impacts and test the assumptions behind policies or actions, we can learn which strategies are most beneficial, and adapt and improve our strategies in response to new knowledge. An adaptive management framework for our indicators, however, requires a high degree of flexibility about which indicators are selected and how they are grouped and analyzed. For example, flexibility is needed to accommodate various geographic scales (local, lake watersheds, whole basin), environmental issues, ecosystem components (physical, chemical, biological) and/or human-related issues. As needed, indicators would also be grouped to provide assessments of progress toward objectives of the GLWQA, GLBTS, LaMPs, or other planning and strategy documents. The Great Lakes suite of indicators would provide the flexibility to combine and recombine sets of indicators to inform the decision-maker about issues as specifically as possible. Indicator monitoring should lead to specific actions or to refinements of current strategies so that support for both actions and monitoring can be enhanced.

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## **Assessment of Ongoing Efforts**

MAJOR ACTION REQUIRED. The current suite of indicators has been reorganized to adopt the concept of bundles. Specific relevant indicators are identified for each bundle topic, and a two-dimensional matrix of indicators and issues helps identify indicators relevant to topics. The process requires manual reassembly of indicator descriptions and reports.

## **Recommended Actions**

Action: Develop and make widely available a relational database that contains information on 1) the attributes of each indicator, 2) current data and 3) interpreted information provided by the indicator. See “Accessibility” below. The database should allow the indicators to be sorted and filtered by a variety of criteria and/or key words, and various combinations of indicators could then be retrieved and analyzed as appropriate for the end user.

Indicator System Characteristics: Inclusion of a full range of types of indicators

## **Desired State (Goals)**

Indicators serve a variety of purposes. Some are environmental measures, while others reflect human activities that modify the environmental components. Some help determine if environmental objectives have been achieved while others help determine why objectives have not been met. The model most frequently used for the Great Lakes suite of indicators would be P-S-R (pressure, state, human response) with the incorporation of one or more additional elements as appropriate (e.g. D – drivers).

The underlying concept for this model is adaptive management responding to environmental threats. Human actions create pressures on the environment around us, leading to changes in the state or conditions in the environment, which in turn leads us to respond with various activities to reduce the impacts of our actions.

## **Assessment of Ongoing Efforts**

ADDITIONAL EFFORT REQUIRED. The current suite of Great Lakes indicators recognizes the PSR model (i.e. Pressure, State, human Response). Interconnections between indicators should be better defined, however, to more explicitly identify how the state of the environment, the pressures and the human activities are related. Peer reviewers have suggested moving to DPSR model, which would add the category of “Drivers” to the type of indicators.

## **Recommended Actions**

Action: Identify and clarify the interconnections between and among the indicators, especially those associated with specific issues or areas. Provide better “thread” linking environmental conditions, pressures on the environment, and human activities to mitigate the pressures.

**Cost: Not available at present**

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## Selection through a formal process

### **Desired State (Goals)**

The selection of Great Lakes indicators requires careful consideration by the subject experts and the stakeholders and decision-makers, i.e., the end users. The indicators would reflect a high degree of conformity to a predefined set of screening criteria. Those indicators that rated highly for all or most of the factors would be the best candidates for inclusion in the set. Important factors that would be used to select a set of indicators for the Great Lakes basin ecosystem include:

- **Necessary:** Is each indicator necessary to give us the information we need to assess the state of the ecosystem?
- **Sufficient:** Will the suite of indicators provide sufficient information to give a picture of the overall health of the ecosystem?
- **Feasible:** Are the methods for sampling and measuring the indicator variables technically feasible, appropriate, and resource efficient (economically and in terms of human resources)?
- **Lead to management action:** Does each indicator provide information useful for influencing environmental decisions and managerial actions?

Other criteria which can be used to select indicators include: scientific validity, understandability, relevance, representativeness, interpretability, data availability, timeliness and cost considerations.

### **Assessment of Ongoing Efforts**

PROCESS WELL ESTABLISHED, BUT ADDITIONAL EFFORTS REQUIRED.

#### a. Experts, decision-makers, stakeholders

The process for selecting Great Lakes indicators involved panels of experts for geographic areas and issues. The original panels are no longer active, but several similar efforts are ongoing for additional sectors of the Great Lakes basin ecosystem. For example, the Great Lakes Coastal Wetlands Consortium has selected a suite of indicators and is currently developing common monitoring protocols. Also, a group has been assembled to consider indicators for Forest Lands in the Great Lakes basin, based on the internationally-recognized Montreal Protocol.

#### b. Criteria

ONGOING Criteria for indicator selection are well established. The Great Lakes Collaboration can build on the SOLEC process, using the same criteria.

### **Recommended Actions**

Action: Develop a process to screen potential indicators through the set of criteria.

Action: Organize and support an expert group for agriculture lands indicators

Action: Organize and support an expert group for surface waters in the watershed: lakes, streams

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Action: Organize and support an expert group for the other Strategy Team indicators, as needed:

- Nonpoint Source
- PBT Reduction
- Invasive Species
- Habitat/Species
- AOCs
- Sustainable Development

Specific additional focus areas include:

- Consider a request for a Sustainable Development index.
- Investigate *Genuine Progress Index* to determine if it is appropriate and useful for the Great Lakes.
- Consider a request for Commercial Fishery indicator
- Coastal Health

**Cost: Not available at present**

## **Indicators are broadly accepted**

### **Desired State (Goals)**

The suite of Great Lakes indicators would be relevant to the assessment questions (management concerns) at all levels of governance, i.e., federal, state, local and tribal jurisdictions. Because the indicators would be broadly accepted, there would be strong institutional support for their implementation, assessment and reporting.

### **Assessment of Ongoing Efforts**

ONGOING, BUT ADDITIONAL EFFORT REQUIRED In order to foster acceptance of the indicators, stakeholders at all levels of government, as well as nongovernmental organizations, have been encouraged to participate. Participation has been voluntary, and some agencies have recognized the benefits of collaboration more than others.

### **Recommended Actions**

Action: Great Lakes Collaboration to encourage member agencies and observers to adopt the use of indicators in better decision-making and Great Lakes environmental management.

**Cost: Not available at present**

## **Monitoring protocols defined**

### **Desired State (Goals)**

To be fully functioning, common monitoring and evaluation protocols would be developed for each indicator, and each monitoring jurisdiction would follow the protocols. Relevant elements would include data collection methods, logistics,

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information management, quality assurance, and costs. An integrated, collaborative monitoring program would also be instituted to ensure the most efficient, cost effective approaches are implemented.

## **Assessment of Ongoing Efforts**

ADDITIONAL EFFORTS REQUIRED. Common protocols for the monitoring of Great Lakes ecosystem components across the basin have not been established between U.S. and Canada, nor between the states and Province of Ontario. Some encouraging developments have occurred, however. A Binational Monitoring Inventory has been established by U.S. and Canada that should reduce redundancy between monitoring programs. Discussions between EPA and EC have been underway to align their monitoring programs more closely, or to make them more complementary. A rotating monitoring schedule has been established for more intensive monitoring and/or research in each Lake. The Great Lakes Coastal Wetlands Consortium is developing common monitoring protocols for the wetlands indicators.

For most other monitoring efforts that involve more than one agency, uniform protocols for indicators are not followed. Examples include measurement of contaminants in fish, and detection of PBTs in water. Even the assessment of lake trout populations is handled differently in each lake.

## **Recommended Actions**

Action: Great Lakes Collaboration to encourage member agencies and observers to develop and adopt common protocols for the monitoring required to fully implement the Great Lakes suite of indicators.

**Cost: Not available at present**

## **Agency commitments**

### **Desired State (Goals)**

The Great Lakes suite of indicators will have the support of the multiple Great Lakes Collaboration agencies and cooperating stakeholders. The suite will be supported operationally and financially. For each indicator, an agency or organization will have primary responsibility for ensuring that the required implementation steps are completed for the monitoring or other data collection, assessment and reporting.

## **Assessment of Ongoing Efforts**

ADDITIONAL WORK REQUIRED. Agency commitments to monitoring, assessing and reporting the Great Lakes indicators are piecemeal, at best. EPA and EC fund and operate monitoring programs for some of the Great Lakes indicators. Other indicator data are obtained by personal request. USFWS claim 'ownership' of 5 (or 6?) indicators. Other agencies have not formally declared responsibility for data collection, evaluation and reporting.

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## **Recommended Actions**

Action: Great Lakes Collaboration to encourage member agencies and observers to incorporate specific Great Lakes indicators into their monitoring programs and to assume responsibility for the data collection, assessment and reporting of specific indicators.

Action: Each indicator should have an identified agency or group that has primary responsibility for its implementation.

**Cost: Not available at present**

## **Accessibility**

### **Desired State (Goals)**

Fundamental to the implementation of an effective system of Great Lakes indicators and information is the accessibility of the information to all stakeholders. Included would be metadata (information about the data), data tables, analyses, technical reports, and interpreted information for the public and non-technical audiences. An integrated system for information availability and exchange would be easily searchable by stakeholders.

In addition to a passive system from which data can be accessed, an active reporting and distribution system is required to effectively provide decision-makers with current information. Periodic reporting to Great Lakes stakeholders through conferences, publish reports, peer reviewed literature, direct mailings and other outreach venues will complement online availability of indicator information.

### **Assessment of Ongoing Efforts**

ADDITIONAL WORK REQUIRED. Access to data and interpretive information is critical to influencing environmental decisions and activities. Both passive availability and active distribution of data are needed to address the needs of a broad range of stakeholders.

## **Recommended Actions**

Action: To communicate findings of indicators for the Great Lakes Collaboration, a communication strategy will need to be created and implemented.

Action: Develop an online system for indicator descriptions, data, and interpreted information. The system should have features that include:

- Searchable
- Indicator descriptions
- Indicator reports
- Indicator underlying data
- Indicator summaries & interpretations
- Flexible groupings of indicators for retrieval
- Geo-referenced

**Cost: Not available at present**

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## Data and Information Management

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The Data and Information workgroup envisions a **Great Lakes Enterprise information system** comprised of two components. First, there needs to be a true, distributed, enterprise **data management system** connecting all applicable databases within the Great Lakes user community. This system would integrate and provide access to all Great Lakes data through a distributed data architecture network that would allow access to, and integration of, all Great Lakes data that are held within organizations who are working in and around the Great Lakes basin. Secondly, the Great Lakes information system would provide **decision support systems and system models** using these data to support multi-scaled management decisions.

To accomplish this daunting vision we believe the following need to be addressed, scoped, planned, and implemented.

### Problem Statement

Integration of Great Lakes information systems is prevented by a host of significant technological, process, and policy constraints. They are significant and require commitment from all levels of U.S. and Canadian government to overcome.

The first and maybe most simple problem is **discovery** of where the data is, its format, metadata, ownership, platform, and accessibility. This is a simple task at the Federal/Canadian level, but becomes more difficult as ownership moves to the State/Provincial, and local or private organizational levels. This process of data discovery will take time if there is a focused effort to accomplish it.

The second set of obstacles is the variability in data standards, data management systems, and the natural unwillingness to change to meet someone else's objectives are problems. Standards are developed to meet project needs, local geographic need, proprietary software requirements, or are adapted out of convenience, or a variety of other reasons driven by local business needs (operating in silos). The same piece of data (wetlands, landscape, ecological, etc.) may have numerous classifications depending on the organization and their specific classification objectives. Understanding and accounting for this variability is central to developing a system or enterprise approach. At a minimum these standards should be represented in accompanying metadata. However, metadata usage is not currently common across institutional operations. Data documentation is essential to its inclusion in an enterprise system. Creating a **central set of standards** that cut across all data attributes (projection, source, scale, precision, etc.) is critical to creating the Great Lakes enterprise system.

The third set of obstacles is posed by the **logistics of accessing the data**: whether by moving to a central storage site or linking through a dynamic enterprise database system. Realizing that each piece of data will have unique issues of projection, database design, naming conventions, field properties, and a host of other technical specifics is essential in designing the implementation strategy. Each of these will need to be considered in designing the database architecture and the connectivity protocols linking the vast array of datasets. In some cases databases will have to be reformatted, in others conversion or linking algorithms created to bring datasets together.

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The fourth issue to be addressed is the **variability in user and institutional sophistication** and the ability to provide automated spatial or database access. In many cases data may only be available through spreadsheets, local pc databases or even paper products whereas other organization have operating, web enabled, enterprise systems. This also relates to the issues of data collection, maintenance, and coordination. Who will have the collection responsibilities, what if an organization does not have web-enabled data sharing capability, or how do we avoid data collection duplication (potential problem between jurisdictions and the consequences of using one dataset over another).

The shear volume and size of individual datasets can also create access and distribution problems. Spatial data, especially those that use imagery, are often very large datasets, typically many to hundreds of megabytes in file size. Storing and/or accessing these large datasets are potentially problematic. Large bandwidths and high speed inter system connectivity also become significant consideration in system design. Many organizations currently do not have high speed capabilities at this time.

Funding has also become problematic within the GIS community. Over the past few years the movement has been to fund the development of large, complex applications, tools and systems to store, manage and display GIS data. While this can be commended, there is little acknowledgement in the fact that these developmental systems are, all too often, serving up comparatively poor data. The concept seems to be that as long as there is interoperability and the ability to access data then “all is right with the world”. Nothing could be further from the truth. The fact is that data collection is costly and quality data is not properly recognized as an important asset to all organizations who are using those data. Therefore, the preference is to provide funding to make poor data look good through applications that use those data – it is much more cost effective (cheaper) and usually more timely. The misconception there is that if data is in a digital format then it must be right and management and politicians can easily showcase the tools using any quality of data that is in the system. Many critical environmental and resource planning decisions are being made using poor quality data and that needs to be addressed through the funding of high quality data collection projects. The old adage of “garbage in, garbage out” holds true, despite the fact that the garbage is wrapped in glossy paper and tied with a pretty bow.

Lastly, there are all the **institutional and legal constraints** to sharing data. Some organizations treat data in a very proprietary context and do not allow access to those data while others have implemented security infrastructures to protect the integrity of their data. The process of developing relationships and agreements allowing for data access will be a significant task in itself. This is currently demonstrated by the problems the Canadian Land Information Ontario had in developing their system. Also, the Environmental Information Exchange Network in the U.S. is an operating model dealing with these issues.

## Desired State (Goals)

The ultimate, long term vision for the Great Lakes Enterprise Information System includes:

- High quality data
- Common data standards
- Agreements between users for data use and maintenance
- Access to data across all institutional boundaries

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- Web management systems that facilitate access, query, analysis, and decision support; and
- An infrastructure that will ensure the system's growth and sustainability.

These are all difficult challenges. However, long term, integrated monitoring, assessment, and management across all Great Lakes resources and institutions cannot be realized until this vision becomes reality. We are very fortunate to have partners experienced in developing this type of system. The lessons learned from the implementation of the Land Information Ontario project can be used as a model for issue resolution, processes required, and the challenges to be expected that the Great Lakes Collaboration can take advantage of. Each of these vision areas need to be explored and defined through deliberate stakeholder discussions. Fully understanding the implications of each expectation is critical to developing the implementation plan. Strong partnerships are essential to the establishment of a cooperative approach to integrated data and information systems, across any jurisdiction. In order to ensure that there is a coordinated effort among organizations there needs to be the political and organizational support that allows staff to become true “partners”, in every sense of the word. The development of personal, working relationships between multiple levels of government, academia and other organizations cannot be accomplished without senior level support. The establishment of a partnership model also needs strong champions who have the ability to leverage political and organizational support. These “champions” need to have the flexibility to communicate the goals and objectives for developing the partnerships, while having the ability to dedicate the time and effort required developing those key contacts, not to mention the associated funding to allow for travel etc. Communication is the key to developing strong working relationships between organizations and needs to be recognized and supported in order to be successful.

## Assessment of Ongoing Efforts

Current activities within the Great Lakes Basin can be generally described as; uncoordinated data collection; little adherence to data standards or no global standards across the Basin; a “Silo” or self serving approach to data collection and information management; a general lack of communication across organizations; a general lack of funding to sustain data and information activities; a lack of information management standards from funding sources; project based activities that are driven by the availability of funding and result in data only meeting those project objectives; projects are implemented as a result of political reaction, not strategic planning; occur in an environment of jurisdictional and organizational exclusion; data sharing policies are restrictive; and reactive management limits the potential to plan (strategically) and sustain projects through cooperative approaches and partnerships. Each of these will need to be addressed to develop a strategic implementation plan. All represent the opposite of the Great Lakes system vision.

Although there are examples of good data management and data sharing across the Great Lakes Basin, they are few and far between. Organizations need to adopt a more coordinated approach to sustainable data related to environmental and resource

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management. There is a need to establish Data Custodians (leaders) who are able to take on the responsibilities of ensuring that critical data are well managed and accessible. Well managed data includes the establishment of broad stakeholder based approaches in developing standards, collection and maintenance strategies for those data. One organization cannot possibly collect and maintain critical data on its own and partnerships are the key to ensuring that those data are current, accurate and complete. Various program communities need to work together to help support and sustain those key data. Presently organizations are unable to coordinate data collection activities due to political, organizational or financial realities that exist. Lack of funding and support to establish those coordinated efforts are likely the primary reasons for organizations who are involved in data collection and maintenance. All too often data are collected as a result of a reaction to a particular crisis, not for the sake of ensuring and sustaining good quality data that can be used for environmental and resource decision making. This results in rapid collection that is uncoordinated, without standards and generally not maintained. If good quality data were collected and maintained it would be available in the event of a crisis and allow those to react to the crisis, not react to the lack of data.

As indicated earlier, funding of GIS activities are often focused on the development of tools and applications, while very little is put into the management and collection of quality data. It is commonly known that 80% of the cost of implementing a GIS system is data and there has been a significant lack of funding being made available to collect and manage quality data. Tools and applications only showcase what is available but the real value is in the data itself. There are many examples of duplicate data collection activities across jurisdictions and organizations. A very simple example of this would be road information. Roads are collected by many different organizations (federal, provincial, state, municipal, private sector etc.), which take time, money and effort for each organization to collect, store, manage and maintain each of those data. Those collection efforts result in a variety of standards, database designs and accessibility – based on individual organizational needs. The duplication of costs associated with the collection of one data set (that all organizations need) results in a significant waste of time, money and effort (quite often this is all public funding). A more coordinated approach is essential in the current fiscal climate.

The only alternatives to implementing an integrated Great Lakes Basin data and information system are to incrementally implement the required components that would address one or several of the restrictions to achieving this vision. For example, developing strong, sustainable partnerships that cross borders and organizations with funding to ensure the partnerships can be productive (requires meetings, travel and appropriate communication tools) is essential. A cooperative and collaborative approach to information management cannot be established without proper funding and support from senior management. Ad hoc “volunteer” teams are currently developed as the needs arise but those are not sustainable due to lack of funding and support. Partnership development and communication needs to be focused, and formalized, not designated as “5% other duties as assigned” in a job specification. That requires the recognition that partnerships play a major and important role in establishing a cooperative, well managed network of environmental and resource managers. It must

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be realized that the establishment of a strong partnership network takes time and requires champions within the community who can be dedicated to establishing those working relationships across organizations. It cannot be accomplished within a few conference calls, or on a part time, volunteer basis.

Establishing Data Custodians for critical data sets is essential to developing a coordinated approach to the collection and management of those data. Leaders in the field that can work with stakeholder groups to develop comprehensive data standards, which can be accepted within the user community, would forward the overall goals. Data collection and management is costly and it is imperative that organizations work together to establish a cooperative, accessible environment that provides quality data to those who need those data. Reducing the duplication of efforts in collecting data (“collect once, used by many” motto) is a cost effective strategy and should be encouraged throughout the environmental and resource community. If the needs of multiple organizations can be satisfied during a data collection exercise, through the implementation of stakeholder based standards, all organizations would benefit. Field work is expensive and if a project requires a particular data set to be collected it should be collected to satisfy the needs of the broader community, not only a particular project, through the establishment, and stakeholder acceptance, of common standards for those data.

Working with partners to implement web enabled services to access and provide information to partners would provide data access and begin to create a new technological culture comfortable with web based data access and sharing. Agencies need to provide education and training to those organizations that do not have current capabilities. They also need to develop the leadership in the areas of information management both within the stakeholder community, but also within the political community to forward the ideas of strategic planning and project sustainability. There is the alternative to support research on remote sensing and GIS data acquisitions, collaborative approaches, and the capabilities of the data and technologies to meet current and developing needs. This could include developing Centers of Excellence for remote sensing and GIS applications/tools. The development of tools and applications for environmental and resource management should be coordinated, rather than each organization developing those in isolation. Experts should be able to combine resources, expertise and research into new technology so that efforts are not wasted in solving issues that others may have already experienced. Finally, programs to create forums for discussion and collaboration could greatly assist in moving all these agendas forward.

However, pursuing any one or a combination of alternatives can only achieve limited progress toward the over all Great Lakes Information System goals. Only through a deliberate and focused effort to develop the Great Lakes Enterprise Information System will current stakeholder and political expectations be met.

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## Recommended Actions

The Data and Information Team recommends the following actions to implement a data and information system for the Great Lakes Basin:

1. The System goals need to be clearly defined.
2. Create or assign the responsibility for strategic plan development to a group of individuals with the technical and political connections to adequately scope this effort and lay out a systematic implementation plan.
3. Establishment of a Coordinating Committee who can be dedicated to the development of inter-agency partnerships and cooperation across jurisdictions throughout the Great Lakes Basin. This requires senior management support and funding to realize the benefits.
4. Create a specific strategic plan that articulates the issues and solutions. That identifies existing operational models and opportunities for connection, expansion, collaboration, etc. The plan should identify new policies required for implementation and agency rolls in operational oversight.
5. Create an inventory of all existing and pertinent datasets. The logistics of integrating each must be identified. Is there access or viewing constraints (sensitive or protected data)?
6. Identify “tools” both existing and needed (could be models or decision support systems). This should be underway with the decision support group.
7. Develop policies that allow for transfer/access of key data sets between institutions.
8. Basin wide implementation of web services for discovery, reporting and access of data and projects. This process could facilitate the above efforts and begin to educate stakeholders in the power of web-based data/GIS systems.
9. Establishment of strong information management processes throughout community.
10. Establishment of Data Custodians who are dedicated and supported.
11. Development of partnership approaches for data, including; standards, science and research, collection, maintenance, and access/sharing.
12. Funding to ensure that these efforts are sustainable.

## Cost:

Strategic Implementation plan.

- Interagency and technical support required.
- Funded and committed participation
- Estimated 3 FTE's for one year (Canadian, technical, and administrative participants)

Incremental Development and Implementation – four years.

- Operations Team (manager/coordinator, web support, and dba support) -
- Network @ T10
- Servers and storage

Total five year effort – \$2.0 million

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## Research and Monitoring

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### Problem statement

Significant resources are currently devoted to research and monitoring (R&M) to support resource management decisions throughout the Great Lakes region. The R&M is conducted by a variety of organizations representing Federal, Tribal, State, and local governments and the private and public sectors. While there exist efforts at various scales and for various media (air, land, water, wetlands, wildlife) to coordinate the R&M (appendix 1), there is no Great Lakes region-wide strategy to coordinate the effort. This lack of an accepted region-wide strategy prevents the R&M efforts from achieving their maximum societal and resource benefit.

### Desired State

A Great Lakes region-wide R&M strategy that responds to multiple societal and resource objectives is needed. The strategy must be based on sound science and provide consistent data across multiple media (air, land, water, wetlands, wildlife). The strategy must provide an approach to funding the required R&M for the long-term. The strategy must be flexible to address changing societal and resource needs. The strategy should include R&M efforts identified by the other Great Lakes Regional Collaboration strategy teams..

### Assessment of Ongoing Efforts

There have been a number of efforts to develop R&M inventories in the Great Lakes (Appendix 3). These inventories must be pulled together and collaboratively assessed by members of the R&M community. The assessment should assure that all national and regional programs are included (Appendix 4). The assessment should result in figures and tables that describe R&M locations and the data being produced. The assessment should also include the nature of the funding and the long-term funding expectation (Appendix 5). The assessments should probably be conducted by media; however, the individual media based assessment result must be integrated. Additionally, the assessment process must include the description of the desired R&M state for each media. Finally, there should be an assessment of the gap between the ongoing work and the desired state.

### Evaluation of Alternative Strategies

There are numerous examples of efforts to coordinate R&M at a variety of scales (Appendix 6). These examples should be analyzed to determine if there are common activities that are useful to facilitating coordinated R&M. With limited expectation of expanding funding sources, the strategy must either: 1) be primarily built upon the

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adjustment of existing R&M, or; 2) resources must be re-allocated towards a more regionally defined R&M program. It is imperative that whichever approach is selected that the R&M objectives of all stakeholders be included as a part of the strategy.

## Recommended Actions

1. Assess inventories and provide a succinct description of ongoing work;
2. Assess coordination strategies and provide a succinct description of important strategies to include in the Great Lakes collaboration effort;
3. Define a unifying framework to address R&M coordination across all media/strategy teams.

## Costs:

No estimate available.

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## Decision Support

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Decision support in the context of Great Lakes ecological restoration and protection could be defined as a family of systems that includes information resources, established decision making processes, management oversight and communications. A decision support system (DSS) supplements, complements and may amplify knowledge about an environmental, social or economic process. Ordinarily, a DSS is seen as a technological system reliant upon computers that also include observational systems, monitoring programs, relational databases, logic diagrams of processes, and pre-determined or anticipated outcomes or actions. DSSs are not reliant upon any particular architecture, but rather can be developed using a smorgasbord of components, computing systems and management schemes.

Decision support in the context of Great Lakes ecological restoration and protection needs to explicitly address the needs for multiparticipant decisionmaking processes, including groups of individuals (either like-minded or disparate), groups, hierarchic teams or complex organizations. These definitions recognize that decisionmaking is a knowledge-intensive process. That is, the decisionmaker is engaged in acquiring knowledge, selecting previously-stored knowledge, generating new knowledge, assimilating knowledge into storage, and emitting knowledge.

An overarching factor in the design, implementation and management of decision support tools for Great Lakes ecological restoration and protection is the temporal frame that the DSS needs to accommodate. Long-term decision support can involve historic or pre-historic information resources including decadal environmental and anthropogenic trends, longer scale management strategies (e.g., agricultural best management practices, silvaculture, fishery management, lake level regulation) and long-term program metrics. Shorter-term decision support applications could involve habitat restoration prediction and monitoring dealing with improvements in water quality, sediment reduction, invasive control or persistent bioaccumulative toxic (PBT) cleanup.

Real-time or near-real time applications of decision support tools reflect activities that are typically conducted within a one-day (or even hourly) timestep. They are dramatic when available or can be easily conceptualized during design. Examples of these applications include public water supply monitoring, beach management, nearshore hydrodynamic processes, oil and toxic spill response planning and terrorist or natural disaster mitigation.

## Problem Statement

Exploitation of technological tools across the Great Lakes – St. Lawrence River basin is hampered by an array of institutional, technical and funding constraints. Information resources exist but are frequently not readily available. Environmental observation systems function more in a piecemeal fashion than as an integrated whole. Monitoring programs have only recently been inventoried system-wide, but have not been

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rigorously peer-reviewed. The monitoring inventories have not been fully exploited in a comprehensive needs assessment to identify critical data collection and analysis gaps. Some of this analysis is being conducted as a function of the on-going Great Lakes Regional Collaboration with each of the respective strategy teams evaluating the adequacy of existing information system resources and recommending institutional corrections.

Establishment of appropriate indicators of ecological health has made substantial headway, but funding for monitoring programs to assess progress has been very limited.

While many resource management operations can be described verbally, few of them have defined their system engineering requirements in logic diagrams that can be addressed in DSS design. Endpoints for ecological restoration and protection are generally not clearly espoused, curtailing the ability to apply decision support tools.

Broad implementation of decision support technologies requires, at a minimum, the following:

- adequate documentation of information resources;
- comprehensive system engineering models;
- interagency information integration;
- robust information discovery, evaluation and access systems;
- interoperable process models;
- recurring stakeholder discussion forums; and,
- technical training and support.

## **Desired State (Goals)**

The desired state is one that decision support tools are utilized in an efficient, cost-effective, systematic and comprehensive manner which fully utilizes knowledge resources to achieve distinct resource management goals.

## **Assessment of Ongoing Efforts**

Specific on-going decision support activities need to be defined and evaluated within this section.

## **Recommended Actions**

Not defined yet.

## **Cost:**

No estimate available.

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## Communication

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### Problem Statement

Hundreds of independent federal, state/provincial and municipal programs are operating together in the Great Lakes region but with separate missions, audiences and messages. The region has a wealth of environmental monitoring programs, scientific research and environmental planning initiatives underway. Likewise, a wide array of communications tools is currently employed in the region. The quantity of Great Lakes information is growing rapidly along with the tools through which to share the information. However, there is little integration and coordination of communication efforts to adequately share collected information with the many audiences in the Great Lakes.

### Desired Goals

The primary goal is the coordinated communication of scientific and technical information within the Great Lakes region to benefit a wide variety of audiences. These audiences -- both decisionmakers and stakeholders -- may include Congress and policymakers; existing federal, state/provincial, municipal agencies; non-governmental Great Lakes organizations; tribal communities; and the general public, among others. A well-planned and executed Communications Strategy will be integral to the long-term success of the GLRC.

### Assessment of Ongoing Efforts

*A Summary Statement on Existing Great Lakes Communications Tools for Non-technical Audiences* was prepared by the Communications Workgroup. This inventory includes significant regional efforts underway in five areas of communication: Internet/web, email/discussion forums, print publications, meetings/conferences, mainstream media/newspapers. These five channels were identified as the primary routes by which the public currently obtains information about Great Lakes issues.

### Recommended Actions

A comprehensive Communications Strategy is needed to communicate relevant Great Lakes information to specific audiences. Existing regional communications tools (e.g., the Great Lakes Information Network) will be critical components of these efforts. To create this plan the following steps need to be taken. The equivalent of 1-2 FTE dedicated to these actions is advised.

1. Establish a permanent, regional Communications Workgroup to ensure recommendations of the GLRC are put into action. [\$25,000 - 50,000]

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2. Establish the goals of a Communications Strategy. [\$25,000 - 50,000]
  - Clear, credible and backed by science.
  - Cohesive, general messages for use by all participants. The messages should consider the outcomes that are desired.
  - Determine who should develop and execute the strategy and how it would be coordinated, both internally and with other ongoing communications activities (LaMPs, SOLEC, etc).
  - Determine how the strategy would be financially supported.
  - Develop timelines, budgets and responsibilities.
  
3. Develop a detailed current situational analysis. [\$25,000 - 50,000]

Components of this analysis would include the following:

  - Identification of key audiences (not just "the public" but specific groups) and messages/strategies/techniques to communicate with each. The communication objectives should be specified for each audience.
  - Detailed listing of current scientific and technical data generated in the Great Lakes region and how that data can be shared. [This information should be provided by the greater Indicators and Information Strategy Team and liaisons to that team). Determination of any gaps.
  - Detailed listing of the current communication tools available in the region. [Building on the *Summary Statement on Existing Great Lakes Communications Tools for Non-technical Audiences*]
  - An evaluation to determine the relevant information that needs to be communicated. This information would likely be the same information/messages contained in the strategy being developed by the GLRC. Using the GLRC as a starting point, the Communications Workgroup could develop "key messages" for each of the strategy teams. These messages, aimed primarily at the public, could help to explain the GLRC and its mission to a lay audience. "The significance of the Great Lakes in our lives" would be an example message.
  - Benchmarking of successful programs that effectively communicate scientific and technical information in the region.
  
4. Determine specific messages for each audience and the communication tools appropriate to deliver these messages. The strategy should also include effective methods to translate scientific materials for a lay audience. [\$25,000 - 50,000]
  
5. Execute a communications plan (message and delivery channels) for each identified audience. Communication channels may include some or all of the following: web sites, press releases, fact sheets, a toll-free Great Lakes hotline, brochures, press interviews, audio and video, Public Service Announcements, special events and meetings, displays and exhibits, advertising, and others to be determined. Long-term maintenance for communication channels such as web sites and hotlines should be accommodated in this budget. [\$100,000 - 200,000]

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6. Develop and implement an evaluation system to determine the effectiveness of the communications efforts and success in reaching target audiences. [\$10,000 - 20,000]

## **Costs:**

Total estimated initial investment: \$210,000 - 420,000

Total estimated annual investment: \$250,000

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## Glossary of Terms

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**Adaptive Management:** A rigorous combination of management, research, monitoring, and means of changing practices so that credible information is gained and management activities are modified by experience.

**Drivers:** Large scale events or human-related sectors broadly influence many of the pressures on the ecosystem. Examples include energy generation, transport, industry, agriculture and tourism.

**Goal:** A condition or state desired to be brought about through a course of action or program. Goals are usually qualitative statements that provide direction for plans and projects. Goals are not specific numerical limitations, but conditions or states which can be obtained through careful planning and implementation.

**Indicator:** In the context of SOLEC, it is a measurable feature (or features) that provides outcome-oriented, managerially and scientifically useful evidence of environmental and ecosystem quality or reliable evidence of trends in quality.

**Indicator suite for the Great Lakes:** A compilation of indicators necessary and sufficient to characterize the state of the Great Lakes ecosystem, pressures impacting components of the ecosystem, and management actions to alleviate the pressures.

**Lakewide Management Plans (LaMPs):** A comprehensive strategy developed jointly by the United States and Canada to restore and protect beneficial uses in the open waters of each Great Lake.

**Objective:** Specific descriptions of the state of condition that must be met in order to achieve goals and vision.

**Pressure Indicators:** Indicators that provide information about the pressures that modify or influence components of the environment or of human health and well-being. Examples include the amount of pollutants discharged to the environment, the rate of urbanization, the presence of exotic species such as zebra mussels, and the amount of wetlands filled in.

**Remedial Action Plans (RAPs):** Plans that embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern throughout the Great Lakes ecosystem basin.

**Response or Human Activities Indicators:** Indicators that address societal responses give us valuable information about what we are doing to prevent, reduce or eliminate the stresses, and whether we are achieving what we set out to do.

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**State Indicators:** Indicators directly measure environmental conditions, as in “state of the environment” by providing information to help answer questions that concern us such as: Can we eat the fish? Can we swim at the beaches? Can we drink the water? Is the ecosystem healthy and functioning as we would expect?

**Target (or endpoint):** Specific, attainable, quantitative end points for indicators that determine achievement of objectives.

**Vision:** A general description of the desired state of a lake, geographical area, or bioregion that is expressed by a group of stakeholders. A vision statement provides a description of a desired state – it provides direction and establishes a horizon to be sought.

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## References

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### Indicators

Selection of Indicators for Great Lakes Basin Ecosystem Health. Version 3. 1999.  
Prepared by Paul Bertram (U.S. Environmental Protection Agency) and Nancy Stadler-Salt (Environment Canada).

Selection of Indicators for Great Lakes Basin Ecosystem Health. Version 4. 2000.  
Prepared by Paul Bertram (U.S. Environmental Protection Agency) and Nancy Stadler-Salt (Environment Canada).

The Great Lakes Indicator Suite: Changes and Progress 2004. Draft for Comment and Discussion at SOLEC 2004. 2004. Prepared by Christina Forst (ORISE intern to U.S. Environmental Protection Agency), Paul Bertram (U.S. Environmental Protection Agency) and Nancy Stadler-Salt (Environment Canada).

SOLEC documents online at <http://epa.gov/glnpo/solec/index.html>

Process for Selecting Environmental Indicators and Supporting Data, Prepared by U.S. Environmental Protection Agency, Data Quality Action Team, EPA Contract No. 68-W4-0331 D04, October 1997

Jackson, Laura, Janis Kurtz and William Fisher, 2000. Evaluation Guidelines for Ecological Indicators, U.S. Environmental Protection Agency, Office of Research and Development, EPA/620-R-99/005. Research Triangle Park, NC.

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## Background Information

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### Research and Monitoring

- 1) Great Lakes institutional structures that support coordinated R&M (BEC, LAMPs, Sea Grant Research Program, WRRI, IJC-CGLRM, GLC, Great Lakes Beach Assn., LMMCC, WI GW coordinating council, WAVE, Lake Erie and Lake Superior research groups, IJC Science Advisory Board, GLPF, GLFC, etc.)
- 2) Inventory of desired R&M from various strategy teams
- 3) Great Lakes R&M inventories (GLC, Environment Canada, Council Great lakes research inventory, etc.)
- 4) R&M programs in the Great Lakes that may not be captured in current inventories (List of Waters (beach health), Emerging Issues (bacteria, PCP, pharmaceuticals, etc.), EMAP, NAWQA, NOAA Status and Trends, USGS BEST program, etc.)
- 5) Trends in R&M funding (in Great Lakes, in other parts of the country, relative to need, who providing funding, priority funding areas);
- 6) R&M Coordination approaches (IOOS, NMN, CEC EMA, Gulf of Maine, Coast of Louisiana, Cheseapeake Bay, , NWQMC, MDCB, State and Regional Monitoring Councils, Mississippi Gulf Hypoxia Task Force, Pacific Northwest Aquatic Monitoring Partnership

### Communications

#### Existing Communication Tools for Non-technical (i.e., public) Audiences

##### Mainstream Media / Newspapers, TV, Radio

1. Primary: Great Lakes Radio Consortium (broadcast on Public Radio stations regionally)
  - IL – Chicago Tribune, Chicago Sun-Times
  - IN: South Bend Tribune, The Northwest Indiana Times
  - MI: Detroit Free Press, The Detroit News
  - MN: Duluth News Tribune, Minneapolis Star Tribune, St. Paul Pioneer Press
  - NY: Rochester Democrat and Chronicle, The Buffalo News
  - OH: The Toledo Blade, Cleveland Plain Dealer
  - ON: The Globe and Mail, The Windsor Star, Toronto Sun
  - PA: Erie Times-News, Pittsburgh Post-Gazette
  - QE: Montreal Gazette, La Presse, Le Devoir
  - WI: Milwaukee Journal Sentinel, Green Bay Press-Gazette, Green Bay News-Chronicle

Comprehensive list of other media sources at <http://www.great-lakes.net/links/media/>

2. Local TV and radio stations

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## 3. Tribal newspapers and radio

### Web

#### 1. Great Lakes Information Network (GLIN)

[www.great-lakes.net](http://www.great-lakes.net) or [www.glin.net](http://www.glin.net)

Since its inception in 1993, GLIN has provided timely and comprehensive data and information on the environment and economy to the region's scientists, managers, policymakers and residents. GLIN is maintained by the Great Lakes Commission, with development led by a regional advisory board. As subsections of GLIN, several related web sites are notable:

- BeachCast - [www.glin.net/beachcast](http://www.glin.net/beachcast)
- Great Lakes Daily News - [www.glin.net/news](http://www.glin.net/news)
- Great Lakes Hydrology / Current Conditions - [www.glin.net/conditions](http://www.glin.net/conditions)  
Water levels forecasts from U.S. Army Corps of Engineers – Detroit District very popular with boaters/fishers and shoreline property owners.
- The Education And Curriculum Homesite (T.E.A.C.H.) - [www.teachgreatlakes.net](http://www.teachgreatlakes.net) or [www.glin.net/teach](http://www.glin.net/teach)

#### 2. Great Lakes Environmental Directory - <http://www.greatlakesdirectory.org/>

A project of the Environmental Association for Great Lakes Education and the Great Lakes Aquatic Habitat Network & Fund to foster and support a vital, effective grassroots sector working locally to protect the natural resources of the Great Lakes basin.

#### 3. Great Lakes Forever - <http://www.greatlakesforever.org/>

Great Lakes Forever – an initiative led by the Biodiversity Project based in Madison, Wis. – is designed to raise awareness of the ecological value of the Great Lakes and concern about the threats to the ecosystem's health, and to encourage citizen involvement in Great Lakes protection.

Others: Great Lakes Restoration ([www.restorethelakes.org](http://www.restorethelakes.org)), Healing Our Waters ([www.healingourwaters.org](http://www.healingourwaters.org)), Protect the Great Lakes ([www.protectthegreatlakes.org](http://www.protectthegreatlakes.org)), U.S. EPA / Environment Canada programs ([www.binational.net](http://www.binational.net)), and numerous web sites of federal/state agencies and Great Lakes-related programs.

### Email/Discussion Forums

#### 1. glin-announce listserv - <http://www.great-lakes.net/lists/glin-announce/>

Postings include general Great Lakes announcements, new reports, resource management policy issues, requests for proposals, federal budget updates, and announcements of regional conferences or special Great Lakes events. Subscribers: 1,500.

Other GLIN-hosted lists (100+), various issues/workgroups – <http://www.glin.net/lists/>  
Total subscribers ~10,000.

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2. alt.great-lakes newsgroup - <http://news-reader.org/alt.great-lakes/>

Open discussions of the Great Lakes and adjacent places, primarily tourism and fishing-related discussions. Approximately 400 messages per month.

3. Numerous statewide email lists from natural resource agencies, enviro advocacy groups.

## Print

1. Great Lakes Atlas - <http://www.epa.gov/glnpo/atlas>

Published jointly by U.S. EPA and Environment Canada. Third Edition, published 1995.

2. Publications from Great Lakes Sea Grant Network – [www.greatlakesseagrant.org](http://www.greatlakesseagrant.org)

Seven programs serving the Great Lakes region: IL/IN, MI, MN, NY, OH, PA, WI

3. Numerous publications from federal/state/local natural resource agencies.

## Meetings/Conferences

1. Great Lakes Conference / Biennial Meeting of International Joint Commission -

[http://www.ijc.org/2005biennial/about\\_en.php](http://www.ijc.org/2005biennial/about_en.php)

2. State of the Lakes Ecosystem Conference (SOLEC) -

[http://cfpub.binational.net/solec/intro\\_e.cfm](http://cfpub.binational.net/solec/intro_e.cfm)

3. Lakewide Management Plan (LaMP) forums -

<http://www.epa.gov/greatlakes/gl2000/lamps/>

Others: International Association for Great Lakes Research (IAGLR) Annual Conference, numerous state-specific Great Lakes hearings/workshops on Annex, invasive species, etc.

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