Great Lakes Monitoring Inventory and Gap Analysis:

Highlighting Monitoring Activities and Recommendations for Addressing Shortfalls and Improving Monitoring Coordination in the Great Lakes Basin

DRAFT

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Acronyms

AIRS	Aerometric Information Retrieval System
BEC	Binational Executive Committee
DDT	Dichlorodiphenyltrichloroethane
EC	Environment Canada
IADN	Integrated Atmospheric Deposition Network
NOAA	National Oceanic and Atmospheric Administration
PAH	Poly-aromatic hydrocarbon
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
SOLEC	State of the Lakes Ecosystem Conference
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VOC	Volatile Organic Compounds

EXECUTIVE SUMMARY

The Great Lakes Monitoring Inventory and Gap Analysis, funded through a grant from the Joyce Foundation, is the first attempt to develop a comprehensive binational inventory of monitoring programs in the Great Lakes basin and evaluate current levels of monitoring efforts as related to regional monitoring needs. Working with federal, state/provincial, and local organizations, the Great Lakes Commission developed a comprehensive database of descriptive information on current monitoring programs in the Great Lakes basin. In total, information describing more than 600 monitoring programs is contained in the Great Lakes Monitoring Inventory.

Following the initiation of the Great Lakes Monitoring Inventory and Gap Analysis project, the Binational Executive Committee (BEC), a committee composed of US EPA, Environment Canada, state agencies, tribal authorities, and other representatives, requested the development of a framework for a similar regional monitoring inventory effort. The Great Lakes Commission participated in all of the BEC coordinated planning meetings, and, in addition, scheduled several coordination meetings of its own. In order to avoid duplication of effort, it was agreed that all data collected through the Great Lakes Commission and BEC inventory efforts would be mutually exchanged.

Results of the Great Lakes Monitoring Inventory indicate that the majority of sampling programs are found at the state/provincial level, followed by federal government, local government, university, nongovernmental organizations and private organizations. In total, 521 programs were reported for the U.S. portion of the Great Lakes basin, with 123 programs reported for the Canadian portion of the basin. Results indicate that while state agencies manage the largest percentage of reported U.S. monitoring programs, the majority of monitoring by Canadian organizations was reported from the federal sector. The combined U.S. and Canadian monitoring inventory results indicate fairly even geographic distribution of monitoring efforts across the Great Lakes.

A core set of Great Lakes monitoring needs was established to serve as the foundation for analyzing gaps and overlaps in Great Lakes monitoring programs. Using the SOLEC indicators to identify basinwide monitoring needs, twenty-one monitoring categories were identified for the Great Lakes basin. These include fish consumption, drinking water, beach safety, air, water quality, sediment quality, soil quality, groundwater, climate/weather, fish population health, wildlife ecology, aquatic invasive species, benthic and invertebrate ecology, coastal wetlands, plant ecology, habitat and community, atmospheric deposition, nutrient management, land use, erosion, and urban issues. Details of the gap analysis findings are found throughout the report and are summarized below. Most of the findings below focus on gaps in the monitoring system. Please read individual sections of the report to gain a complete picture of the extent of monitoring in the Great Lakes basin.

Highlights from the Gap Analysis Findings

1. Fish Consumption
    - While the US EPA follows the procedures established by the SOLEC indicator for measuring contaminants in sport fish through boneless, skin-on fillets of the dorsal muscle, the Ontario Sport Fish Contaminant Monitoring Program tests contaminant levels from skin-off dorsal fillets.
    - The Ontario program includes both dioxin and dioxin like PCB contaminant levels for establishing fish consumption restrictions while counterparts in the US rely solely on dioxin

like PCB analysis. This discrepancy in analysis methods could limit the usefulness of these data for a Great Lakes basinwide evaluation.

2. Drinking Water
   - Most drinking water monitoring is directed at evaluating treated drinking water systems. Due to the high cost of this type of monitoring, few resources are available for monitoring surface water sources. More resources may need to be directed at monitoring surface drinking water sources to get an accurate understanding of the health of the ecosystem.
   - It appears as if most states and provinces test well water during the well installation process but subsequent testing of wells is not required for single family users. To maintain a set of baseline data the basin may benefit from increasing regulatory monitoring requirements of private, single family, well water systems.
3. Beach Safety
   - While standards are defined at the federal level, states have been given a certain degree of autonomy to design their own monitoring programs to meet their specific needs. This has lead to a decentralization of beach monitoring activities resulting in somewhat inconsistent, disjointed monitoring efforts and beach advisory postings. While each program collects *E. coli* data, the number of sampling sites and frequency of monitoring vary considerably among states and local agencies.
4. Air Monitoring
   - There are concerns about possible network reductions due to budget cuts to ambient air monitoring programs. Concurrently, there are discussions of implementing new U.S. national standards that may require more stringent monitoring efforts. With current levels of funding it may not be possible to maintain an effective network of ambient air monitoring stations.
5. Water Quality
   - While the cost of monitoring increases each year, the level of governmental funding dedicated to water quality monitoring remains the same. The result is a continuous decrease in monitoring efforts in order to stay within previously set budgets. More effort needs to go toward allotting financial resources based on current monitoring needs rather than previously set limits.
   - Michigan's Clean Michigan Initiative bond funding system is a good example of an innovative funding source. Because of this funding system, Michigan has the resources necessary to maintain a comprehensive water quality monitoring program. This type of funding system may serve as a good example for other states and provinces seeking additional financial resources.
   - Limited data on toxic chemical concentrations in offshore waters of the Great Lakes may be a monitoring gap in the Great Lakes basin. It is important to note that toxic chemical concentrations are also measured via indirect methods, such as in sediments and fish tissue. More investigation is needed to determine if the benefits of monitoring the toxic chemical concentrations in water is worth the added expense when similar data are being collected in sediments and fish.
6. Sediment Quality
   - Results of the monitoring inventory also indicate that while there is a considerable amount of issue-driven sediment sampling, more baseline sediment monitoring may be needed. Currently there is little guidance on baseline sampling for open waters and nearshore areas of the basin. To successfully address SOLEC indicators specific monitoring guidelines may need to be developed in this area.
7. Soil
   - Currently, no SOLEC indicator specifically calls for soil monitoring. To develop baseline data on soil characteristics and the potential environmental impacts of alternations, SOLEC participants may want to consider adding an indicator to address soil composition and contamination.

- The US Department of Agriculture National Resources Conservation Service manages the Soil Climate Analysis Network (SCAN). This program is the only U.S. basinwide program collecting real-time soil moisture and temperature locations in the Great Lakes basin. A need for additional sampling locations has been identified and consequently SCAN is seeking to expand its network.

8. Groundwater
   - More resources may need to be directed toward monitoring groundwater discharges in the region. No specific groundwater discharge monitoring programs were reported to the inventory.
   - The USGS gaging station program monitors surface water, groundwater, and water quality extensively across the U.S. portion of the basin. Due to federal, state, and non-governmental budget cuts, funding for this important program is threatened.
9. Climate/Weather
   - Overall monitoring for the climate change indicators appears to be quite complete, but the continuing need for this monitoring should be emphasized to those with budgetary oversight to ensure that monitoring coverage continues.
   - A considerable amount of weather related data is collected at land based stations. While 47 marine buoys are present, they are not as widespread as land-based stations. These differences in spatial coverage may lead to accuracy differences between land and marine temperature models.
10. Fish Population Health
    - A Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state and provincial organizations, has been developed to address fisheries related issues. This partnership framework is a strong example of effective coordination and collaboration and may be used as a model for other areas of Great Lakes monitoring.
    - The Canadian Department of Fisheries and Oceans Great Lakes Fish Contaminants Surveillance Program has been collecting important fish contaminant data since 1977. Funding for this program was cut in the spring of 2005. This has created a gap in regional fish contaminant monitoring and interrupts one of the few Great Lakes long-term fish contaminant monitoring programs capable of documenting trends and changes in the Great Lakes basin.
    - Results of the inventory indicate that more fish habitat monitoring is needed in the Great Lakes basin at both the federal and state and provincial levels in order to fully address SOLEC indicators.
11. Aquatic Invasive Species (AIS)
    - The region would benefit from development of a scientifically based early detection monitoring program. This early detection monitoring strategy should be coupled closely with a rapid response program. This type of monitoring program, which would enable regional managers to effectively and efficiently detect invasions, is important when considering the limited funds currently available.
    - The region would benefit from a coordinating body to organize and record AIS monitoring and management activities. A binational AIS monitoring office is needed to serve as a central location for coordinating monitoring activities and serve as a central resource for AIS related monitoring data.
12. Coastal Wetlands
    - Wetland ecosystem health is seen as a high priority in the region, but additional resources may be needed to reach short and long-term goals set forth by the Great Lakes Strategy. Implementation of a monitoring plan from the Great Lakes Coastal Wetlands Consortium will address most of these goals. In addition, implementation of state wetland monitoring plans called for by the US EPA Office of Wetlands, Oceans, and Watersheds may require additional resources.

- A comprehensive inventory of coastal wetlands has been completed, and landscape level changes can be computed at a course scale, but there are currently no programs to regularly update the individual wetland boundaries.
- There are numerous efforts to restore coastal wetlands, but no programs appear to be tracking restoration success basinwide.

13. Wildlife Ecology
    - Results indicate that Natural Heritage Inventory Programs and related biological community surveys may collect data needed to evaluate the nearshore species diversity indicator. Two potential limitations:
        - Datasets are primarily land-based and
        - The scope may not be focused enough.
    - Wildlife managers in the region and SOLEC decision makers should re-evaluate the wildlife monitoring needs of the Great Lakes basin to determine how best to fill in potential monitoring gaps and coordinate individual species monitoring programs.
14. Benthic and Invertebrate Ecology
    - General monitoring for benthic macroinvertebrate abundance and diversity may be sufficient (except in the Lake Superior basin), but native species may be being overlooked.
    - Zooplankton and phytoplankton are regularly collected at only eleven sites throughout the basin. Also, monitoring for Diporeia and Hexagenia is limited to only a few programs in single lake basins. These programs need to be expanded if a better understanding of the population dynamics of these species is desired.
    - There are a number of programs monitoring mussel populations, but further investigation is needed to determine if this provides a thorough enough investigation into these sensitive native species whose population viabilities are threatened.
15. Plant Ecology
    - Forest age-class and forest successional stage data collection appears to be limited.
    - Little monitoring data are available regarding insect or disease monitoring in terrestrial plant communities.
    - A number of SOLEC indicators need to be further defined in order to properly assess data availability.
16. Habitat and Community
    - A standardized habitat classification map for the entire Great Lakes basin would be highly useful for bringing habitat monitoring together for a basinwide assessment and for focusing stewardship efforts.
    - The Illinois Department of Natural Resources Critical Trends Assessment Program provides a strong example of using species and habitat occurrence data as a foundation for assessing habitat conditions and ecological health. Expansion of this type of program throughout the entire Great Lakes basin would improve availability of important habitat quality information.
17. Atmospheric Deposition
    - The Integrated Atmospheric Deposition Network (IADN) appears to be the only program collecting information on the parameters necessary to evaluate SOLEC's Atmospheric Deposition of Toxic Chemicals indicator. A potential limitation of IADN lies in the distribution of sampling stations and in the corresponding activities at each station.
    - The necessary spatial frequency of sampling locations remains unknown. Atmospheric monitoring of dioxin and mercury is particularly costly, so more research should be conducted to determine the appropriate spatial distribution of atmospheric deposition sampling locations.
18. Nutrient Management
    - Additional effort should be made to compare results from nutrient and pesticide management programs (i.e. rates of growth in implementation) with direct monitoring of nutrients and pesticides in surface waters.
19. Land Use

- Potential limitations to the USGS National Land Cover Characterization Project and the NOAA Coastal Change Analysis Program (C-CAP) are the time periods between dataset development, the spatial resolution of the imagery, and the level of detail of the classification system.
- A more detailed analysis, focused on evaluating specific GIS data needs and availability, should be conducted to identify specific gaps or overlaps in land use and land cover data.

20. Erosion
    - Comprehensive coastal erosion monitoring programs like Pennsylvania's Bluff Recession Monitoring project and Ohio's Lake Erie Coastal Erosion Study are valuable examples of coastal erosion monitoring. It would be useful from a basinwide perspective if other states and provinces in the basin were to implement such monitoring programs.
21. Urban Issues
    - Results indicate that wastewater treatment programs are focused primarily at the local and municipal level. The focus of the Great Lakes Monitoring Inventory did not make it possible to evaluate wastewater treatment monitoring efforts, because the inventory focused primarily on federal and state programs. Additional effort is needed to fill in these informational gaps in the inventory.

Conclusions and Recommendations

The Great Lakes Monitoring Inventory and Gap Analysis is the first comprehensive resource developed to report on monitoring activities in the basin and how these activities meet previously set goals to protect the environmental health of the Great Lakes basin. Recommendations have been developed based on results from the inventory and the analysis of gaps and overlaps in monitoring efforts. These recommendations are divided into two categories: recommendations for improving the Great Lakes basin monitoring network and recommendations for conducting future inventory update efforts.

Monitoring Community Recommendations

These recommendations, based on the results of the monitoring inventory and gap analysis, are general recommendations directed at improving the monitoring network in the region.

1. Form coordinating bodies to organize monitoring efforts in each main issue area. Formation of such coordinating bodies was suggested as a necessary element for effective management of monitoring efforts. An example of such a partnership can be seen in the Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state and provincial organizations, that has been developed to address fisheries related issues. This partnership framework is a strong example of effective coordination and collaboration and may be used as a model for other areas of Great Lakes monitoring.

2. Encourage regular discussions among individuals managing similar monitoring programs. There is currently limited interaction between program managers managing similar monitoring efforts in different parts of the Great Lakes basin within a number of monitoring areas. Conference calls conducted as part of this project led to a number of sideline discussions among program managers about the discrepancies of individual monitoring protocols across the basin. These types of open discussions will increase coordination and collaboration potential across monitoring programs, leading to more comparable datasets to evaluate basin wide trends.

3. The monitoring inventory should be used by the SOLEC indicator working groups as a resource for information on monitoring efforts currently taking place in the region. Currently there is no systematic process in place for identifying monitoring efforts that address each SOLEC indicator. The Great Lakes Monitoring Inventory and Gap Analysis provides the foundation for identifying relevant monitoring efforts. During the next review of SOLEC indicators, reviewers should examine the inventory and this report to better document monitoring programs under each indicator.

4. Evaluate monitoring needs, costs, and current regulations prior to establishing funding levels. Funding levels should be based on resources needed to meet previously set monitoring objectives and regulatory requirements. Funding levels also need to account for constantly changing monitoring costs.

5. Monitoring programs need to be assessed for compatibility. Reporting on SOLEC indicators requires an assessment of programs collecting data and a comparison of results across these programs. In many cases, monitoring for a given indicator is accomplished by a number of programs at various organizations, and often for purposes other than reporting for basinwide indicators. Before summarizing data together from these disparate datasets, it is critical that a compatibility analysis be conducted to determine if the monitoring methods, data analysis and reporting elements are comparable between programs. If it is not, steps will need to be taken to better coordinate programs to allow for direct comparison and aggregation of data.

6. Federal and state monitoring directives and mandates should more carefully look at regional basinwide monitoring needs. Many of the programs included in the inventory are national in scope and are thus designed to meet national objectives. Often, these objectives are not compatible with the informational needs of the Great Lakes or other regions. Regional offices of federal agencies need to work to encourage program administrators to allow greater discretion and flexibility to address regional needs. Similarly, state and provincial and critical local or non-governmental programs need to have the flexibility to be altered to address regional information needs. Without this flexibility, data generated by more narrowly defined monitoring programs may not be useable in a regional context, resulting in monitoring inefficiencies or ineffectiveness.

7. Encourage regional and local level participation at planned monitoring coordination meetings. Regional and local agencies perform a great deal of monitoring in the basin, as evidenced by the results from the monitoring inventory. Their experience and data can be extremely valuable to basinwide monitoring coordination efforts and, if included, could lead to greater monitoring efficiency and effectiveness. Monitoring program managers at state/provincial and key local or non-governmental organizations should be included in monitoring coordination meetings and conferences so that they can take part in monitoring network design.

8. Short-term, small-scale monitoring programs should be balanced with basinwide monitoring initiatives. Monitoring is needed at a variety of levels to address numerous objectives. Both small-scale and basinwide monitoring programs are taking place widely across the basin. Each of these levels of monitoring can provide a great deal of value, and when analyzed in conjunction with one another to provide a deeper understanding of the Great Lakes ecosystem. The Great Lakes monitoring community needs to engage in a direct assessment of monitoring needs and capacities to determine how best to balance the needs for narrowly targeted monitoring with the needs for broad-based, long-term monitoring. When data are not compatible and cannot be made to be compatible, the region needs the ability to set priorities between competing needs.

9. State and regional monitoring programs should better utilize citizen-based or volunteer resources. The monitoring inventory includes a number of examples of citizen or volunteer based monitoring programs. Often these programs are designed to raise the public's awareness of environmental issues, but in many cases, the programs include thorough quality assurance designed to generate credible data. The vast availability of volunteer resources should not be overlooked, as they may provide a cost-effective way to collect broad-scale status and trends data. State/provincial, regional, and federal programs should assess the viability of using volunteer data to enhance the effective monitoring breadth of their programs.

Great Lakes Monitoring Inventory Improvements

The value of the Great Lakes Monitoring Inventory is directly tied to its accuracy and completeness. Development of a comprehensive monitoring inventory is a large-scale, regional effort that takes into account many factors, including participation by the full range of monitoring organizations, as well as information accuracy and completeness. The authors of this report made extensive efforts to collect complete information on the full range of monitoring programs in the basin, but, as this was the first attempt at an initiative of this scale, it is likely that a number of programs were overlooked. In order to improve the utility and the validity of this tool and the associated recommendations for improving monitoring coverage and coordination, steps need to be taken to insure that the Great Lakes Monitoring Inventory accurately and completely reflects monitoring activities in the Great Lakes basin.

The following is a list of recommendations for addressing potential gaps in the monitoring inventory data collection efforts.

1. More detailed information is needed on monitoring efforts in the Canadian portion of the Great Lakes basin. Currently, the representation of Canadian programs in the Great Lakes Monitoring Inventory is limited. The Binational Executive Committee (BEC) monitoring inventory development team focused primarily on collecting information on Canadian monitoring programs, while the Great Lakes Monitoring Inventory focused primarily on U.S. monitoring activities. This split was made to avoid duplication of effort. It was agreed that all program information collected by both parties would be mutually exchanged. The lack of Canadian monitoring program information in the Great Lakes Monitoring Inventory may be the result of a few factors, including 1) the BEC inventory timeline for data collection didn't match the Great Lakes Monitoring Inventory timeline; 2) a more passive data collection effort was employed by the BEC monitoring inventory; or 3) limited monitoring efforts in the Canadian portion of the basin. It should be noted that the Canadian entries that have been submitted into the inventory lack the depth needed to analyze monitoring efforts in sufficient detail. This makes it difficult to perform a valid comparison across monitoring efforts in both Canada and the United States in many cases.

2. The completeness and accuracy of monitoring inventory needs to be regularly evaluated by the Great Lakes monitoring community. While every attempt was made to include all current monitoring programs into the monitoring inventory, programs may have been missed or incompletely represented. A thorough review was conducted prior to publication of this report but it will be important to regularly review the inventory throughout its life so that entries remain current and new programs are added.

3. More information on specific monitoring locations is needed. While programs were asked to submit specific sampling station locations, a minority of program managers provided this level of detail. The result is that the geographic analysis included in the gap analysis is based in large part on general geographic descriptions. The analysis would be much improved with a complete set of

monitoring locations included for each program in the database. As the inventory is updated, it is important that particular emphasis be placed on obtaining monitoring location information.

4. More information is needed on the funding sources that support monitoring programs. This information is necessary to perform an accurate and complete analysis of current funding patterns, reliability of these funding sources and funding needs to address monitoring gaps. While the authors of this report made an effort to include a level of analysis of the reliability and sustainability of funding for monitoring in each analytical section of the gap analysis, in most cases, the funding information was too incomplete to draw realistic conclusions. As the inventory is updated, it is important that emphasis be placed on documenting funding sources and amounts for each monitoring program.

5. Program descriptive information needs to be expanded. For many monitoring program entries, only a subset of the requested information was submitted or available. Much of the information contained in the database was collected from public resources and this information is incomplete. These information gaps were described in each section of the gap analysis. It is important to complete entries for those programs in the inventory with missing information.

6. Active, ongoing data collection efforts should be continued through the Binational Executive Committee (BEC) monitoring inventory effort. As noted above, the entire database of monitoring programs collected through this initiative was shared with the BEC monitoring inventory team. As the parties to the BEC have been called upon to complete this inventory and use it for further planning and coordination of monitoring activities, it may be incumbent upon the BEC's representative agencies to continue management of the inventory.

7. Binational Executive Committee (BEC) Monitoring Inventory field list should be expanded. Expansion of the field list included in the BEC inventory is necessary to capture important elements associated with monitoring efforts, many of which have been captured by the Great Lakes Monitoring Inventory effort. Some of these include funding source, budget, sampling protocol, sampling parameters, sampling station locations, and staff description. Without this information, it is difficult to use the BEC inventory for assessment or coordination purposes.

Conclusions

The Great Lakes Monitoring Inventory includes hundreds of important monitoring programs that each contribute to our overall knowledge about the Great Lakes ecosystem. Each program, in its own way, enhances the effectiveness of resource management in the region. However, few of these programs are designed to yield broad information about the status and trends of the Great Lakes resources as a whole. This gap analysis illustrates many, but not all, of the gaps in environmental monitoring at the basinwide level. It is imperative that the monitoring community and the resource managers that they serve seek out ways to coordinate and combine their knowledge so that Great Lakes resources may be effectively managed as an integrated system. In this way, the monitoring community may make the whole system truly greater than the sum of its parts.

Great Lakes Monitoring Inventory and Gap Analysis:

Highlighting Monitoring Activities and Recommendations for Addressing Shortfalls and Improving Monitoring Coordination in the Great Lakes Basin

Section I. Introduction

The Great Lakes basin, the largest freshwater system in the world, contains more than 20 percent of the world's freshwater supply and more than 95 percent of the surface freshwater found in the United States. The more than 30 million people who live in the Great Lakes basin -- roughly 10 percent of the U.S. population and 30 percent of the Canadian population -- benefit from the drinking water, transportation, power and recreation and other benefits provided by the lakes. The Great Lakes watershed encompasses all of the state of Michigan as well as parts of Illinois, Indiana, Minnesota, New York, Ohio, Pennsylvania, Wisconsin and the Canadian province of Ontario.

As population growth and industrialization pressures increase, the Great Lakes basin faces increasing environmental threats. Currently many efforts are underway to document and monitor the environmental health of the basin. While the Great Lakes basin benefits from the efforts of a multitude of monitoring and data collection agencies and organizations, there remains a great deal of additional progress required in the area of monitoring program coordination and collaboration. This need has been highlighted in recent years by the increasing demand for a more holistic and regionally consistent assessment of the health of the Great Lakes.

In a recent report, the U.S. Government Accountability Office (GAO) concluded that monitoring strategies in the basin are not coordinated in such a way to ensure effective use of limited resources available. [1] The report also states that, at the time the report was released in September 2004, there was no centralized repository of information on monitoring activities. Furthermore, it stated that without such information it is difficult to coordinate existing data and determine what additional information is needed to establish baseline conditions and assess progress toward restoration goals.

The Great Lakes Regional Collaboration (GLRC) is a wide-ranging, cooperative effort to design and implement a strategy for the restoration, protection and sustainable use of the Great Lakes. In 2003, the Great Lakes governors identified nine priorities for Great Lakes restoration and protection. Since their release, these priorities have been adopted by the Great Lakes mayors, the Great Lakes Commission and other Great Lakes leaders. These priorities form the organizing principle for the Great Lakes Regional Collaboration Strategy. The Great Lakes Regional Collaboration Strategy, unveiled in December 2005, specifically addressed the need for improved regional observing and monitoring systems addressed in the Indicators and Information section of the GLRC strategy. The Great Lakes Monitoring Inventory provides a key building block for developing such an observing and monitoring system. Coordination with initiatives such as the Great Lakes Observing System (GLOS), an integrated observing system being developed to provide critical real-time data to the region, will further enhance data coordination and collaboration efforts.

Up to this point, an inventory of monitoring programs for the entire Great Lakes basin had not been developed. This has constrained coordination and collaboration potential among agencies both nationally and binationally. With no centralized location for monitoring program information, there has been a lack of data sharing and aggregate analysis at the basin level. Efforts have been undertaken, primarily within individual lake basins, to coordinate data collection efforts, but until now little has been done to develop a basis for an information network focused on the Great Lakes basin as a whole.

However, one basinwide initiative deserves specific mention for its attempts to define the informational needs in the basin and develop a framework for monitoring coordination and consistent basinwide reporting. The State of the Lakes Ecosystem Conference (SOLEC), co-developed and organized by Environment Canada and US EPA, is an effort to bring scientists and ecosystem managers together from across the basin to develop indicators of Great Lakes health in response to requirements in the Great Lakes Water Quality Agreement. More than a series of biennial conferences, this process has set the stage for developing a cohesive monitoring network for the basin. As described in the methodology sections below, the SOLEC indicators form the basis of the monitoring needs assessment required for an effective gap analysis. The network of SOLEC participants also provided this project with points of contact for obtaining information to complete the monitoring inventory. Further information about the SOLEC process is provided in the Needs Assessment section.

The Great Lakes Monitoring Inventory and Gap Analysis is the first attempt to develop a comprehensive binational inventory of monitoring programs in the Great Lakes basin and evaluate the current level of monitoring effort as they pertain directly to regional monitoring needs. By surveying federal, state, local, university, and nongovernmental organizations, a database of active monitoring programs was developed and will serve as a central location for monitoring program information for the Great Lakes region.

Section II. Project Overview

In 2002, The Joyce Foundation funded the Great Lakes Commission to initiate the Great Lakes Monitoring Inventory and Gap Analysis project. Working with federal, state/provincial, and local organizations, the Commission developed a comprehensive survey of current monitoring programs in the Great Lakes basin. The Great Lakes Monitoring Inventory contains a variety of descriptive characteristics, including, but not limited to, contact information, program description, parameters, geographic characteristics, program funding, and data collection procedures.

Using the results of the monitoring inventory and a list of monitoring needs derived from the SOLEC indicator list, monitoring gaps and overlaps based on geographic coverage, program content, and agency coordination were identified. Management recommendations were developed based on the results of the gap analysis to highlight opportunities for improving monitoring effectiveness and coordination in the Great Lakes basin. Specific recommendations for improving monitoring coverage and coordination across the Great Lakes basin will be distributed to resource managers, federal and state legislators, and the general public.

Section III. Monitoring Inventory

A. Methods

The Great Lakes Commission worked with federal, state/provincial, and local organizations to develop a binational inventory of current monitoring programs in the Great Lakes basin. A project advisory group was created to provide input to the Great Lakes Commission staff. The group was comprised of representatives from U.S. and Canadian government, university, and nongovernmental organizations. This group was called upon to advise on the development of the database structure for the monitoring inventory, the monitoring organization contact list, and preliminary monitoring program inventory. This group was also called upon to provide input on the completeness and accuracy of the monitoring inventory and gap analysis.

The initial list of monitoring organizations and programs was based largely on results from previous monitoring inventory efforts and input from the project advisory group. For this project, monitoring was defined as any active, ongoing project collecting data used to detect environmental changes over time. The inventory effort focused exclusively on active monitoring programs therefore what may appear to be missing information may in fact be a discontinued program. Monitoring organizations were initially contacted via email and asked to submit descriptive information about their monitoring programs via an online survey. Telephone interviews, email, and Internet searches were also used to encourage responses and fill in missing information. The online survey remained open for more than eight months and remains active to facilitate further data collection. The information submitted to the inventory was supplied voluntarily by program managers or other individuals with knowledge about the programs in the survey.

It should be noted that the scope of the data collection effort changed slightly during the course of the project. Following the initiation of the project, the Binational Executive Committee (BEC), a committee composed of US EPA, Environment Canada, state agencies, tribal authorities, and other representatives, requested the development of a framework for a similar regional monitoring inventory effort. The Commission participated in all planning meetings orchestrated under BEC's auspices, and, in addition, scheduled several coordination meetings of its own. These meetings were designed to reach agreement on the regional needs of a monitoring inventory and to coordinate the inventory's content and development requirements. Additionally, the meetings sought to determine the best strategy for developing and distributing an inventory, avoid duplication of effort, and meet the needs of basin resource managers. After unfruitful attempts to synchronize data collection efforts, the Great Lakes Commission decided to focus on U.S. federal, state, local, university, and nongovernmental monitoring activities while the BEC inventory development team focused primarily on Canadian monitoring programs. In order to avoid duplication of effort, it was agreed that all data collected through the Commission and BEC inventory efforts would be mutually exchanged. Unfortunately, data collected through the BEC inventory did not match the depth and breadth of data collected through the Commission's inventory. As a result, there is considerably more detailed information available for monitoring programs conducted by U.S. agencies and organizations. Expansion of the field list included in the BEC inventory is necessary to capture important elements associated with monitoring efforts, many of which have been captured by the Great Lakes Monitoring Inventory effort. Some of these include funding source, budget, sampling protocol, sampling parameters, sampling station locations, and staff description. The Commission made efforts to fill in additional details for programmatic information collected by the BEC process, but much information on Canadian programs is lacking. Upon completion of this report the data collected through the Great Lakes Monitoring Inventory effort will be handed over to the Binational Executive Committee (BEC) monitoring inventory effort for future management.

B. Results

The Great Lakes Monitoring Inventory currently contains information describing more than 600 monitoring programs. The monitoring programs in the Great Lakes Monitoring Inventory range from long-term, basinwide programs run by federal agencies, to local-scale projects run by nongovernmental organizations with limited funding. The monitoring inventory contains extensive descriptive characteristics including, among others, contact information, program description, parameters measured, geographic characteristics, program funding, and data collection procedures. See Appendix A for a condensed list of monitoring programs.

Before results of the Great Lakes Monitoring Inventory are discussed, it is important to note that while considerable effort was made to collect monitoring program information, results relied on voluntary participation from monitoring agencies. Obtaining the participation of monitoring organizations and making contact with the appropriate monitoring program managers or their staff were two key factors influencing results of the inventory. The quality of information in the inventory database was also contingent on the accuracy and specificity of responses to the inventory survey, though efforts were made to clarify responses and fill in missing information through follow-up communication. In addition, in order to avoid duplication of effort, collection of Canadian monitoring program information was left primarily to the BEC monitoring inventory effort. The BEC inventory efforts employed a passive approach to data collection, so relatively little data was available, at the time this report was completed, for the Canadian portion of the Great Lakes basin. The Commission will continue to work – both independently and in cooperation with the BEC monitoring team -- to complete the inventory of Canadian monitoring programs.

Results of the Great Lakes Monitoring Inventory indicate that the majority of sampling programs are found at the state/provincial level followed by federal government, local government, university, nongovernmental organizations and private organizations (Figure 1).

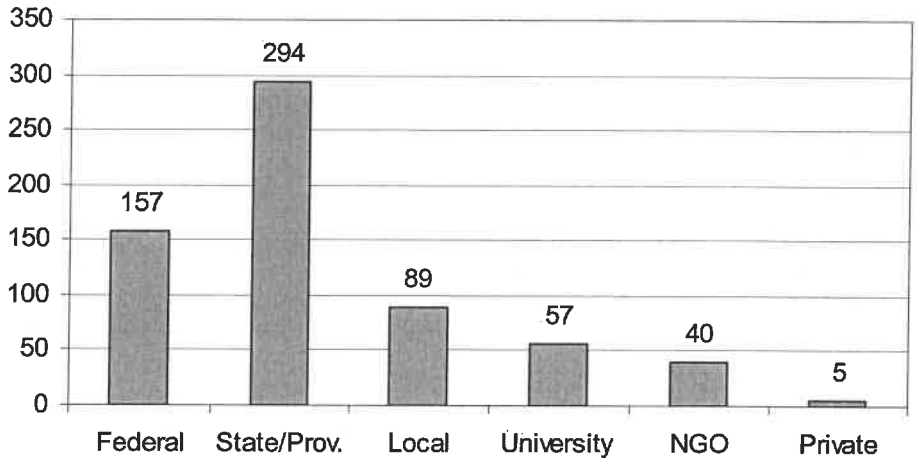

Figure 1. Monitoring programs reported for different agency groups in both U.S. and Canada.

In total, 521 programs were reported for the U.S. portion of the Great Lakes basin, with 123 programs reported for the Canadian portion of the basin. Results indicate that while state agencies manage the largest percentage of reported U.S. monitoring programs, the majority of monitoring by Canadian organizations was reported from the federal sector (Figure 2 and Figure 3).

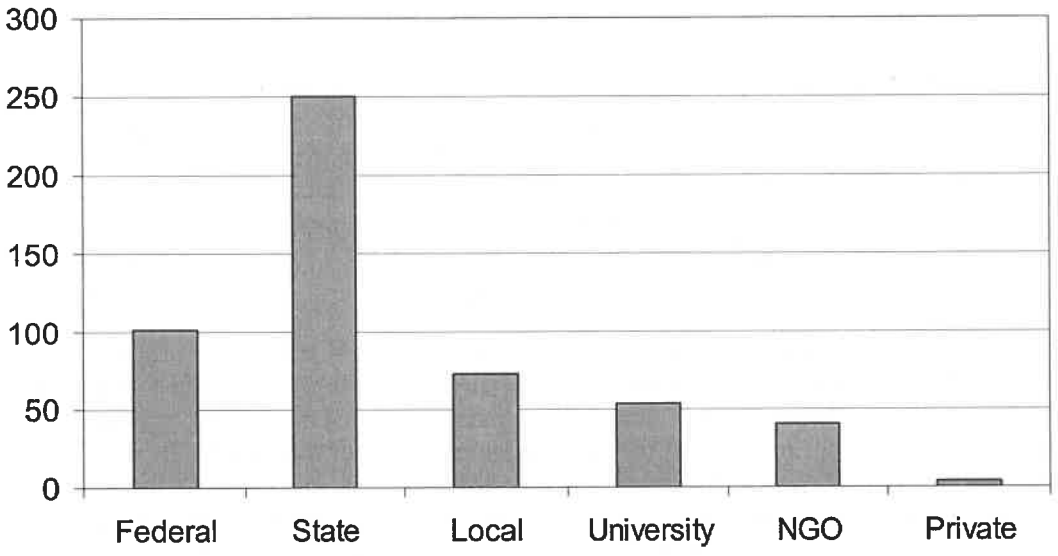

Figure 2. U.S. monitoring programs reported for different organization categories..

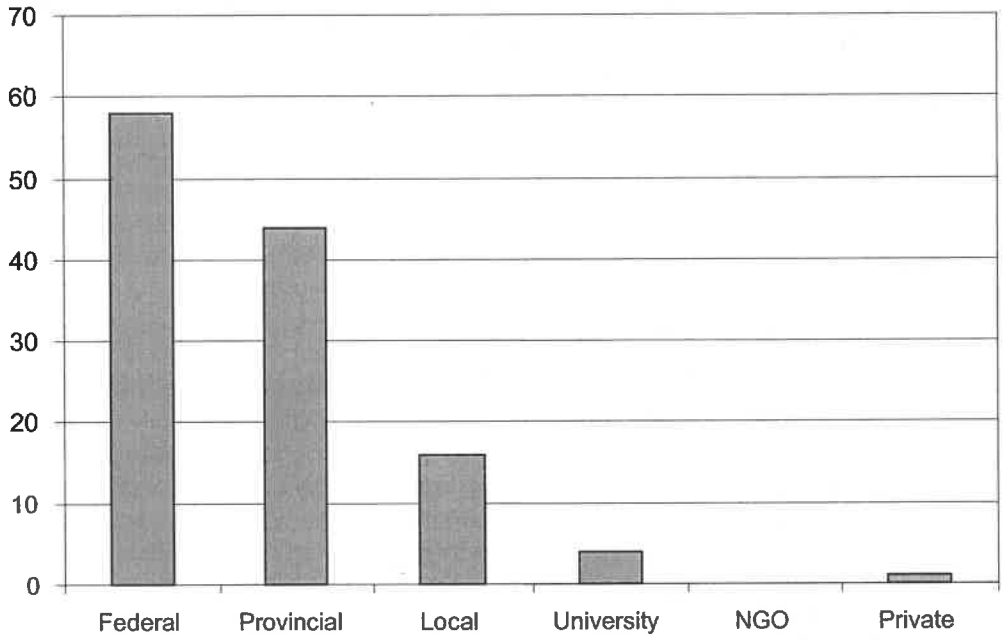

Figure 3. Canadian monitoring programs reported for different organization categories.

The combined U.S. and Canadian monitoring inventory results indicate fairly even geographic distribution of monitoring efforts across the Great Lakes. The greatest number of programs were reported from the Lake Erie basin (341 monitoring programs) followed by Lake Michigan with 299, Lake Superior with 240, Lake Ontario with 198, and Lake Huron with 165 (Figure 4). These numbers include lake basin specific and multi-lake basin monitoring programs..

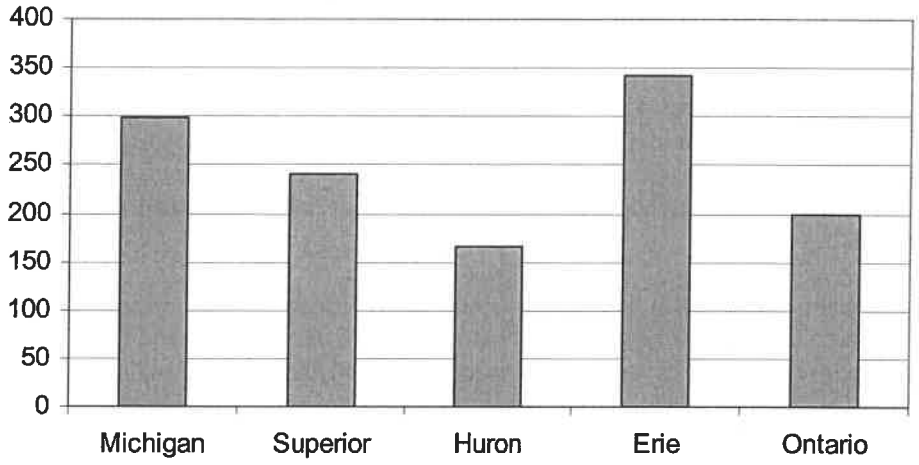

Figure 4. Number of monitoring programs reported for each of the Great Lakes.

Results of the monitoring inventory will be available to Great Lakes resource managers and the general public through a web-based, fully searchable database. Results of the Great Lakes Monitoring Inventory, in combination with the needs assessment discussed in the following section, will be used to evaluate gap and overlaps in Great Lakes monitoring activities.

Section IV. Needs Assessment

A core set of Great Lakes monitoring needs was established to serve as the foundation for analyzing gaps and overlaps in Great Lakes monitoring programs. Because the value of monitoring programs is tied closely with how well the resulting data address key environmental concerns, there is great utility in aligning and evaluating monitoring programs based on these environmental concerns. Therefore, the SOLEC indicators were used as the foundation for a needs assessment for the Great Lakes basin and a list of key monitoring needs was established.

In 1998, SOLEC developed a set of indicators to serve as a baseline for environmental status and trends in the Great Lakes basin. The SOLEC conference is held every two years and an indicator report is generated in the off years in response to reporting requirements in the Great Lakes Water Quality Agreement (GLWQA). The conferences are hosted by the U.S. Environmental Protection Agency and Environment Canada on behalf of the two countries with the purpose of restoring and maintaining the physical, chemical and biological integrity of the Great Lakes Basin.

Since its inception in 1998, the SOLEC indicator list has evolved to include 84 primary indicators for which experts within the Great Lakes – St. Lawrence River system community periodically generate reports. The generation of SOLEC indicator assessment reports relies upon access to supporting data. The 2003 SOLEC Peer Review Report raised a concern regarding the lack of standardization and the subjective nature of the current indicator assessment process. [2] Data identification is often based on informal surveys and best professional judgment. By using the SOLEC indicators as the framework for the Great Lakes needs assessment, the Great Lakes Monitoring Inventory and Gap Analysis project not only identifies monitoring programs that address the SOLEC indicators, it also assesses gaps and overlaps in current monitoring efforts.

Using the SOLEC indicators as the basis, twenty-one monitoring needs were identified for the Great Lakes basin. In order to condense the number of indicators to a more manageable number, the indicators were grouped into four general categories. See Table 1 for a list of the Great Lakes monitoring needs developed for this project and the associated SOLEC indicators.

Table 1. Great Lakes monitoring needs and related SOLEC indicators.

Monitoring Need	SOLEC indicator (indicator number)
Human Health	
Fish Consumption	Contaminants in Sport Fish (#4201)
Drinking Water	Drinking Water Quality (#4175)
Beach Safety	Beach Advisories, Postings and Closures (#4200)
Air	Air Quality (#4202)
Habitat and Biodiversity	
Fish Population Health	Fish Habitat (#6) Salmon and Trout (#8) Walleye (#9) Preyfish Populations and Communities (#17) Lake Trout (#93) Contaminants in Young-of-the-Year Spottail Shiners (#114) Contaminants in Whole Fish (#121) External Anomaly Prevalence Index for Nearshore Fish (#124) Status of Lake Sturgeon in the Great Lakes (#125)
Wildlife Ecology	Contaminants in Colonial Nesting Waterbirds (#115) Contaminants Affecting Productivity of Bald Eagle (#8135)

Monitoring Need	SOLEC indicator (indicator number)
	Nearshore Species Diversity and Stability (#8137) Contaminants Affecting the American Otter (#8147) Breeding Bird Diversity and Abundance (#8150) Threatened Species (#8161)
Non-native Species	Sea Lamprey (#18) Exotic Species (#9002)
Benthic & Invertebrate Ecology	Native Freshwater Mussels (#68) Benthos Diversity and Abundance (#104) Phytoplankton Populations (#109) Zooplankton Populations (#116) Hexagenia (#122) Benthic Amphipod (Diporeia spp.) (#123) Nearshore Species Diversity and Stability (#8137)
Coastal Wetlands	Coastal Wetland Invertebrate Community Health (#4501) Coastal Wetland Fish Community Health (#4502) Coastal Wetland Amphibian Diversity and Abundance (#4504) Contaminants in Snapping Turtle Eggs (#4506) Wetland-Dependent Bird Diversity and Abundance (#4507) Coastal Wetland Area Extent by Type (#4510) Coastal Wetland Restored Area by Type (#4511) Sediment Flowing into Coastal Wetlands (#4516) Phosphorus and Nitrogen Levels (#4860) Effect of Water Level Fluctuations (#4861) Coastal Wetland Plant Community Health (#4862) Land Cover Adjacent to Coastal Wetlands (#4863) Human Impact Measures (#4864)
Plant Ecology	Health of Terrestrial Plant Communities (#8162) Forest Health Criterion #1: Conservation of Biological Diversity (#8500) Forest Health Criterion #2: Maintenance and Productive Capacity of Forest Ecosystems (#8501) Forest Health Criterion #3: Maintenance of Forest Ecosystem Health and Vitality (#8502) Forest Health Criterion #4: Conservation and Maintenance of Soil and Water Resources (#8503)
Habitat and Community	Area, Quality, and Protection of Lakeshore Communities (#8129) Nearshore Species Diversity and Stability (#8137) Protected Nearshore Areas (#8149) Status and Protection of Special Places and Species (#8163)
Land Use and Human Impact	
Atmospheric Deposition	Atmospheric Deposition of Toxic Chemicals (#117) Acid Rain (#9000)
Nutrient Management	Sustainable Agricultural Practices (#7028) Nutrient Management Plan (#7061) Integrated Pest Management (#7062)
Land Use	Land Cover-Land Conversion (#7002) Ground Surface Hardening (#7054) Habitat Fragmentation (#8114) Extent of Hardened Shoreline (#8131) Nearshore Land Use (#8132) Extent and Quality of Nearshore Natural Land Cover (#8136)

Monitoring Need	SOLEC indicator (indicator number)
	Artificial Coastal Structures (#8146)
Erosion	None
Urban Issues	Commercial/Industrial Eco-Efficiency Measures (#3514) Household Stormwater Recycling (#3516) Urban Density (#7000) Brownfield Redevelopment (#7006) Water Withdrawal (#7056) Energy Consumption (#7057) Solid Waste Generation (#7060) Municipal Wastewater Treatment (#7063) Vehicle Use (#7064)
General Monitoring	
Water Quality	Phosphorus Concentrations and Loadings (#111) Toxic Chemical Concentrations in Offshore Waters (#118)
Sediment Quality	Concentration of Contaminants in Sediment Cores (#119) Sediment Available for Coastal Nourishment (#8142)
Soil	None
Groundwater	Natural Groundwater Quality/Human-Induced Changes (#7100) Groundwater and Land: Use and Intensity (#7101) Base Flow Due to Groundwater Discharge (#7102) Groundwater Dependent Animal and Plant Communities (#7103)
Climate/Weather	Climate Change: Ice Duration on the Great Lakes (#4858) Climate Change: Effect of Crop Heat Units (#9003)

These Great Lakes monitoring needs serve as the basis of comparison and analysis within the monitoring gap analysis. There are a number of SOLEC indicators that were not addressed through this process. These include Commercial/Industrial Eco-Efficiency Measures (#3514), Household Stormwater Recycling (#3516), Biologic Markers of Human Exposure to Persistent Chemicals (#4177), Geographic Patterns and Trends in Disease Incidence (#4179), and Economic Prosperity (#7043). In addition, the monitoring inventory did not target economic, epidemiological or social monitoring and, therefore, no relevant information was collected to evaluate these indicators. It is also important to note that a few of the SOLEC indicators fall into more than one need category.

Section V. Gap Analysis

A. Methods

Determining the extent of current monitoring programs and understanding where gaps in monitoring exist is an important first step in achieving broad coordination and collaboration among monitoring organizations. Understanding the scope of monitoring performed and how it relates to Great Lakes basin monitoring needs is also crucial in order to develop of an effective and efficient regional monitoring strategy.

To identify gaps and overlaps in monitoring efforts, the monitoring inventory was evaluated within the structure of the monitoring needs assessment. The 21 monitoring needs categories are closely aligned with the SOLEC indicators established to target regional restoration goals. (See Table 1 in the previous section for links between these key management need areas and SOLEC indicators.) To conduct this analysis, the monitoring programs were first associated with one or more of the indicators by examining the program goals and description. The indicators were then assessed by comparing monitoring program characteristics with the purpose and intent of each indicator as defined through the SOLEC process. Throughout this report any mention of indicators refers to the SOLEC indicators. Commission staff specifically examined each monitoring program or groups of programs addressing a given indicator by geographic distribution, sampling frequency (or level of effort), parametric specificity and programmatic sustainability (as determined by the stability and source of funding). Each of the monitoring needs categories presented below reviews current monitoring programs followed by a findings section that addresses potential monitoring gaps and possible areas to focus on to increase efficiency of monitoring programs in the basin.

B. Results

Programs in the monitoring inventory were analyzed in relation to previously-identified monitoring needs for the Great Lakes basin. Related needs are grouped into four sections addressing the broad categories of Human Health; General Monitoring; Habitat and Biodiversity; and Land Use and Human Impact.

The findings presented in this section represent potential monitoring gaps or areas of concern in the Great Lakes basin monitoring efforts as reported to the Great Lakes Monitoring Inventory. As the monitoring inventory evolves and becomes more complete, it may be found that the gaps initially identified are not truly gaps but rather missing information.

1. Human Health
a. Fish Consumption

A major human health concern in the Great Lakes basin is consumption of contaminated fish. Bioaccumulation, the build-up of chemicals from the environment in the aquatic food chain, is the primary reason for the high contaminant concentrations in Great Lakes fish. Through environmental deposition or direct environmental pollution, chemical contaminants are fed into an ecosystem and, in turn, absorbed into tissues of organisms in that ecosystem. The concentration of some chemicals in the tissues of top predators, such as lake trout and large salmon, can be millions of times higher than the concentration in the water. Some of the contaminants of concern are mercury, polychlorinated biphenyl (PCB), and persistent bioaccumulative toxic chemicals[3].

States and provinces have primary responsibility for developing their own fish consumption guidelines to protect the public from health risks associated with eating contaminated fish. The primary contaminants

that are generally monitored are mercury, PCBs, chlordane, dioxins, and DDT. Using fish contaminant levels collected from state wide monitoring programs and accepted human levels of contaminated fish consumption, U.S. states typically issue five types of advisories and bans, including no-consumption advisories for the general population, no-consumption advisories for sensitive subpopulations, restricted-consumption advisories for the general population, restricted-consumption advisories for sensitive sub-populations, and commercial fishing ban [4].

The goal of the Contaminants in Sport Fish (#4201) indicator is to assess the levels of mercury, dioxin and PCBs in Great Lakes sport and commercial fish and determine the potential harmful effect of consumption of contaminated fish on human health. Official SOLEC requirements of this indicator are to determine contaminant levels from a 5 fish composite made up of boneless, skin-on fillets of the dorsal muscle. Based on inventory results, the Great Lakes region has 18 monitoring programs that address fish consumption concerns related to human health. Each of the eight Great Lakes states and the province of Ontario has dedicated fish contaminant monitoring programs. These programs will be discussed in more detail below.

Illinois – Illinois Environmental Protection Agency manages the state's *Fish Contaminant Monitoring Program*. The objectives of the Illinois *Fish Contaminant Monitoring Program* are to detect the presence and build-up of toxic and potentially hazardous substances in fish; determine the impact of fish contaminants upon aquatic environments; and provide information to aid in the location of contaminant discharge. In the small portion of Illinois that lies within the Great Lakes basin, there are 17 areas where fish advisory data are collected. Data are collected on mercury, PCB, and a number of other pesticides and contaminants, but there is no specific mention of dioxin. No specific information is available on sampling frequency or funding.

HIGHLIGHT – Fish Consumption

- While the US EPA follows the procedures established by the SOLEC indicator for measuring contaminants in sport fish through boneless, skin-on fillets of the dorsal muscle, the Ontario Sport Fish Contaminant Monitoring Program tests contaminant levels from skin-off dorsal fillets.
- The Ontario program includes both dioxin and dioxin like PCBs contaminant levels for establishing fish consumption restrictions while counterparts in the US rely solely on dioxin like PCB analysis. This discrepancy in analysis methods could limit the usefulness of these data for a Great Lakes basinwide evaluation.

Indiana – Indiana Department of Environmental Management manages the *Fish Tissue Contaminants Monitoring Program*. The goal of this program is to support issuance of fish consumption advisories, monitor for trends, and collect information on effects to wildlife. The primary sampling parameters are percent moisture, percent lipid, metals, organochlorine compounds, PAH, PBDE, semivolatiles, and VOC. This program reported that currently there are more than 40 sampling locations that cover the entire Lake Michigan and Lake Erie watershed within the State of Indiana on a rotating 5 year basis. Sites are selected to cover a large number of locations including sites specifically on the St. Joseph River, Trail Creek, Burns Harbor, the Grand Calumet River/Indiana Harbor Canal, the St. Joseph (Erie), St. Mary's and Maumee River. It was reported that the state of Indiana provides the funding for this program but no specific information was given regarding which type of funds are used.

Michigan – The objectives of Michigan Department of Environmental Quality's *Fish Contaminant Monitoring Program* are to evaluate the need for sportfish consumption advisories and commercial fishing regulations; identify spatial and temporal trends, and evaluate the effectiveness of existing programs. Twenty six fixed station sampling sites monitor whole fish for mercury, PCBs, and pesticides biennially. Edible portion samples are collected for analysis to support consumption advisory development. The number and location of these sites varies from year to year. Caged fish studies have been conducted to varying degrees in about 40 watersheds. Studies are repeated as needed in problematic watersheds. While monitoring efforts include sampling contaminants in caged fish, edible portion and whole fish, only a subset

of the data includes information relevant to the Contaminants in Sport Fish (#4201) indicator, which requires testing of the edible portion of the fish. Primary funding for this project comes from Michigan's general state funds and the Clean Michigan Initiative.

Minnesota – Minnesota Department of Natural Resources manages the state's *Fish Contaminant Monitoring Program*. Approximately every 5 years, this program samples and analyzes for contaminants, including mercury and PCBs, in common fish species. There was no specific mention of dioxin monitoring. Funding for this program comes from the state general fund and also the game and fish fund.

New York – New York State Department of Environmental Conservation manages the state's *Sportfish Contamination* program. This program monitors fish contamination throughout New York waters for PCBs, organochlorides, mercury, and dioxins. No further information is available on sampling frequency or funding.

Ohio – The Ohio Environmental Protection Agency manages *Ohio's Sport Fish Tissue Monitoring Program*. This program collects fish samples and evaluates the tissue contaminant data to issue the appropriate fish consumption advisories. The parameters monitored for this program include chlordane, dieldrin, mirex, PCBs, DDT, mercury and heavy metals. No further information is available regarding sampling frequency or funding.

Pennsylvania – Pennsylvania Department of Environmental Protection's *Fish Consumption Advisory* program provides guidance to individuals or segments of the population at greater risk from exposure to contaminants in fish. Program officials did not provide specific information for this program.

Wisconsin – The objectives of Wisconsin Department of Natural Resource's statewide *Fish Contaminant Program* include protection of fish consumers, resource management, and environmental protection. This program has been in place since the mid-1970s. Fish are collected from approximately 50 to 100 sites each year. Current analyses include about 600 samples analyzed for mercury, 350 for total PCBs, 30 for banned pesticides, 20 for dioxin/furan analysis and 10 for PBDEs. Monitoring consists of different components including baseline, advisory, Great Lakes, and trend monitoring. Baseline Fish Contaminant monitoring focuses on sampling new sites and sites where contaminant data are old or limited, or where existing data shows that concentrations may be high and additional data would be beneficial to determine advisory needs. Advisory Fish Contaminant Monitoring refers to monitoring of fish for contaminants where PCB based fish consumption advice is in place and monitoring is conducted to update consumption advice. This monitoring is generally conducted in major industrial rivers and locations where remediation may be necessary. Great Lakes contaminant monitoring consists of collection of fish for contaminant analysis on a biennial basis. Samples include both game fish and forage fish from Lake Superior and Lake Michigan. The final component of this program is to determine trends and geographic patterns of contamination for general DNR staff use. Funding for this program currently comes from a number of sources. Collection of fish is supported by fisheries staff sampling through other programs. Analysis of samples is supported by the Wisconsin State Laboratory of Hygiene and EPA Clean Water Act Performance Partnership Grant 106 funds. Other supplies and processing are also supported by Clean Water Act funds. Gaps include limits on the number of sites where fish can be collected each year, the number of fish that can be processed, and the number and types of analytes that can be assayed on each sample.

Ontario – Ontario Ministry of the Environment/Ontario Ministry of Natural Resources manages the *Ontario Sport Fish Contaminant Monitoring Program*. This program samples the skin-off dorsal fillets of fish collected around Ontario are analyzed for a suite of contaminants (e.g. PCBs, mercury, mirex, DDT, dioxins/furans). These contaminant levels are used to produce fish consumption restrictions (advisories) in the Guide to Eating Ontario Sport Fish. The *Sport Fish Contaminant Monitoring Program* monitors persistent toxic contaminants in sport fish in the Great Lakes and selected inland lakes and rivers. The

contaminant levels are analyzed and used to develop sport fish consumption advisories (recommended meals per month) based on health protection guidelines from Health Canada. The Program advises the public on safe levels of sport fish consumption through the biennial production of the Guide to Eating Ontario Sport Fish. It should be noted that this program includes both dioxin and dioxin like PCBs contaminant level analysis for establishing fish consumption restrictions while counterparts in the US rely solely on dioxin like PCB analysis.

A number of human health related fish monitoring programs take place at the federal level. US EPA manages the national *Fish Consumption Advisories program.* The Great Lakes National Program Office manages the *Great Lakes Fish Monitoring Program (GLFMP).* The GLFMP consists of two separate elements, an Open Lakes Trend Monitoring Program for whole fish (Element 1) and a Game Fish Fillet Monitoring Program (Element 2) to assess the risks of persistent and bioaccumulative contaminants on the health of the fishery, and on the fish consuming wildlife. Element 1 of the GLFMP is directed at monitoring contaminant trends in the open water of the Great Lakes, and assisting in evaluating the impacts of contaminants on the fishery. Element 2 of the GLFMP is directed at monitoring potential human exposure to contaminants through consumption of popular sport species, as well as providing temporal trend data for top predator species, which have shorter exposures than the lake trout collected in Element 1. Coho salmon and Chinook salmon are collected from Lakes Michigan, Huron, Ontario, and Superior and rainbow trout are collected from Lake Erie during the fall spawning run. Composites of each species, consisting of five individual fish fillets, are analyzed for organic contaminants to assess potential human exposure and to compare it to the meal advice set forth in the *Protocol for a Uniform Sport Fish Consumption Advisory.* These data complement those from Element 1. Trends are not meant to be concluded from Element 2, as the voluntary nature of the program does not allow for consistent collection of salmon from year to year. For trend analysis, GLNPO is currently using only the fish tissue contaminant data for coho salmon from Lake Michigan that are larger than 500 mm. The GLFMP currently collects samples, for both elements of the program, from a set number of sites per lake. Collections alternate on a yearly basis, with even and odd year collections. Element 2 samples consist of 5 skin-on fillets for a total of 15 fish collected per site. The GLFMP currently utilizes an established chemical parameter list for analysis that includes OC pesticides, PCBs, Mercury, and some emerging contaminants of concern. While EPA does not issue fish consumption advice, Great Lakes States and Tribes include GLFMP data in their data sets as a way to increase robustness.

Another federal program managed by the U.S. Geological Survey is the *National Contaminant Biomonitoring Program Database.* With 16 monitoring locations in the Great Lakes basin, this program seeks to document trends in occurrence of persistent toxic chemicals in fisheries. Parameters included in this program are PCB, dieldrin, mercury, DDT, and other contaminants. U.S. Geological Survey also manages the *National Water Quality Assessment Program* (NAWQA) which includes some fish contaminant sampling. In the Great Lakes basin the NAWQA program focuses on western Lake Michigan drainages and Lake Erie-Lake St. Clair drainages.

Another federal program working on fish contamination issues in the Great Lakes basin is the *Great Lakes Human Health Effects Research Program* (GLHHERP), conducted by the Center for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR). This program is designed to characterize exposure to contaminants via consumption of Great Lakes fish, and investigate the potential for short- and long-term adverse health effects. Rather than focusing on measuring contaminant levels in fish this program focuses on determining the effect of fish consumption on humans. This program provides the human health effects research needed for establishing fish consumption advisories.

For additional information on fish monitoring not directly related to human health please refer to the contaminants discussion in the fish ecology section of this report.

Findings – Fish Consumption

The goal of the Contaminants in Sport Fish (#4201) indicator is to assess the levels of mercury, dioxin and PCBs in Great Lakes sport and commercial fish and determine the potential harmful effect of consumption of contaminated fish on human health. Official requirements of this indicator are to determine contaminant levels from a 5 fish composite made up of boneless, skin-on fillets of the dorsal muscle. Monitoring inventory results indicate that while the US EPA follows the procedures established by the SOLEC indicator for measuring contaminants in sport fish through boneless, skin-on fillets of the dorsal muscle, the *Ontario Sport Fish Contaminant Monitoring Program* tests contaminant levels from skin-off dorsal fillets. This discrepancy in analysis methods could limit the usefulness of these data for a Great Lakes basinwide evaluation.

The primary responsibility for fish contaminant monitoring and development of human health advisories lies at the state and provincial levels. The U.S. state-based fish contaminant monitoring programs appear to be funded primarily at the state level. While there are federal requirements for each state to develop fish consumption advisory guidelines and all states are participating in such projects, there is considerable variability from state-to-state in the scope of monitoring, sampling frequency, and parameters measured. The three contaminants required by the Contaminants in Sport Fish indicator include mercury, PCB, and dioxin. In all of the state-managed fish contaminant monitoring programs for which sampling parameter information was available, fish tissues were sampled for mercury and PCBs, but it appears that Illinois, Indiana, Minnesota, and Ohio do not monitor for dioxin. EPA does not issue fish consumption advice, but Great Lakes States and Tribes include data collected through the US EPA *Great Lakes Fish Monitoring Program* in their data sets as a way to increase robustness.

Ontario Ministry of the Environment/Ontario Ministry of Natural Resources manages the *Ontario Sport Fish Contaminant Monitoring Program*. This program samples the skin-off dorsal fillets of fish collected around Ontario are analyzed for a suite of contaminants (e.g. PCBs, mercury, mirex, DDT, dioxins/furans). These contaminant levels are used to produce fish consumption restrictions (advisories) in the Guide to Eating Ontario Sport Fish. It should be noted that this program includes both dioxin and dioxin like PCBs contaminant levels for establishing fish consumption restrictions while counterparts in the US rely solely on dioxin like PCB analysis.

Human Health
b. Drinking Water

The effort to protect drinking water quality has emerged as a key environmental issue in the Great Lakes basin. The Drinking Water Quality (#4175) indicator assesses the chemical and microbial contaminant levels in drinking water and evaluates the potential for human exposure to drinking water contaminants. This indicator is measured by the number and proportion of drinking water systems that fail to meet water quality regulations. While federal and state agencies set and enforce drinking water standards, each supplier is responsible for the quality of drinking water produced at that facility. While municipalities and their associated drinking water systems undertake significant drinking water quality monitoring programs, the monitoring inventory did not collect monitoring information from each drinking water facility but rather collected program information at federal, state and local government levels.

The following discussion is broken down into two components: public drinking water monitoring and private well testing.

Public Drinking Water Monitoring

U.S. Environmental Protection Agency's Safe Drinking Water Act (SDWA) requires states to develop and implement Source Water Assessment Programs (SWAP) to analyze existing and potential threats to the quality of the public drinking water. Each of the states in the Great Lakes basin has completed a SWAP which includes delineation of source water protection areas; contaminant source inventory; determining the susceptibility of public water supply to contamination from the inventoried sources; and release of assessment results to the public. Because each SWAP draws data from existing state run programs, each state's SWAP will not be discussed in detail but to the extent possible the inventory will address the drinking water monitoring programs supplying data to the SWAP.

U.S. Environmental Protection Agency maintains the *Safe Drinking Water Information System (SDWIS).* SDWIS contains information about public water systems and EPA drinking water regulation violations at these facilities. This database has been in operation since 1993. A website developed for this system provides a listing of all water systems required to submit water quality data. Public water utilities are responsible for monitoring the quality of drinking water provided. Owners of private wells are not required to monitor drinking water quality and are therefore excluded from this list.

HIGHLIGHT – Drinking Water

- Most drinking water monitoring is directed at evaluating treated drinking water systems. Relatively few resources are available for monitoring surface water sources. More resources may need to be directed at monitoring drinking water sources to get an accurate understanding of the health of the ecosystem.
- It appears as if most states and provinces test well water during the well installation process but subsequent testing of wells is not required for single family users. To maintain a set of baseline data the basin may benefit from increasing regulatory monitoring requirements of private, single family, well water systems.

Results of the monitoring inventory show that the following programs collect information in support of SDWIS. The Indiana Department of Environmental Management manages the *Public Water Supply Information* – an online database that provides descriptive information as well as chemical results for public water supplies. Michigan Department of Environmental Quality manages the *Public Drinking Water Chemical Database* which is the state's major source of drinking water data. The *Michigan Source Water Assessment Program* identifies areas that supply public drinking water and inventories contaminants and susceptibility of water to contamination. The Minnesota *Source Water Assessment Program* presents the results of source water assessments online and includes the contribution area for a well or intake; the susceptibility of the source of drinking water to contamination; and contaminants that are of concern to the users of a pubic water supply. Ohio EPA Division of Drinking and Ground Waters manages their *Public Water System Supervision Program* (PWSS). This program was established by the US EPA to ensure that water is safe for human consumption. The Ohio EPA is responsible for scheduling chemical and bacteriological monitoring for Ohio's 5,425 public water systems, reviewing water quality results, determining compliance and enforcement of non-compliant systems. Public water system operators monitor treated drinking water for approximately 100 contaminants on a monthly, quarterly, annual or triennial basis. The Pennsylvania Department of Environmental Protection manages the state's *Drinking Water Reporting System.* This system is an online database of drinking water facilities and sampling results. Wisconsin Department of Natural Resources manages a number of drinking water monitoring programs. The purpose of the *Groundwater Retrieval Network (GRN)* is to link groundwater data residing in various database systems into one central location for analysis. This system reports data from the Department's Public Water Supply (public drinking water supply wells), Private Water Supply (private drinking water supply wells, non-point source priority watershed projects, and special groundwater studies), the Bureau of Waste's Groundwater and Environmental Monitoring System (GEMS) (landfill wells) and the Bureau of Watershed Management's System for Wastewater Applications and Monitoring Permits (SWAMP). Wisconsin DNR also manages the *Public Water Monitoring Program* which includes monitoring

of treated drinking water quality data for groundwater and surface water systems as well as untreated water quality data from groundwater systems. The Wisconsin Department of Agriculture, Trade and Consumer Protection also maintains a *Groundwater Pesticide and Nitrate Database.* Public drinking water monitoring programs found at the local level include Michigan's Oakland County *Drinking Water Supply Program, Well Protection and Education Code* and the New York Cayuga County Health Department *Public Water Supply Monitoring.*

A Canadian program complimentary to US EPA's SDWIS is Ontario Ministry of the Environment's *Drinking Water Surveillance Program (DWSP).* DWSP is a monitoring program developed to provide reliable information on municipal drinking water. DWSP is not a compliance-driven monitoring program. Rather, participation of water supply systems in DWSP is voluntary. This program monitors the chemical composition of drinking water at approximately 150 water systems. In addition Ontario Ministry of the Environment's *Provincial (Stream) Water Quality Monitoring Network (PWQMN)* collects surface water quality information from rivers and streams at over 350 strategic locations throughout Ontario.

Well Water and Investigatory Monitoring

It appears as if most states and provinces test well water during the well installation process but subsequent testing is not required.

The Illinois Environmental Protection Agency manages two programs that evaluate drinking water quality. Illinois' *Groundwater* program provides an overview of the groundwater conditions at community water supply wells in Illinois and provides an overview of groundwater conditions in the major aquifers in Illinois. Among a host of other tasks, the Illinois *Intensive Basin Survey* assesses the success of current procedures to meet drinking water goals. Michigan Department of Environmental Quality's *Drinking Water Contamination Investigation Program* conducts drinking water testing in areas with known or suspected environmental contamination. Minnesota Pollution Control Agency's *Ambient Ground Water Quality Monitoring* consists of a network of 100 to 150 shallow monitoring wells and 100 to 150 deeper drinking water wells. The shallow wells provide an early warning network of initial changes in water quality. The deeper wells provide information about the quality of water that people are drinking. Each well is sampled biennially. Chemical parameters include nitrate, volatile organic compounds, and chloride. The Minnesota Department of Health conducts health risk assessments relating to groundwater once contamination is detected and works with counties to establish water quality databases for private wells. Minnesota currently conducts very limited sampling in the northern areas of the state. More resources may need to be directed at this region. The New York State Department of Health Wellhead *Protection Program* works to protect the ground water sources and wellhead areas that supply public drinking water systems from contamination. In addition, the New York State Department of Environmental Conservation's Division of Water conducts *Ground Water Monitoring* throughout the state. Each year's sampling attempts to monitor selected private and public wells, surficial and bedrock wells, and other geographic areas. For Wisconsin's *Town-based Arsenic Sampling* program homeowners in Outagamie and Winnebago counties sample their well water for arsenic. This data set was developed to evaluate the extent of naturally occurring arsenic in private wells in Northeastern Wisconsin. The Central Wisconsin Groundwater Center administers a *Private Well Water Testing Program* which includes a comprehensive database. U.S. Geological Survey *Groundwater Observation Network* includes water levels measured in approximately 120 wells throughout Wisconsin. The network is part of a comprehensive and ongoing effort to maintain a water resource database responsive to the needs of the state and the nation. Approximately 20 wells are measured daily with electronic recorders; the remainder are measured on a weekly, monthly or quarterly basis by staff or observers.

Ontario Ministry of the Environment's *Drinking Water Surveillance Program (DWSP)* is a monitoring program developed to provide reliable information on municipal drinking water but it also monitors raw

water from well supplies. In addition the *Provincial Groundwater Monitoring Network (PGMN)* also collects data on groundwater quantity and quality.

Heidelberg College National Center for Water Quality Research conducts the *Cooperative Private Well Testing Program.* This is a voluntary program focusing on analysis of water from private wells, and interpretation of the results in the contexts of shallow groundwater quality and human health risks from contaminants in well water. More than 50,000 wells have been tested through this program including sites throughout the entire Great Lakes basin with the majority focused in Ohio. The National Center for Water Quality Research also manages a *Tributary Monitoring Program* that collects highly detailed data on concentrations of a wide range of water quality constituents at stations near the mouths of the major rivers in Ohio and the River Raisin in Michigan. This program is unique in the region because it collects data detailed enough to use as baseline data for drinking water quality source investigations.

For additional information on groundwater monitoring see the Groundwater section of this report.

Findings – Drinking Water

Federal and state agencies set and enforce drinking water standards but each supplier is responsible for the quality of drinking water produced at that facility. The monitoring inventory did not collect monitoring information from each drinking water facility but rather collected program information at federal, state and local government levels. The most comprehensive drinking water monitoring resources in the basin are US EPA's *Safe Drinking Water Information System (SDWIS)* and Ontario Ministry of the Environment's *Drinking Water Surveillance Program (DWSP).* SDWIS provides detailed information on public drinking water facility locations and environmental compliance throughout the U.S. portion of the basin and DWSP provides information on municipal drinking water and is voluntary rather than compliance-driven.

Most drinking water quality monitoring is directed at evaluating treated drinking water systems. Relatively few resources are directed at evaluating surface water sources of drinking water. Evaluation of surface water sources requires monitoring for smaller concentrations of contaminants than general water quality monitoring. Currently there is very little funding for this type of drinking water source monitoring. More resources may need to be directed at monitoring drinking water sources to get an accurate understanding of the health of the ecosystem.

It appears that well water sources are monitored unevenly throughout the states and Ontario. In general, it appears as if most states and provinces test well water during the well installation process but subsequent testing is not required for single family users. Rather than collecting baseline monitoring data, private well testing appears to be largely issue driven. The basin may benefit from increasing regulatory monitoring requirements of private well water systems. Current funding levels do not support such broad scale monitoring of private drinking water monitoring systems.

A relatively new concept in water monitoring is installation of real-time monitoring devices at water intake systems. Such systems would allow for early detection of source water contamination prior to treatment and consumption. The necessity and utility of employing real-time monitoring systems may depend largely on risk characterization in local areas and current ability of drinking water facilities to detect contaminants in surface water sources.

Human Health
c. Beach Safety

Determining if bathing beaches are safe for recreation is an important shared goal across the Great Lakes basin. This issue is heightened in highly populated and industrialized areas. The primary reason for beach safety warnings and closures is bacterial contamination. The wide use of outdated combined sewer systems and the extensive urbanization of landscapes contribute large amounts of nutrients to surface waters in the region, which encourages bacterial growth. While both U.S. and Canadian federal agencies administer reporting systems, state/provincial, tribal, and local agencies are responsible for monitoring water quality at beaches and posting warnings or closures when pollutant levels in the water are too high.

US EPA is required under Clean Water Act to publish criteria for monitoring and assessment of coastal beaches and for promptly notifying the public of any failure to meet the water quality standards. The Clean Water Act authorized EPA to award grants to states to implement monitoring and notification programs, but only if the programs meet certain requirements. One of these requirements is that the monitoring and notification programs must be consistent with US EPA's National Beach Guidance and Required Performance Criteria. US EPA's recommended *E. coli* standard is 126/100 ml for the geometric mean of five samples over 30 days and 235/100 ml for a single sample.

HIGHLIGHT – Beach Safety

- While standards are defined at the federal level, states have been given a certain degree of autonomy to design their own monitoring programs to meet their specific needs. This has lead to a decentralization of beach monitoring activities resulting in somewhat inconsistent, disjointed monitoring efforts and beach advisory postings. While each program collects *E. coli* data, the number of sampling sites and frequency of monitoring vary considerably among states and local agencies.

While beach monitoring is carried out by county and municipal agencies, these agencies report monitoring results to state agencies that, in most cases, are responsible for posting swimming advisories and beach closures. The Great Lakes Monitoring Inventory attempted to collect information on county and municipal monitoring programs but the scope of the project did not allow for contacting each of the nearly 200 local health departments conducting monitoring across the region. An attempt was made to collect detailed information for each state and provincial beach program to help account for limited local level information. This report and the results of the Great Lakes Monitoring Inventory focus primarily on Great Lakes beaches, not inland lake beaches.

The Beach Advisories, Postings and Closures (#4200) indicator assesses the number of health related swimming advisories, beach closures, and posting days for freshwater recreation areas in the Great Lakes basin. Beach advisories, postings, and closures are based on elevated levels of *E. coli*, or other indicator organisms, as reported by county or municipal health departments in the Great Lakes basin.

The monitoring inventory includes 33 monitoring programs that address beach safety in the Great Lakes region. Each of the Great Lakes states and Ontario reported some level of beach monitoring and each also reported a comprehensive monitoring or reporting system at the state/provincial level. These programs are described in more detail below. Primary emphasis is on state level beach monitoring and monitoring coordination programs, but county programs are also discussed where information was available. It also should be noted that the Great Lakes Beach Association includes members from Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Pennsylvania, New York, Environment Canada, and states and countries outside of the Great Lakes Region. This group holds meetings annually to discuss regional beach monitoring issues.

Illinois – The Illinois Department of Public Health runs the *Illinois beach monitoring and notification program*, except for Lake Michigan beaches in Cook and Lake Counties. The state run program monitors only inland lake beaches and therefore will not be discussed in more detail in this report. The Lake County Health Department and Community Health Center *Lake Michigan Beach Monitoring Program* conducts

daily *E. coli* monitoring from the end of May to Labor Day each year at 11 Lake Michigan beaches and weekly *E. coli* monitoring at 2 Lake Michigan Dog Beaches. This program is funded through county and federal funds. The Chicago Park District *Beach Monitoring* program conducts monitoring at the city's 29 lakefront beaches and one in-land beach. These beaches are monitored for elevated *E. coli* levels five days a week. Funding for monitoring the Lake Michigan beaches in Chicago comes from the City of Chicago.

The responsibility for monitoring Cook counties Lake Michigan beaches lies with the municipalities. Some of these municipalities include Kenilworth, Evanston, and Winnetka. In total approximately 38 beaches are monitored in Cook County. More detailed information regarding sampling frequency and parameters was not available.

Indiana – The Indiana Department of Environmental Management (IDEM) *Beach Monitoring* program, developed in cooperation with the Interagency Taskforce on *E. coli*, is responsible for monitoring Indiana's Lake Michigan beach waters for elevated bacteria levels. Participants in this program monitor *E. coli* levels five to seven days per week from Memorial Day through Labor Day at 34 locations along Indiana's Lake Michigan shoreline. Participants in Indiana's Beach Monitoring program include: the Lake County Parks and Recreation Department, the Hammond Health Department, the East Chicago Department of Public and Environmental Health, the Gary Sanitary District, the Town of Ogden Dunes, the Town of Dune Acres, and the LaPorte County Health Department. Though the Dunes National Lakeshore is not authorized to receive federal funding through the BEACH Act, those beaches are monitored 1 day per week. Through a grant awarded by IDEM, the statuses of all recreational beaches are posted to the "EARTH911" website from both the participating communities and the Dunes National Lakeshore. This website is a valuable tool for use by the public in determining the status of a beach they are interested in visiting.

Parameters such as water and air temperature, wave height, wind speed and direction are recorded at the time of sample collection. If a water sample exceeds the 235 cfu/100 ml federal *E. coli* standard, the local beach managers determine whether to post an advisory or close the beach. In 2004 and 2005, IDEM funded two predictive model development projects with the goal of improving the efficiency of monitoring activities along Indiana's Lake Michigan shoreline in future years by replacing the 18-hour sample testing methods currently employed.

Michigan – Michigan Department of Environmental Quality's *Beach Monitoring* program handles beach monitoring in the state. While Michigan counties monitor the beaches through grants awarded by the state, the Beach Monitoring database is a compilation of all of the county collected beach monitoring information. In total 83 counties and 43 local health departments collect data in support of beach advisory postings. Monitoring occurs primarily once a week during the swimming season. There are 833 lakefront and in-land beaches and 360 of these beaches are in 41 counties located along the Great Lakes. Because of the extensive list, each of these counties and sampling sites will not be listed in this document but this program has a comprehensive website on which detailed beach monitoring, advisory, and closing information can be searched for each county and beach monitored. The program is funded through the Clean Michigan Initiative, and the U.S. BEACH Act.

Minnesota – The *Lake Superior Beach Monitoring and Notification Program* administered by Minnesota Pollution Control Agency is responsible for beach monitoring in Minnesota's Lake Superior basin which includes Cook, Lake, and St. Louis counties. In Cook County, Paradise Beach, Kadunce Creek, Durfee Creek Area, Old Shore Road, Grand Marais Campground, Grand Marais Downtown, Cutface Creek Wayside Rest, Temperance River State Park, Schroeder Town Park, and Sugarloaf Cove Beaches are monitored. In Lake County, the beaches monitored include Tettegouche State Park, Silver Bay Marina, Split Rock Lighthouse State Park, Split Rock River, Twin Points Public Access, Gooseberry Falls State Park, Stewart River, Flood Bay, Burlington Bay, Agate Bay and Knife River Marina Beaches. In St. Louis County, Stony Point, Bluebird Landing, French River, Brighton Beach, Lester River, 42nd Ave. East, Lakewalk East/16th Ave. East, Leif

Erikson Park, Lakewalk, Franklin Park, New Duluth Boat Club, Hearding Island Canal, Lafayette Community Club, Southworth Marsh, Park Point Beach House, Sky Harbor, Clyde Ave. Boat Landing, and Boy Scout Landing Beaches are monitored. This program collects samples from 39 Lake Superior beaches and analyzes those samples for *E. Coli*, fecal coliform, water temperature, wave height, and surface winds. Sampling takes place one to two times weekly from May through October. This project is funded through the U.S. BEACH Act and section 406 of the Clean Water Act.

New York – In total, there are 38 New York beaches along the Great Lakes and all are being monitored. All beaches are monitored for *E. coli* while a number of the beaches are also monitored for fecal coliform and enterococci. The majority of the beaches are monitored on a weekly basis. State and county agencies contributing to beach monitoring along New York's Great Lakes coastline include Chautauqua County Department of Health (Blue Water, Main Street, Point Gratiot, Sheridan Bay, Sunset Bay Beach Club, Town of Hanover, Wright Park East, and Wright Park West Beaches), Erie County Department of Health (Wendt, St. Vincent DePaul, Point Breeze, Pioneer Camp, Lake Erie, Hamburg, Evans Town Park, and Bennett Beaches), Geneva District Office monitored by New York State Department of Health (Sodus Point Bayside, Sodus Point Lakeside, and Pultneyville Mariners Beaches), Monroe County Department of Health (Ontario Beach), Niagara County Department of Health (Krull Park Beach), Oswego County Department of Health (Dowie Dale, Mexico Point, Chedmardo, Brennan's Beach, Rainbow Shores Beaches), and New York State Office of Parks, Recreation and Historic Preservation (Evangola and Woodlawn beaches, Erie County; Fair Haven Beach, Cayuga County; Hamlin Area 3 and 4 Beaches, Monroe County; Lake Erie Beach, Chautauqua County; Sandy Island and Selkirk Shores Beaches, Oswego County; Southwick, Wescott Camp, and Wescott Main Beaches, Jefferson County; Wilson Tuscarora Beach, Niagara County).

Ohio – The Ohio Department of Health's *Bathing Beach Monitoring Program* monitors the waters at selected public bathing beaches along the Ohio/Lake Erie border. Swimming advisory recommendations issued by the Department of Health are based upon the *E. coli* or fecal coliform bacteria content of water samples collected. The standard for *E. coli* follows the US EPA's recommended *E. coli* standard of 126/100 ml for the geometric mean of five samples over 30 days and 235/100 ml for a single sample. The fecal coliform standards indicates that a mean based on not less than five samples within a 30-day period shall not exceed 200 fecal coliform colonies per 100 ml of water; and fecal coliform content shall not exceed 400 fecal coliform colonies per 100 ml of water in more than 10% of all samples taken during any 30-day period. In total, the Department of Health monitors 22 stations 4 times a week for elevated *E. coli* or fecal coliform levels. The beaches monitored by the Department in Lucas County include Maumee Bay (inland), Maumee Bay (Erie), and Crane Creek. In Ottawa County beaches monitored include Camp Perry, Port Clinton, Catawba Island, South Bass Island, East Harbor, and Lakeside. In Erie County, the beach on Kelly's Island is monitored. In Lorain County two beaches, Lakeview and Century are monitored. In Cuyahoga County the beaches at Edgewater, Villa Angela, and Euclid are monitored. The beaches at Geneva, Walnut Beach, Lakeshore Park, and Conneaut Township Park in Ashtabula County are also monitored by the Department of Health. Additionally, the Lake County Health District monitors beaches within its jurisdiction at Headlands West, Headlands East, and Fairport Harbor. The Cuyahoga County Board of Health monitors 16 beaches within its jurisdiction, and the Erie County Health District monitors 20 beaches within its jurisdiction. Data from all beach monitoring is reported to the Ohio Department of Health for transmission to the US EPA. Most of these programs are funded by the U.S. BEACH Act.

Pennsylvania – In Pennsylvania there are 12 permitted coastal recreational beaches on the southern shore of Lake Erie. All of Pennsylvania's coastal beaches are located in Erie County. Besides the 11 beaches located in Presque Isle State Park there is one more beach in North East Township on Lake Erie. The Erie County Department of Health (ECDH) subcontracts with Pennsylvania Department of Health (DOH) for funding under the U.S. Beach Act. Presque Isle State Park, which is operated by the Pennsylvania Department of Conservation and Natural Resources (DCNR) is funded through an interagency agreement with the Pennsylvania Department of Health. All monitoring follows US EPA recommended *E. coli* standards. A

predictive model of recreational beach quality based on weather, known sewage discharges, storm events, and water currents is being formulated. The information will be used to see if a correlation can be established with weather and high bacterial counts. If a predictive model is established it would allow the beach managers to close beaches on a presumptive basis. This could prevent swimming in contaminated waters. ECDH is in the process of developing a website for the public to access information on the water quality on permitted Lake Erie beaches.

Wisconsin – The *Wisconsin Beach Monitoring Program* managed by the Wisconsin Department of Natural Resources (WNDR) is funded by the U.S. BEACH Act. The WDNR serves as a link between the federal government and local health departments. Through the Wisconsin Beach Program, the WDNR gives grants to communities along Lake Michigan and Lake Superior to monitor beach water for elevated bacteria levels.

In total, 127 Wisconsin Great Lakes beaches are monitored for elevated *E. coli* levels using a three tiered monitoring approach depending on priority of each beach. At high priority at least 4 samples are analyzed per week during the swimming season. High priority beaches will post swimming advisory signs following US EPA's recommended *E. coli* standard of 126/100 ml for the geometric mean of five samples over 30 days and 235/100 ml for a single sample. Medium priority beaches are sampled twice a week during the swimming season. Low priority beach sampling will be determined by state and local authorities. For medium and low priority beaches, advisories will be posted if an *E. coli* sample exceeds 235/100 ml. All beaches will post a closure sign whenever the level of *E. coli* in the beach water sample exceeds 1000/100 ml. Counties conducting Great Lakes beach monitoring include Ashland (7 sites), Bayfield (16 sites), Brown (4 sites), Door (29 sites), Douglas (12 sites), Iron (5 sites), Kenosha (4 sites), Kewaunee (2 sites), Manitowoc (10 sites), Milwaukee (12 sites), Ozaukee (6 sites), Racine (7 sites), and Sheboygan (13 sites).

Ontario - The Ontario Beach Management Protocol is the strongest guideline for the presence of *E. coli* in North America. It requires the posting of beaches as unsafe for swimming if the level of *E. coli* exceeds 100/100 ml. The Ontario Beach Management Protocol requires weekly testing of recreational water quality throughout the swimming season. The Ontario Ministry of Health's Beach Management Protocol is in charge of setting this standard.

Ontario Parks, under the Ontario Ministry of Natural Resources, collects beach samples from 161 beaches at 27 parks on the Great Lakes throughout all of Ontario. There are approximately 3,700 samples taken during the bathing season. Ontario Parks has an agreement with the Ministry of Health and Long Term Care to follow the Provincial Beach Management Protocol. Most beaches are sampled weekly. When a problem is found, Ontario Park consults with the Local Health Units for posting advisories.

The Windsor-Essex County Health Unit monitors 9 beaches throughout the Windsor-Essex County area including Sand Point, West Belle River, Hillman, Point Pelee National Park North West, Seacliffe Park, Cedar Island Beach Kingsville, Cedar Beach Kingsville, Colchester Beach Essex, and Holiday Beach Amherstburg. Beaches are sampled on a weekly basis during the summer for bacteriological levels. The standards used for determining beach advisories include beach warnings when *E. coli* levels are higher than 100/100 ml and beach closures are posted when *E. coli* levels exceed 1000/100 ml.

Monitoring of Toronto beaches is coordinated by a number of city departments. The Works and Emergency Services Department collects daily water samples. Ten beaches are monitored in Toronto including Marie Curtis Park East, Sunnyside, Hanlan's Point, Centre Island, Ward's Island, Cherry/Clarke, Woodbine, Kew Balmy, Bluffer's Park, and Rouge beaches. These samples are analyzed for *E. coli* content by the laboratories of the provincial Ministry of Health. Toronto Public Health interprets the results and decides if a beach is safe or unsafe for swimming. From June to the end of August, daily water samples are taken from beach locations across the city and tested for water quality.

Federal – US EPA is required under Clean Water Act to publish criteria for monitoring and assessment of coastal beaches and for promptly notifying the public of any exceedance of water quality standards. The Clean Water Act authorized US EPA to award grants to states to implement monitoring and notification programs. US EPA's recommended *E. coli* standard is 126/100 ml for the geometric mean of five samples over 30 days and 235/100 ml for a single sample. The US EPA's *BEACON - Beach Advisory and Closing On-line Notification* is a compilation of all beach monitoring, beach advisory and beach closing information available in the U.S. All information is contributed by participating states.

The Earth 911 *Beach Monitoring Data Repository* is a similar online data distribution system. An additional resource for beach monitoring information is the Natural Resources Defense Council's *State Beach Monitoring Practices* website. This website provides summaries for state run monitoring programs including yearly statistics. It should be mentioned that concerns were raised regarding the completeness and accuracy of NRDC's beach monitoring report. U.S. National Lakeshores conduct their own beach monitoring independent of any US EPA regulations. No detailed information was available on National Lakeshore monitoring.

Environment Canada Ontario Region manages the *Seasonal Water Monitoring and Reporting System (SWMRS)*. During the summer, local Health Units are required to sample water quality of public beaches within their jurisdiction. These beaches are tested for *E. coli* and results are made available through the SWMRS.

Findings – Beach Safety

A considerable level of coordination and collaboration is taking place in the area of Great Lakes beach monitoring. The Great Lakes Beach Association includes members from Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Pennsylvania, New York, Environment Canada, and states and countries outside of the Great Lakes Region. This group holds meetings annually to discuss regional beach monitoring issues.

Programs in each of the Great Lakes states and Ontario reported some level of beach monitoring and each state/province reported a comprehensive monitoring and reporting system at the state level. While US EPA administers the Beaches Environmental Assessment, Closure, and Health Program (BEACH Program), state, tribal, and local agencies are responsible for monitoring water quality at beaches and posting warnings or closures when pollutant levels in the water are too high. The US EPA Beach Act provides the majority of funding for beach monitoring programs in the region. A couple of states, including Illinois, Michigan and New York reported contributing state and local funds as well. While standards are defined at the federal level, lack of centralization of beach monitoring activities results in somewhat inconsistent, disjointed monitoring efforts and beach advisory postings. While each program collects *E. coli* data, the number of sampling sites and frequency of monitoring vary considerably among states and local agencies. It should also be noted that the US and Ontario follow different beach advisory and closing standards. The Ontario Beach Management Protocol is the strongest guideline for the presence of *E .coli* in North America. It requires the posting of beaches as unsafe for swimming if the level of *E. coli* exceeds 100/100 ml. US EPA's recommended *E. coli* standard is 126/100 ml for the geometric mean of five samples over 30 days and 235/100 ml for a single sample.

Human Health
d. Air

Data on air quality and toxic air pollutants is invaluable when trying to understand threats posed to the environment by atmospheric deposition, human health risks associated with poor air quality, and the overall health of an ecosystem. The primary pollutants of concern impacting human health are generally

considered to be particulate matter (PM2.5), ozone and air toxics. In the Great Lakes basin, monitoring efforts are focused both on attainment areas, those areas meeting or exceeding national ambient air quality standards, and non-attainment areas, those areas that do not meet national standards.

Air monitoring data are generally collected through ambient air measurements and emissions estimates. Ambient air concentrations of pollutants in outdoor air are measured at monitoring stations owned and operated mainly by state environmental agencies. Measurements of pollutant concentration are forwarded to US EPA, and US EPA computes a yearly summary for each monitoring station. Emissions estimates are defined as the quantity of pollutants released into the air during a year from materials consumed or products produced. Most emissions estimates are provided to US EPA by state environmental agencies.

The goal of SOLEC's Great Lakes Air Quality (#4202) indicator is to measure levels of criteria pollutants (which include such constituents as carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO2), ozone (O3), particulate matter (PM10 and PM2.5), and sulphur dioxide (SO2)) released into the ambient air and infer the potential impact of air quality on human health in the region.

HIGHLIGHT – Ambient Air

- There are concerns about possible network reductions due to budget cuts to ambient air monitoring programs. Concurrently, there are discussions of implementing new U.S. national standards that may require more stringent monitoring efforts. With current levels of funding it may not be possible to maintain an effect network of ambient air monitoring stations.

Another relevant indicator is Atmospheric Deposition of Toxic Chemicals (#117). This indicator reports estimates of loadings of PCBs, dieldrin, chlordane, DDT, and their metabolites as well as other chemicals based on measured atmospheric concentrations of chemicals in wet and dry deposition. While atmospheric deposition is mentioned in this section, it is discussed in more detail in the Atmospheric Deposition section of this report.

In total, inventory results indicate thirty-two air monitoring programs that measure either ambient air or point source pollutant levels in the Great Lakes basin.

Ambient Air Monitoring

With more than 1,800 monitoring locations, US EPA's *AirData* database represents the largest collection of ambient air monitoring stations in the Great Lakes basin. *AirData* monitoring information is collected primarily by state environmental agencies and forwarded hourly or daily to the US EPA for analysis and storage. Pollutants measured include sulfur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), lead, and particulate matter. Stations are scattered across each state in the Great Lakes basin with the heaviest concentrations in the major urban areas.

AirData presents annual summaries of air pollution data from two US EPA databases: *Air Quality System (AQS)* and *National Emission Inventory (NEI). Air Quality System (AQS)* provides data on air releases throughout the United States. The measurements include both criteria air pollutants and hazardous air pollutants. The US EPA also manages the *National Emissions Inventory (NEI)* that documents air pollutant emission trends. These data are used for air dispersion modeling, regional strategy development, regulation making, air toxics risk assessment, and tracking trends in emissions over time.

Canada reported two broad ambient air monitoring programs. Environment Canada manages the *National Air Pollution Surveillance (NAPS)* Network. NAPS was established in 1969 as a joint program of federal and provincial governments to monitor and assess the quality of ambient air in Canadian cities. Air quality data for sulfur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3) and total suspended particulates (TSP) are measured in cities in the Canadian portion of the Great Lakes basin. Environment

Canada also manages the *Canadian Air and Precipitation Monitoring Network (CAPMON)* which is a non-urban air quality monitoring network.

All of the Great Lakes states operate ambient air toxics monitoring networks. When available, details were provided on each of these networks. In general, these monitoring networks collect measurements of trace metals, volatile organic compounds (VOCs) and carbonyl compounds. States may supplement these measurements with additional chemical testing such as polynuclear hydrocarbons. In association with PM2.5 speciation monitoring efforts, a suite of other measurements collected include organic carbon, elemental carbon, trace metals, nitrate, and sulfate. Measurements of black carbon, trace levels or criteria gases, ammonia, and continuous particulate levels are also collected at various locations throughout the region.

Illinois – Illinois Environmental Protection Agency's *Air Monitoring* program collects particulate matter (PM10 and PM2.5), ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, heavy metals, nitrates, sulfates, and volatile organic compounds at more than 200 sites throughout the state.

Indiana - The Indiana Department of Environmental Management *Ambient Air Monitoring* program collects ambient air quality data daily at more than 100 sites across the state. Parameters monitored include Carbon Monoxide, Lead, Nitrogen Oxides, Particulates (PM2.5), Smog, Sulfur Oxides, Tropospheric Ozone, and Volatile Organic Compounds.

Michigan - Michigan Department of Environmental Quality's (DEQ) *Ambient Air Monitoring* program collects data for comparison to the National Ambient Air Quality Standards at roughly 35 sites in the state. Michigan DEQ also manages the *Air Toxics Monitoring Network*. Parameters include criteria pollutants, air toxics compounds, speciated fine particulate material (PM2.5), and meteorological measurements. Currently there are areas of Michigan designated as non-attainment areas which do not meet national ambient air quality standards. Michigan DEQ is also working with the University of Michigan to study mercury deposition at several locations throughout the state.

Minnesota - Minnesota Pollution Control Agency's *Air Quality Index for Minnesota* provides a simple, uniform way to report daily air quality conditions. The Minnesota Pollution Control Agency (MPCA) takes hourly measurements of pollutants (ozone, sulfur dioxide, fine particulate matter (PM2.5), and carbon monoxide) at air quality sites located throughout the state.

New York - New York State Department of Environmental Conservation's *Ambient Air Quality Monitoring Network* monitors the levels of ozone, sulfur dioxide, nitrogen oxides, carbon monoxide, lead, and particulate matter (PM2.5) in the ambient air. The objectives of the New York State Department of Environmental Conservation *Atmospheric Deposition Monitoring Sites* program are to provide a consistent, quality-assured, long-term acid deposition database; measure acid deposition in sensitive receptor areas; measure acid deposition in urban and upwind areas; use these data to perform spatial and temporal analyses of acid deposition; its precursors, and its effects; and track the effectiveness of acid deposition precursor emissions reductions. The state's monitoring network measures acid deposition and related quantities at eight locations throughout the state to assess the effectiveness of sulfur control policy and other strategies aimed at reducing the effects of acid rain. This program measures precipitation, ozone, humidity, temperature, atmospheric pressure, pH, sulfate, nitrate, chloride, fluoride, calcium, magnesium, potassium, sodium, ammonium, and conductivity. In addition the New York State Department of Environmental Conservation manages the PM 2.5 Monitoring program which monitors PM 2.5 levels in the state.

Ohio – Ohio's Air Monitoring Network managed by the Ohio Environmental Protection Agency monitors ambient air quality standard across the state. Data collected includes TSP, Pb, CO, SO2, O3, NO, NO2,

PM10, PM2.5, VOCs, Wind Speed, Wind Direction, Arsenic, Beryllium, Cadmium, Chromium, Manganese, Nickel, Zinc, and Mercury.

Pennsylvania - The goals of the Pennsylvania Department of Environmental Protection's (DEP) *Ambient Air Monitoring* program are to evaluate compliance with federal and state air quality standards, provide real-time monitoring of air pollution episodes, develop data for trend analysis, support the development and implementation of air quality regulations, and provide information to the public on daily air quality conditions. DEP monitors air quality in areas having high population density, high levels of expected contaminants, or a combination of both factors. Pennsylvania Department of Environmental Protection also manages the *Monitoring Toxic Pollutants* program. This program monitors toxics at 12 sites throughout the state for a group of 188 toxic pollutants. The *Pennsylvania Atmospheric Deposition Monitoring Network* managed by the Pennsylvania Department of Environmental Protection monitors the amount of acid rain falling at one location in Pennsylvania's Lakes Erie basin. Sampled parameters include pH, sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, sodium, specific conductance, and mercury.

Wisconsin – No specific information is available.

Ontario - Ontario Ministry of Environment manages the *Ambient Air Monitoring* program. This program collects data for Ontario's air quality assessment and trend evaluation including data on Carbon Monoxide, Nitrogen Oxides, Particulates, Smog, Carbon Monoxide, Nitrogen Dioxide, Nitrogen Oxides, Ozone, and Sulfur Dioxide levels in the air.

Additional ambient air monitoring programs in the region focus on tracking atmospheric deposition in the basin. A joint US EPA and Environment Canada program, *Integrated Atmospheric Deposition Network (IADN)*, was developed in 1990 to monitor atmospheric deposition of toxic chemicals to the Great Lakes. This program measures wet and/or dry atmospheric deposition at 15 locations on shores of the Great Lakes basin. Five of these stations (3 sites in the US and 2 Canadian sites) are master stations where all IADN chemicals are measured in air and precipitation. The program monitors 80 toxic chemicals, including PCBs, dieldrin, chlordane, and DDT. The remaining 10 stations measure a limited number of the IADN chemicals. The US operates 2 satellite stations both located in urban areas. These stations measure concentrations in both air and precipitation. Canada operates 8 satellite stations. One of these stations measures only air concentrations while the other 7 measure only precipitation concentrations.

The US EPA also manages the *Clean Air Status and Trends Network (CASTNET)* focusing on dry deposition monitoring at five locations in the Great Lakes basin. The US EPA also manages the *Photochemical Assessment Monitoring Stations (PAMS) Network* that monitors ozone and its precursors in areas with persistently high ozone levels. Also EPA's *National Air Toxic Trend Sites (NATTS)* monitors specific high risk air toxics such as benzene, formaldehyde, 1,3-butadiene, acrolein, and chromium.

The Great Lakes Research Consortium manages the *Semivolatile Air Monitoring Network* that collects concentration and loading of organics (including dioxin) in air in New York. The *National Atmospheric Deposition Program* (NADP), which is a cooperative research support program of federal, state, and non-governmental research agencies, measures wet deposition at 31 locations across the Great Lakes basin through the *National Trends Network* program. Other programs managed by NADP are the *Atmospheric Integrated Research Monitoring Network (AIRMON)* and *Mercury Deposition Network (MDN)*. The MDN measures mercury deposition in rainfall at approximately 20 sites within the Great Lakes region. NADP in partnership with Lake Michigan Air Directors Consortium (LADCO) and Central Regional Air Planning Association (CENRAP) operate an ammonia monitoring network at 13 sites across the Midwest and the Plains states. This network has been measuring ammonia/ammonium, nitrate/nitric acid and SO2/sulfate since 2003.

Point Source Monitoring

The US EPA manages the *Toxics Release Inventory* (TRI) which contains information about more than 650 toxic chemicals used, manufactured, treated, transported, or released into the ground, water, or air. Manufacturers of these chemicals are required to report the locations and quantities of chemicals stored on-site to state and local governments. EPA compiles these data in an on-line, publicly accessible national computerized database. TRI tracks approximately 4,500 locations in the Great Lakes basin annually.

The US EPA also manages the *National Emissions Inventory (NEI)* that documents air pollutant emission trends. These data are used for air dispersion modeling, regional strategy development, regulation setting, air toxics risk assessment, and tracking trends in emissions over time. A similar effort to track and predict emission releases is being performed by the Great Lakes Commission through the *Centralized Air Emission Repository On-Line (CAROL)*. This online repository is fully searchable and focused exclusively on the Great Lakes region.

For additional information on atmospheric deposition please refer to the atmospheric deposition section of this report.

Findings - Air

The US EPA's *AirData* program includes data on levels of the key criteria pollutants (CO, NO2, O3, SO2, lead, and particulate matter) called for in SOLEC's Great Lakes Air Quality indicator. AirData presents annual summaries of air pollution data from two US EPA databases: *Air Quality System (AQS)* and *National Emission Inventory (NEI). Air Quality System (AQS) provides* data on air releases throughout the United States. The measurements include both criteria air pollutants and hazardous air pollutants. The US EPA also manages the *National Emissions Inventory (NEI)* that documents air pollutant emission trends. These data are used for air dispersion modeling, regional strategy development, regulation setting, air toxics risk assessment, and tracking trends in emissions over time. Historically, these programs account for more than 9,000 data collection sites in the Great Lakes basin. In Canada, *Environment Canada's National Air Pollution Surveillance (NAPS) Network*, established in 1969, monitors ambient air quality in Canadian cities. Environment Canada also manages the *Canadian Air and Precipitation Monitoring Network (CAPMON)* which is a non-urban air quality monitoring network. Although monitoring sites are found with increased density in urban centers there is strong representation throughout the Great Lakes basin particularly through the US *AirData* program.

While there appears to be a number of federal and state programs collecting information on atmospheric deposition, only *IADN* collects information on the parameters necessary (PCBs, dieldrin, chlordane, and DDT) to evaluate the Atmospheric Deposition of Toxic Chemicals indicator. A potential limitation of *IADN* lies in the distribution of sampling stations and in the corresponding activities at each station. This network may need to be evaluated to determine if five master stations (one per lake) are sufficient to characterize atmospheric deposition. Monitoring inventory results indicate that US EPA's *Toxic Release Inventory* is the primary collector of point source data in the region. No equivalent program was reported for Canada.

Presently, there are concerns about network reductions due to budget cuts to ambient air monitoring programs. Concurrently, there are discussions of implementing new national ambient air quality standards that may be more stringent than current standards. There are concerns that the ambient air quality standards may not be adequately monitored with current levels of funding. In addition to potential need for increased funding for monitoring activities, there need is also a need to invest resources in development of monitoring technology.

2. General Monitoring
a. Water Quality

Great Lakes monitoring organizations reported 142 water quality monitoring programs. These programs range from small, local volunteer monitoring programs to large, regulatory, multi-parameter, federally funded, basinwide water quality monitoring programs. Results of the inventory show that in the Great Lakes open waters, water quality monitoring is being conducted by twenty one monitoring programs. One hundred twenty monitoring programs in the Great Lakes basin are conducting watershed monitoring, including inland lakes, rivers, and nearshore zones. Major programs in each of these areas will be discussed as will relevant SOLEC indicators.

Open Water Monitoring

In the Great Lakes basin, the greatest number of water quality monitoring programs was reported in the Lake Michigan basin. One reason for this may be that more jurisdictions are responsible for Lake Michigan than any other Great Lake. Open water monitoring showed a relatively even effort across the Great Lakes basin. Open water monitoring results indicate that the greatest number of programs occur in Lake Michigan and Lake Erie, with Lake Huron and Lake Superior reporting the lowest number of monitoring programs (Figure 5).

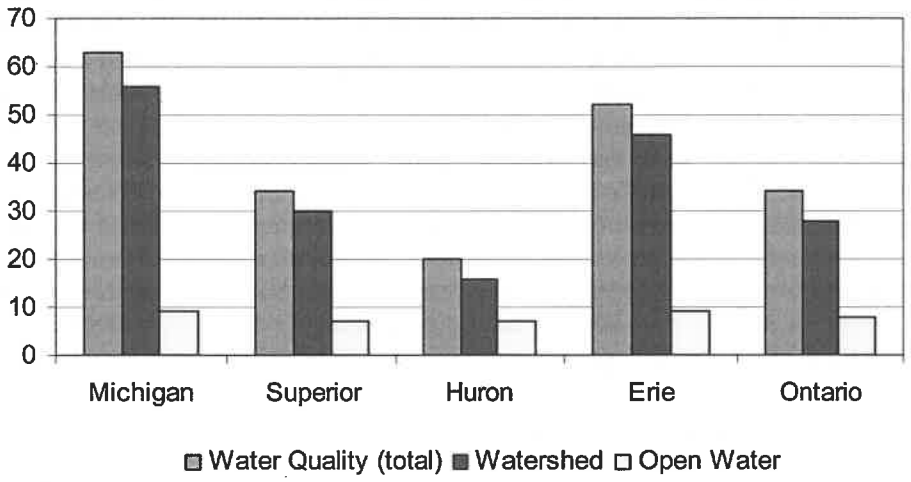

Figure 5. Number of water quality monitoring programs reported to the monitoring inventory by lake for open water, watershed (inland lakes, rivers, nearshore), and combined sampling efforts.

Two SOLEC indicators specifically address water quality in offshore waters. The first is the Toxic Chemical Concentrations in Offshore Waters (#118) indicator that examines the concentration of priority toxic chemicals in offshore waters and infers the potential impacts of toxic chemicals on the Great Lakes aquatic ecosystem and progress being made toward elimination of these toxics from the Great Lakes. Chemicals of interest include PCBs, deildrin, chlordane, DDT and metabolites, hexaclorobenzene, toxaphene, and mercury.

The second is the Phosphorus Concentrations and Loadings (#111) indicator with the goal of measuring the total phosphorus levels in springtime open waters and annual total phosphorus loads to each lake. This indicator is used to assess the total phosphorus levels and loadings, and evaluate trophic status and food web dynamics in the Great Lakes.

Open water monitoring is being performed by 21 U.S. and Canadian water quality monitoring programs. Table 2 presents a summary of federal and state/provincial programs grouped by agency, including organization, department and program title. Please see the complete inventory for more detailed information on each program and a more complete listing of reported local government, university, and other non-governmental programs. In total, 12 open lake water quality monitoring programs were reported by U.S. agencies in the Great Lakes basin and nine were reported by Canadian agencies.

Table 2. Federal and state/provincial water quality monitoring programs in Great Lakes open waters.

Organization	Department	Monitoring Program Title
U.S. Federal Government		
U.S. Environmental Protection Agency	Great Lakes National Program Office	Long-Term Open Lakes Monitoring Program
U.S. Environmental Protection Agency	Great Lakes National Program Office	Lake Erie Dissolved Oxygen Depletion
U.S. Environmental Protection Agency	Great Lakes National Program Office	Limnology Program
U.S. Geological Survey	Tunison	Nearshore Lake Ontario Ecosystem Study Plan
U.S. State Government		
Illinois Environmental Protection Agency	Bureau of Water, Surface Water Section	Lake Michigan Monitoring Program
Michigan Department of Environmental Quality	Water Division	Water Chemistry Monitoring Project
Canadian Federal Government		
Environment Canada	Environmental Conservation, Ecosystem Health	Great Lakes Surveillance Program
Environment Canada	National Water Research Institute	Effects of zebra mussels (sub-project to open lake nutrient assessment)
Environment Canada	Environmental Conservation Branch	Lake Erie exit loadings of chemical parameters
Environment Canada	National Water Research Institute	Open lake trace metal cycling
Canadian Provincial Government		
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Great Lakes Index Station Network Monitoring
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Great Lakes Water Intake Monitoring
Ontario Ministry of the Environment		Nearshore monitoring and assessment
Ontario Ministry of the Environment		Clean Water Regulation (MISA) Monitoring Data Ontario Point Sources

United States

In total, 12 U.S. monitoring programs sample water quality in the open waters of the Great Lakes basin. The majority of this monitoring appears to be taking place at the federal level through US EPA.

Federal – Four U.S. federal programs monitor water quality in the open waters of the Great Lakes. Of these programs three are conducted by the US EPA and the other is managed by US Geological Survey.

US EPA's *Long-Term Open Lakes Monitoring Program* visits all of the Great Lakes, and consists of spring and summer sampling of a network of fixed stations in the open waters of the lakes. Parameters sampled include total phosphorus, total dissolved phosphorus, nitrate and nitrite, dissolved reactive silica, pH, total alkalinity, specific conductance, and turbidity. Sampling began in 1983 in Lakes Erie, Huron and Michigan, in 1986 in Lake Ontario and in 1992 in Lake Superior.

US EPA's *Lake Erie Dissolved Oxygen Depletion* program monitors the status of dissolved oxygen in the waters of the Lake Erie basin at a fixed network of stations several times each summer. These data are then used to assess the timing, extent and severity of reduced oxygen conditions. Ten sampling stations are monitored six times each summer to measure dissolved oxygen levels.

US EPA's *Limnology Program* sampling strategy is to collect water and biota samples at specific water depths from a limited number of locations in each lake twice every year to collect information on key environmental factors that influence the food chain and fish of the Great Lakes.

HIGHLIGHT – Water Quality

- While the cost of monitoring increases each year, the level of governmental funding dedicated to water quality monitoring remains the same. The result is a continuous decrease in monitoring efforts in order to stay within previously set budgets. More effort needs to go toward allotting financial resources based on current monitoring needs rather than previously set spending limits.
- Michigan's Clean Michigan Initiative bond funding system is a good example of an innovative funding source. Because of this funding system, Michigan has the resources necessary to maintain a comprehensive water quality monitoring program. This type of funding system may serve as a good example for other states and provinces seeking additional financial resources.
- Lack of data on toxic chemical concentrations in offshore waters of the Great Lakes may be a monitoring gap in the Great Lakes basin. However, it is important to note that toxic chemical concentrations can be measured in media other than water, including sediments and fish. More investigation is needed to determine if the benefits of monitoring the toxic chemical concentrations in water is worth the added expense when similar data is being collected in sediments and fish.

US Geological Survey *Nearshore Lake Ontario Ecosystem Study Plan* monitors water and sediment chemistry using fish and benthic organisms as indicators. Specific details on this program were not available.

While it is not an active monitoring program it should be mentioned that US EPA conducted a Lake Michigan Mass Balance study in 1994 and 1995 sampling seasons. The objectives of this study were to identify chemical loading rates, establish baselines, predict benefits, and improve understanding of ecosystem dynamics. The Lake Michigan Mass Balance Study measured PCBs, mercury, trans-nonachlor, and atrazine in rivers, the atmosphere, sediments, lake water, and the food chain. To characterize Lake Michigan over 200 locations were sampled during the course of the project. The data are currently being analyzed and an ecosystem model is being developed.

Another program that should be mentioned is the joint program between US EPA and Environment Canada to sample contaminants and toxics in each of the Great Lakes except Lake Michigan. This program uses the US EPA's Lake Guardian research vessel to measure contaminant concentrations. Each year the Lake Guardian monitors a different Great Lake. This is not considered an active continuous monitoring program and therefore not included in the Great Lakes Monitoring Inventory because monitoring activities are based on needs identified for each lake at the time of sampling.

State – Two open water water quality monitoring programs were reported by state agencies. Illinois Environmental Protection Agency conducts the *Lake Michigan Monitoring Program* which monitors water quality at 18 locations parallel to the Illinois shoreline up to 5 miles offshore. Sampling includes turbidity, conductivity, pH, ammonia-n (total), kjeldahl-n (total), nitrite and nitrate-n (total), chemical oxygen demand, fecal coliform, chloride, sulfate and phenols. Funding for this project comes through the Federal Clean Water Act.

Michigan Department of Environmental Quality's *Water Chemistry Monitoring Project (WCMP)* assesses temporal and spatial trends in surface water contaminant levels; assesses the current status and condition of individual waters of the state and determines whether Michigan Water Quality standards are being met. In total, 48 sites are monitored throughout the state for an extensive list of chemical and physical properties. Most of these sites are located in inland waters with the exception of seven monitoring locations in Lake Huron's Saginaw Bay and four monitoring sites in Lake Michigan's Grand Traverse Bay. These monitoring sites may be considered a combination of nearshore and open water monitoring efforts. Funding for this program comes through Clean Michigan Initiative bond funding.

Local – Two programs were reported at the county and city level. Michigan's Macomb County Health Department conducts the extensive *Lake St. Clair Water Quality Assessment.* The objectives of this project include establishment of a surface water and sediment quality database; evaluation of impact of climatological variables and sewer overflows on surface water quality; and collection of sediment chemistry data at previously identified locations of concern. The project includes five complementary monitoring activities: nearshore, offshore, watershed, bathing beach, and wet weather. This program samples at 122 locations for chromium, kjeldahl nitrogen, aluminum, copper, salinity, conductivity, water temperature, air temperature, precipitation, and wind speed and wind direction.

In Lake Michigan, the Milwaukee Metropolitan Sewerage District conducts the *WATERBase - Milwaukee Metropolitan Sewerage District Water Quality Monitoring Data* program. The Milwaukee Metropolitan Sewerage District (MMSD) maintains an extensive water quality monitoring program to aid in pollution abatement, facilities planning, and flood control. As a result, a large data set of traditional water quality measurements beginning in 1975 became available. In total, six offshore sites are monitored for an extensive list of chemical and physical properties.

University – Three open lake water quality monitoring programs were reported by three universities in the Great Lakes basin. University of Wisconsin - Milwaukee conducts the *WATERBase - Lake Michigan Monitoring Buoy* and the *WATERBase - Monthly Lake Michigan Monitoring Program.* The *Lake Michigan Monitoring Buoy* monitors temperature, conductivity, dissolved oxygen, pH, turbidity, and algal fluorescence twice daily at a site approximately sixteen kilometers offshore from the Milwaukee Harbor. The *Monthly Lake Michigan Monitoring Program* monitors eight sites extending from the Milwaukee Harbor to a pelagic station sixteen kilometers offshore, and includes a perch spawning reef and an urban water intake area. The suite of measurements includes temperature, water clarity, water chemistry, phytoplankton and zooplankton abundance, and bacterial and plankton productivity.

Cornell University conducts one monitoring program in the open waters of Lake Ontario. The *Biomonitoring program for Lake Ontario* analyzes water samples at multiple stations for nutrients (TP, Chl-

a and N), zooplankton, and possibly phytoplankton from May through end of September. This program includes seven locations in the nearshore and offshore waters of Lake Ontario monitored twice a month.

Non-governmental Organizations – Grand Traverse Band of Ottawa and Chippewa Indians conducts the *Grand Traverse Band Water Quality Program* to monitor waters within the historic reservation for the purpose of determining the current water quality conditions and detecting long-term trends in water quality. Currently two locations are being monitored including Lake Michigan's Grand Traverse Bay and off of northern Leelanau County, Michigan. Sampling includes an extensive list of chemical and physical properties.

Canada

In total, nine open lake water quality monitoring programs were reported by Canadian agencies in the Great Lakes basin.

Federal – Environment Canada conducts four open water monitoring programs. Environment Canada's *Great Lakes Surveillance Program* monitors water quality as required through the Great Lakes Water Quality Agreement in each of the Great Lakes, except for Lake Michigan, once every two years. Monitoring of water quality is conducted for nutrients, major ions and organic contaminants, as well as selected biological (chlorophyll a) and physical (e.g., temperature, specific conductance) parameters. The main objectives of the program are to ensure compliance with water quality objectives, evaluate water quality trends and identify emerging issues. Sampling typically includes 98 stations on Lake Ontario, 53 stations on Lake Erie, 94 stations on Lake Huron, and 94 stations on Lake Superior. These stations are evenly dispersed throughout each basin. The *Open lake trace metal cycling* program measures trace levels of Cadmium, Chromium, Lead, Manganese, Iron, and Nickel in water. The *Lake Erie exit loadings of chemical parameters* program measures the annual exit loading estimates for nutrients, organic contaminants, in-use pesticides, trace metals in dissolved phase and suspended sediment. The *Effects of zebra mussels (sub-project to open lake nutrient assessment)* program monitors the impact of zebra mussels on water quality particularly the balance of phosphorus and nitrogen.

As mentioned previously, a joint program between US EPA and Environment Canada is in place to sample contaminants and toxics in each of the Great Lakes except Lake Michigan. This program uses the US EPA's Lake Guardian research vessel to measure contaminant concentrations.

Provincial – Ontario Ministry of the Environment conducts four open water monitoring programs that collect water quality information. The *Great Lakes Index Station Network Monitoring* program provides information on where and how water quality conditions are changing over time by periodically monitoring a suite of environmental indicators. A total of 66 core sites have been established throughout the basin. Sampling is undertaken each summer for concentrations of priority toxic contaminants in sediment and suspended particulate material. The primary objective of the *Great Lakes Water Intake Monitoring* is to identify trends in nutrient status using nutrient concentrations and phytoplankton biomass as indicators. This is accomplished by year-round collection of phytoplankton and nutrient samples from intakes at seventeen water treatment plants that draw water from the Great Lakes. This information is useful when trying to assess the long-term trends of nutrient loads and related nutrient management programs in the Great Lakes. An additional program conducted by Ontario's Ministry of the Environment is the *Clean Water Regulation (MISA) Monitoring Data Ontario Point Sources*. The *Nearshore monitoring and assessment* program samples water, sediment and biota in nearshore zone. Specific details on the last two programs were not available.

University – The University of Windsor Great Lakes Institute for Environmental Research manages the *Western Basin contaminants* program. This program investigates contaminant (OCs, PCBs, and PAHs) levels in water, sediment, birds, fish, benthos, and plankton.

Watershed Monitoring

Watershed monitoring (inland lakes, rivers, nearshore) is being performed by 120 U.S. and Canadian water quality monitoring programs. Table 3 presents a summary of federal and state/provincial programs grouped by agency, including organization, department and program title. Please see the complete inventory for more detailed information on each program and a more complete listing of reported local government, university, and other non-governmental programs. In total, 106 watershed water quality monitoring programs were reported by U.S. agencies in the Great Lakes basin and 14 were reported by Canadian agencies.

In the U.S., much of the watershed monitoring is taking place in association with requirements placed on states to identify and monitor Total Maximum Daily Loads (TMDL) for attaining water quality standards. Under the US EPA Clean Water Act, the Great Lakes states have adopted provisions into their water quality standards and National Pollutant Discharge Elimination System (NPDES) permit programs that are consistent with US EPA guidance. As a result each state has implemented some type of ambient water quality monitoring system.

Table 3. Great Lakes federal and state/provincial watershed water quality monitoring programs.

Organization	Department	Monitoring Program Title
U.S. Federal Government		
U.S. Geological Survey		National Water Information System (gaging stations)
U.S. Geological Survey	Network Operations Section	Water Quality Sampling in Cooperation with State of Michigan (2001 - present)
U.S. Geological Survey	National Water Quality Assessment Program	National Water-Quality Assessment (NAWQA) Program
U.S. State Government		
Hoosier Riverwatch	IN Department of Natural Resources	Hoosier Riverwatch
Illinois Environmental Protection Agency	Division of Water Pollution Control-Lakes Unit	Illinois Volunteer Lake Monitoring Program
Illinois Environmental Protection Agency	Surface Water Section	Ambient Water Quality Monitoring Network (AWQMN)
Illinois Environmental Protection Agency	Surface Water Section	Intensive Basin Surveys
Illinois Environmental Protection Agency	Surface Water Section	Facility-Related Stream Surveys
Illinois Environmental Protection Agency	Surface Water Section	Ambient Lake Monitoring Program (ALMP)
Illinois Environmental Protection Agency	Surface Water Section	Illinois Clean Lakes Program (ICLP)
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section	No title given
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section	No title given

Organization	Department	Monitoring Program Title
Indiana Department of Natural Resources	Division of Soil Conservation	Lake and River Enhancement Program
Michigan Department of Environmental Quality	Water Division	Water Chemistry Monitoring Project
Michigan Department of Environmental Quality	Water Division	Cooperative Lakes Monitoring Program (CLMP)
Michigan Department of Environmental Quality	Water Division	Lake Quality Assessment Project
Michigan Department of Environmental Quality	Water Division	Water Quality Monitoring
Minnesota Pollution Control Agency	Environmental Outcomes	Biological Monitoring
Minnesota Pollution Control Agency		North Shore Streams Monitoring Project
Minnesota Pollution Control Agency	Environmental Outcomes Division	Lake Assessment Program (LAP)
Minnesota Pollution Control Agency		Citizen Lake Monitoring Program
Minnesota Pollution Control Agency	Environmental Outcomes Division, Rivers and Streams Monitoring Unit	Citizen Stream-Monitoring Program
Minnesota Pollution Control Agency	Regional Environmental Management Division	Total Maximum Daily Load Studies
Minnesota Pollution Control Agency	Environmental Outcomes Division	Minnesota Milestone (Routine Stream) Monitoring
Minnesota Pollution Control Agency	Environmental Outcomes Division	Integrated Stream Monitoring
Minnesota Pollution Control Agency		Stream Toxics Monitoring
Minnesota Pollution Control Agency		Basin Flow and Chemistry Monitoring
Minnesota Pollution Control Agency		Lakes Regional and Trend Monitoring
New York State Department of Environmental Conservation	Division of Water	Rotating Intensive Basin Studies
New York State Department of Environmental Conservation	Division of Water	Finger Lakes Synoptic Water Quality Investigation
New York State Department of Environmental Conservation		Finger Lakes Biomonitoring
New York State Department of Environmental Conservation	Division of Water	Water Quality Study of the Finger Lakes
New York State Department of Environmental Conservation (NYSDEC)	Lake Services Section, Division of Water	Citizens Statewide Lake Assessment Program
Ohio Department of Natural Resources	Division of Natural Areas and Preserves	Ohio Stream Quality Monitoring Project (SQM)
Ohio Environmental Protection Agency	Division of Surface Water	Statewide Biological and Water Quality Monitoring and Assessment
Ohio Lake Management Society		Citizen Lake Awareness and Monitoring (CLAM)
Pennsylvania Department of Environmental Protection		Citizens' Volunteer Monitoring Program (CVMP)
Pennsylvania Department of Environmental Protection	Division of Water Quality Assessment & Standards	Pennsylvania's State-Wide Surface Waters Assessment Program

Organization	Department	Monitoring Program Title
State University of New York	College of Environmental Science & Forestry	Nutrient Dynamics in Salmon Creek, NY
Wisconsin Department of Natural Resources	Watershed Management	WI Long Term Trend Monitoring
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Citizen Lake Monitoring Network
Canadian Federal Government		
Environment Canada		Pesticides In Aquatic Ecosystems
Environment Canada		Niagara River Upstream/Downstream Monitoring Program
Environment Canada		St. Clair Water Quality Monitoring Program
Environment Canada		Wolfe Island Monitoring Program
Environment Canada	National Water Research Institute	Agricultural non-point sources of pollution
Environment Canada		St. Clair & Detroit River Water Quality Monitoring Program
Canadian Provincial Government		
Ontario Ministry of the Environment		Provincial (Stream) Water Quality Monitoring Network (PWQMN)
Ontario Ministry of the Environment		Clean Water Regulation (MISA) Monitoring Data Ontario Point Sources

United States

In total, 106 U.S. monitoring programs sample water quality in the watersheds of the Great Lakes basin. Because of the large number of programs found in this category, only federal and state programs will be discussed in detail. Details on all programs can be found by examining the full monitoring inventory.

Federal – Three federal monitoring programs have been identified that focus on water quality monitoring in Great Lakes watersheds. These three programs are administered by the U.S. Geological Survey (USGS). It should be noted that there are 3 US EPA programs that include water quality data. These programs are considered databases rather than monitoring programs and will be discussed in the section following the discussion on water quality monitoring in watersheds.

USGS manages three water quality monitoring programs in the Great Lakes basin watershed. In 1991, USGS implemented the *National Water-Quality Assessment (NAWQA) Program*, which has target sampling programs in western Lake Michigan drainages and the Lake Erie-Lake St. Clair basin with a total of 171 sampling locations. Sampling focuses on evaluating data for trends and includes monitoring of general water chemistry, pesticides, contaminants in bed sediments, and contaminants in fish and benthic invertebrates.

National Water Information System (gaging stations), also managed by U.S. Geological Survey (USGS), which collects a combination of water quality and water level data at roughly 75,000 locations in the basin, though the number of active stations is much smaller. The USGS gaging station program monitors surface water flows and quality, and groundwater extensively across the basin. At present, funding for these sampling locations is threatened because a large portion of the operating budget comes from disparate sources outside of USGS, such as state agencies and universities, which can be subject to budget cuts. *Stream Water Quality Data* are also collected in cooperation with the State of Michigan (2001 – present).

This program collects mercury, PCB, common constituents, anion, cation, and nutrient data daily. Other reported activities that collect some level of monitoring data in US EPA Region 2 include the Lake Ontario Lower Foodweb Assessment (LOLA), tributary monitoring (no further information was available), sediment studies for Lake Ontario, and an unnamed cooperative monitoring project with Canada. No additional information was submitted for these programs.

State – In total, state governments conduct 38 water quality monitoring programs in the Great Lakes watershed. Each state's programs will be discussed below.

Illinois

Illinois Environmental Protection Agency reported six water quality monitoring programs in its portion of the Great Lakes basin watershed.

The *Ambient Water Quality Monitoring Network (AWQMN)* provides baseline water quality information, to characterize and define trends in the physical, chemical and biological conditions of the state's waters and to identify new or existing water quality problems. In total 213 locations are sampled for air temperature, water temperature, dissolved oxygen, pH, conductivity, turbidity, nutrients, metals, and conventional constituents. This program is funded by the federal Clean Water Act.

One of the primary objectives of the *Ambient Lake Monitoring Program (ALMP)* is to identify areas with significant water quality problems that need further investigations or remediation. Approximately 50 sites are monitored five times a year for phosphorus, chlorophyll, secchi transparency, dissolved oxygen and temperature. Similarly an objective of the *Illinois Clean Lakes Program (ICLP)* is to diagnose current lake water quality problems. This program monitors 3-5 sites twice monthly for air temperature, water temperature, dissolved oxygen, pH, conductivity, alkalinity, turbidity, secchi transparency, and nutrients.

Illinois *Intensive Basin Surveys* program focuses on identifying the chemical, physical and biological quality of selected Illinois streams. Monitoring for this program takes place on a five-year cycle in roughly 100 locations throughout the state. Another stream monitoring program is *Facility-Related Stream Surveys*. This program provides stream quality assessment information for wadeable streams that receive point source discharges.

Finally, the *Illinois Volunteer Lake Monitoring Program* is volunteer-based water quality sampling program that provides historical data to document water quality impacts and support lake management decision-making. The program also serves as an educational program. This program is funded by the federal Clean Water Act. Sites are sampled twice monthly during the summer months for water clarity (secchi disk), water color, aquatic plants, site depth, weather conditions, zebra mussels, ammonia, nitrates, total phosphorus, total suspended solids, volatile suspended solids, and chlorophyll.

Indiana

Four water quality monitoring programs were reported from the Indiana portion of the Great Lakes basin.

Indiana Department of Environmental Management Office of Water Management conducts two water quality monitoring programs. The first program samples a statistically defined number of randomly selected sites to assess and characterize the overall water quality and biological integrity of the state. This program monitors for a large list of chemical contaminants on a five-year rotation. The second program provides basic information to reveal water quality trends and provide data for existing and prospective users of Indiana surface water. No additional information is available for these programs.

Indiana Department of Natural Resources' *Lake and River Enhancement Program* monitors surface water chemistry parameters across the state. No descriptive information was provided for this project.

Hoosier Riverwatch is a statewide volunteer stream monitoring program for schools, citizens, watershed groups, and government agencies that monitors seven locations in the Great Lakes basin. Roughly 700 sampling locations throughout the state sample for BOD, dissolved oxygen, *E. coli*, nitrate, nitrite, pH, phosphate, phosphorus (total), turbidity and water temperature. Funding for this program comes from Indiana Department of Natural Resources Division of Soil Conservation.

Michigan

Michigan Department of Environmental Quality reported four water quality monitoring programs in its portion of the Great Lakes basin watershed.

The purpose of the Michigan Department of Environmental Quality *Water Chemistry Monitoring Project (WCMP)* is to assess temporal and spatial trends in surface water contaminant levels, assess the current status and condition of individual waters of the state, and determine whether Michigan Water Quality standards are being met. In total 48 sites are monitored throughout the basin for an extensive list of chemical and physical properties. Most of these sites are located in inland waters with the exception of seven monitoring locations in Lake Huron's Saginaw Bay and four monitoring sites in Lake Michigan's Grand Traverse Bay. Funding for this program comes through Clean Michigan Initiative bond funding.

A related project, *Water Quality Monitoring*, looks at whether rivers and streams are attaining water quality standards and meeting designated uses. All wadable rivers and streams across the state are sampled on a five-year rotating cycle. This program is funded through the Clean Michigan Initiative and general state funds.

The *Lake Quality Assessment Project* assesses water quality and trophic conditions in randomly selected lakes. Approximately 80 lakes are sampled for transparency, total phosphorus, chlorophyll a, nitrogen, dissolved oxygen and temperature twice a year during a five-year rotating basin cycle. Funding is provided through Clean Michigan Initiative bond funding.

A volunteer monitoring program collecting water quality data in Michigan is the *Cooperative Lakes Monitoring Program (CLMP)*. This program is a citizen's volunteer lake monitoring program designed to obtain baseline data on lake productivity indicators for Michigan's inland lakes. Parameters sampled include transparency, total phosphorus, chlorophyll a, and aquatic macrophytes. Funding is provided from Clean Michigan Initiative bond funds, federal funds, and lake association contributions.

Michigan's Clean Michigan Initiative bond funding system is a good example of an innovative funding source. Because of this funding system, Michigan has the resources necessary to maintain a comprehensive water quality monitoring program. This type of funding system may serve as a good example for other states and provinces seeking additional financial resources.

Minnesota

Minnesota Pollution Control Agency reported 11 water quality monitoring programs in its portion of the Great Lakes watershed.

The *Total Maximum Daily Load Studies* program identifies sources and sets load targets to meet water quality standards and beneficial uses for the major and minor watersheds in the state. Federal funds support this project. No further descriptive information is currently available for this project. A related project, *Basin Flow and Chemistry Monitoring*, conducts monitoring to determine the flow and concentration of pollutants coming from each tributary across the state and how these amounts vary at different times of the year, and no additional information is currently available for this project.

Five programs focus on stream water quality monitoring. The *Minnesota Milestone (Routine Stream) Monitoring* program looks at water quality changes over time by continually recording basic chemical measures of stream water quality. Approximately 80 sites are monitored for pH, ammonia, nitrite-nitrate, turbidity, temperature, and dissolved oxygen. Federal funds support this project. The *Integrated Stream Monitoring* project monitors rivers and streams using an integrated approach designed to provide a more holistic picture of river water quality. Basic physical and chemical water quality parameters are monitored at approximately 100 sites each summer. This project is funded by state funds. The *Biological Monitoring* program monitors the condition of wadeable streams and wetlands. Approximately 200 sampling locations are spread throughout the state. This project is also funded by the state. The *North Shore Streams Monitoring Project* assesses the current water quality conditions at eight sites in the state to provide baseline information on water quality trends. The *Stream Toxics Monitoring* monitors trace metals, including mercury, arsenic, cadmium, chromium, copper, lead, nickel, and zinc in streams in the state's major river basins. No additional information is currently available for this project.

Two programs focus on the water quality of inland lakes. The *Lake Assessment Program (LAP)* samples water quality at 45 sites for total phosphorus, total suspended solids, conductivity, transparency (secchi disk), dissolved oxygen, total Kjeldahl nitrogen, temperature, and chlorophyll-a. State funds support this program. The *Lakes Regional and Trend Monitoring* program samples 30 lakes once to twice a month from June through September. These data are added to the regional database and used for assessing trends. No additional descriptive information is currently available for this project.

Two volunteer monitoring programs conduct water quality monitoring in Minnesota. The *Citizen Lake Monitoring Program* collects transparency, total phosphorus, and chlorophyll data at nearly 1,400 sites. *Citizen Stream-Monitoring Program* collects transparency, appearance, recreational suitability, precipitation, and stream stage at 473 locations in the state. Funding for administration of both of these projects come through the state's general fund.

New York

Six water quality monitoring programs were reported from New York. The New York State Department of Environmental Conservation (NYSDEC) is conducting five of these programs and State University of New York, Syracuse manages one.

NYSDEC's *Rotating Intensive Basin Studies* is a statewide assessment program collecting chemical, toxicity, macroinvertebrate, and sediment data. No additional information is currently available for this project.

The *Citizens Statewide Lake Assessment Program* managed by NYSDEC is a volunteer lake monitoring program. Sampling is conducted statewide for parameters including chloride, conductivity, nitrogen, pH, rainfall, salinity, transparency (secchi disk), suspended and dissolved sediments, water temperature, aquatic vegetation, and chlorophyll.

The Finger Lakes region is the focus area for three of NYSDEC's monitoring programs. *Finger Lakes Synoptic Water Quality Investigation* assesses the conventional water quality and limnologic trends within the Finger Lakes. The *Finger Lakes Biomonitoring* program monitors water chemistry and zooplankton in the region and the *Water Quality Study of the Finger Lakes* program assesses water quality conditions and trends in the Finger Lakes.

The State University of New York's Syracuse *Nutrient Dynamics in Salmon Creek, NY* is a program that studies the processes controlling nutrient delivery from the watershed to the stream. No additional information is currently available for this project.

Other reported activities that collect some level of monitoring data in New York include the Buffalo Remedial Action Plan (RAP) 2005 sediment sampling program, sampling related to sediment remediation work in the St. Lawrence River, RAP coordination in 18 Mile Creek by the Niagara County Conservation District, and Monroe County combined sewer overflow and stormwater abatement monitoring. No additional information was submitted for these programs.

Ohio

In total, three water quality monitoring programs were reported from Ohio.

The Ohio Environmental Protection Agency manages the *Statewide Biological and Water Quality Monitoring and Assessment* program. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 300-400 sampling sites to collect biological, chemical, and physical data.

The Ohio Department of Natural Resources conducts the *Ohio Stream Quality Monitoring Project* (SQM), which uses a variety of biological testing techniques to compile information on the quality of the state's rivers and streams. Volunteers are trained to collect and classify aquatic invertebrates. The Ohio SQM Project maintains data on 20 state scenic river segments.

The *Citizen Lake Awareness and Monitoring (CLAM)*, managed by Ohio Lake Management Society, is a volunteer lake monitoring program. No additional information was provided for this project.

Pennsylvania

Pennsylvania Department of Environmental Protection reported two water quality monitoring programs within the state.

Pennsylvania's *State-Wide Surface Waters Assessment Program* is a statewide, fixed station water quality sampling system. This program was designed to conduct state-wide stream assessments for all streams, and causes and sources of impairments. Currently there are 120 sampling locations.

The *Citizens' Volunteer Monitoring Program (CVMP)* is a citizen volunteer monitoring network, which collects water quality information as well as performs habitat assessments and water quality ratings based on benthic macroinvertebrate sampling.

Wisconsin

Two water quality monitoring programs were reported from Wisconsin. Both are being conducted by Wisconsin Department of Natural Resources.

The *Wisconsin Long Term Trends* (Tributary) monitoring network consists of 42 surface water monitoring stations throughout the State. Sites are sampled either quarterly or monthly for a variety of parameters including nutrients, suspended solids, dissolved oxygen, and trace metals.

The *Citizen Lake Monitoring Network* is a volunteer monitoring network engaged in sampling water quality conditions at over 850 lakes in Wisconsin. This network is designed to increase public information and involvement in lake management as well as provide water quality data to resource managers.

Wisconsin DNR has also monitored approximately 15 nearshore stations on Lake Michigan (10 meter water depth) the past two years (and plans to continue) for nutrients, suspended solids, dissolved oxygen, conductivity, light penetration, algae nutrient content, and dreissenid mussels as part of a study of nuisance algae.

Local – Local governments also contribute a substantial effort to water quality monitoring in the region. Local governments reported 18 water quality monitoring programs taking place in the Great Lakes watershed. These programs are primarily focused on smaller, regional monitoring efforts and therefore will not be described in detail in this section.

University – In total, universities conduct 24 water quality monitoring programs in the Great Lakes watershed. University of Wisconsin, Heidelberg College, and Cornell University are major contributors to Great Lakes monitoring. As with local government monitoring programs, these efforts are primarily focused on smaller, regional monitoring efforts and therefore will not be described in detail in this section.

Non-governmental Organizations – Non-governmental organizations reported 21 water quality monitoring programs taking place in the Great Lakes watershed. The majority of these programs are local level volunteer water quality monitoring efforts.

Canada

In total, 14 water quality monitoring programs focusing on watersheds were reported by Canadian agencies in the Great Lakes basin. Of these programs, six are conducted at the federal level by Environment Canada, two are conducted by Ontario Ministry of the Environment, and the remaining programs are conducted by regional conservation authorities.

Federal – Environment Canada's watershed water quality monitoring takes place primarily in the interconnecting channels of the Great Lakes basin, including the St. Lawrence, Niagara, St. Clair, and Detroit Rivers. In 1975, the *Niagara River Upstream/Downstream Monitoring Program* was initiated to measure weekly water quality samples for nutrients, major ions, trace metals, pesticides, chlorobenzenes, PCBs, and PAHs. The data from this program are used to determine Lake Erie exit loads, Lake Ontario input loads from the Niagara River, and to monitor the effectiveness of remedial efforts along the Niagara River corridor. The *St. Clair Water Quality Monitoring Program* samples various water quality parameters to track improvements in point and non-point source loadings to the river. The *Wolfe Island Monitoring Program* involves the collection of water and suspended sediment samples at a station located at Banford Point on Wolfe Island. Monthly concentrations of trace organics (pesticides, chlorobenzenes, PCBs, PAHs), trace metals, nutrients and major ions are measured. The data from this station are used to determine exit loads from Lake Ontario, and to provide information on upstream water quality conditions for the St. Lawrence River basin. The *St. Clair & Detroit River Water Quality Monitoring Program* was initiated in 2001 to assess a wide range of organic and inorganic contaminants. The intent of this program is to identify contaminants of concern and detect differences in contaminant concentrations in upstream and downstream locations. A federal program not focused on the connecting channels is Environment Canada's *Pesticides In Aquatic Ecosystems* program. Through this program, surface water is monitored for in-use pesticides in the Great Lakes and in selected watersheds. Surface water environments as well as precipitation are scanned for pesticides commonly used in Ontario. Finally Environment Canada's *Agricultural Non-Point Sources of Pollution* monitors levels of nitrogen, phosphorus, and suspended sediments. No additional information was available for this program.

Provincial – Ontario Ministry of the Environment's *Provincial (Stream) Water Quality Monitoring Network (PWQMN)* collects surface water quality information from rivers and streams at over 350 strategic locations throughout Ontario. Monthly samples are analyzed for a suite of parameters including nutrients, metals, chloride and turbidity. Ontario Ministry of the Environment also manages the *Clean Water Regulation (MISA) Monitoring Data Ontario Point Sources* database. No descriptive information is currently available for this project.

Regional – Four conservation authorities reported their participation in the PWQMN. The St Clair Regional Conservation Authority's *Habitat Stewardship Program* monitors monthly water chemistry, including ammonia, chloride, conductivity, nitrogen, pH, phosphorus, total suspended solids, and water temperature, at twelve sites and benthic macroinvertebrates at 67 sites annually. Funding for this program comes from Environment Canada. In addition, the Upper Thames River Conservation Authority reported the *Benthic Sampling Program*. No descriptive information is currently available for this project.

Water Quality Databases

The US EPA manages three large databases that store water quality data for the Great Lakes basin. Data in these databases is collected by regional, state, and local agencies as well as privately run companies.

US EPA's *STORET* (Storage and Retrieval) database, though not a monitoring program itself, contains raw biological, chemical, and physical surface and ground water data collected by federal, state, and local agencies, Indian tribes, volunteer groups, universities, and others. In addition to water quality data, STORET contains information on why the data were gathered, sampling location, and methods used to sample and analyze the data. STORET has been in operation since 1999 and includes nearly 9,000 sites in the Great Lakes basin. A small percentage of these stations are in open waters of the Great Lakes basin rather than in inland lakes, rivers, or nearshore areas. STORET contains a great deal of historical data going back to the early part of the 20th century. This database is an excellent reference for looking at temporal and spatial trends.

The *Permit Compliance System (PCS)* has been providing information for more than 30 years on companies in the U.S. that have been issued permits to discharge waste water into rivers. This system provides information on when a permit was issued and expires, how much the company is permitted to discharge, and the monitoring data showing what the company has discharged. The PCS database tracks permit compliance and enforcement status to meet the informational needs of the National Pollutant Discharge Elimination System (NPDES). PCS collects data from more than 3,500 locations spread throughout the Great Lakes basin with the highest concentrations in the more heavily urbanized areas.

BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) is a multi-purpose environmental analysis system for use by regional, state, and local agencies in performing watershed and water quality based studies. Though it is not a monitoring program, it integrates a geographic information system (GIS), historical watershed and meteorological monitoring data, and state-of-the-art environmental assessment and modeling tools into one convenient package. Among other information included in the database are industrial facilities' discharge sites, water quality stations, bacteria stations, a national sediment inventory, and water quality observation stations.

Findings – Water Quality

Open Waters – US EPA's *Long-Term Open Lakes Monitoring Program* and Environment Canada's *Great Lakes Surveillance Program* are the most extensive open water monitoring programs in the Great Lakes basin. It appears as if federal agencies are primarily responsible for monitoring the open waters of the basin. Nearshore and offshore monitoring conducted by other agencies generally occurred within fifteen kilometers of the shoreline. One exception to this general conclusion is Macomb County, Michigan's *Lake St. Clair Water Quality Assessment* program which monitors at 122 locations throughout the U.S. portions of Lake St. Clair.

Watershed – At the federal level, one of the most comprehensive water quality monitoring programs in the Great Lakes watershed is the USGS *National Water Information System (gaging stations)*, which in the past

has collected a combination of water quality and water level data at roughly 75,000 locations in the basin. This is a very valuable resource for the region. Unfortunately, funding for these sampling locations is threatened because a large portion of the operating budget comes from sources outside of USGS, such as state agencies and universities. Three gaging stations in the Great Lakes basin are currently being shut down.

At the state and provincial level, all states and provinces reported dedicated water quality monitoring programs in their sections of the Great Lakes watershed. Ontario Ministry of the Environment reported a comprehensive stream monitoring program called the *Provincial (Stream) Water Quality Monitoring Network* (PWQMN). Each U.S. state reported specific lake monitoring programs, stream monitoring programs, and large scale volunteer water quality monitoring programs. Funding for these state level programs originates from mixed sources. Some states reported support from federal funds while others reported state or non-governmental funding. Michigan's Clean Michigan Initiative bond funding system is a good example of an innovative funding source. Because of this funding system, Michigan has the resources necessary to maintain a comprehensive water quality monitoring program. This type of funding system may serve as a good example for other states and provinces seeking additional financial resources.

Nearshore monitoring was identified as a potential monitoring gap. This type of monitoring is generally considered underfunded and therefore not enough monitoring is taking place in the nearshore zones of the Great Lakes basin. This is the area that humans spend most of their time and where the largest anthropogenic effects are seen. More financial resources may need to be directed to nearshore monitoring to address this need.

Indicators – The Toxic Chemical Concentrations in Offshore Waters (#118) indicator calls for the monitoring of PCBs, dieldrin, chlordane, DDT, metabolites, hexaclorobenzene, toxaphene, and mercury. Results of the monitoring inventory show a fair amount of water quality monitoring in the open waters of the Great Lakes basin, but little data are collected on these toxic substances. Three programs specifically mentioned collecting toxic chemical data. These are Environment Canada's *Niagara River Upstream/Downstream Monitoring Program*, Michigan Department of Environmental Quality's *Water Chemistry Monitoring Project*, and University of Wisconsin – Milwaukee/Milwaukee Metropolitan Sewerage District's *WATERBase Monitoring Project*. It appears as if lack of data on toxic chemical concentrations in offshore waters of the Great Lakes may be a monitoring gap in the Great Lakes basin.

It is important to note again that toxic chemical concentrations can be measured in media other than water, including sediments and fish. Typical toxic chemical concentrations in water are much lower than associated concentrations in sediment and fish. Monitoring for these toxic contaminants in water must therefore include tests suitable for detecting extremely low levels of these contaminants. This type of monitoring is very expensive. Currently, toxic chemical investigation in the Great Lakes basin appears to be largely focused on sediments and fish. More investigation is needed to determine if the benefits of monitoring the toxic chemical concentrations in water is worth the added expense when similar data are being collected in sediments and fish.

The Phosphorus Concentrations and Loadings (#111) indicator calls for measuring the total phosphorus levels in the springtime open waters and annual total phosphorus loads to each lake. Most water quality monitoring programs, including those in the open water, inland lakes, rivers, and streams of the Great Lakes basin, reported phosphorus monitoring as part of their sampling protocol. While it appears as if there is a good deal of data available on phosphorus concentrations in waters of the Great Lakes basin, most of these programs, other than Michigan Department of Environmental Quality *Water Chemistry Monitoring Project*, appear not to be focused on determining the sources of contamination and local loading levels. More monitoring may need to be directed at identifying and reducing the impact of the sources of phosphorus contamination.

Water quality monitoring is widespread and diverse in the Great Lakes basin. Programs vary from locally focused to those addressing basinwide issues. In most cases, programs monitor for a wide range of parameters using diverse strategies and methodologies. Additionally, the monitoring programs in the basin address many more water quality issues than the few SOLEC indicators specifically addressing surface water quality. Using the information in this report and the inventory itself, the water quality monitoring community should examine program details against basinwide needs to determine how best to coordinate monitoring. A significant concern was raised about the cost of monitoring increasing each year while the level of governmental funding dedicated to water quality monitoring remains the same. The result is a continuous decrease in monitoring efforts in order to stay within previously set budgets. More effort needs to go toward allotting financial resources based on current monitoring needs rather than previously set limits.

General Monitoring
b. Sediment Quality

In the Great Lakes basin 43 sites have been designated Great Lakes Areas of Concern (AOC). These areas are located across the Great Lakes basin and designated as AOCs largely due to high degrees of sediment contamination. Sediment contamination is created primarily by industrial and municipal discharges, combined sewer overflows, and urban and agricultural non-point source runoff. Contaminated sediments pose serious human and ecological health concerns. Contaminated sediments also allow for a bioaccumulation effect in aquatic organisms, which in turn leads to human fish consumption advisories.[5]

Sediment monitoring is specifically addressed by two Great Lakes indicators: Concentration of Contaminants in Sediment Cores (#119) and Sediment Available for Coastal Nourishment (#8142). In total, 50 programs were found that monitor sediments in the Great Lakes basin. A number of these programs, as they relate to the Great Lakes indicators, are reviewed below.

Contaminants in Sediment Cores

The Concentration of Contaminants in Sediment Cores (#119) assesses the concentrations of toxic chemicals in sediment by measuring concentrations in sediment cores at selected sites within the Great Lakes basin at ten year intervals. Chemicals of interest include, but are not limited to, PCBs, deildrin, chlordane, DDT and its metabolites, hexachlorobenzene, toxaphene, and mercury.

HIGHLIGHT – Sediment Quality

- Results of the monitoring inventory also indicate that while there is a considerable amount of issue driven sediment sampling more baseline sediment monitoring may be needed. Currently there is little guidance on baseline sampling for open waters and nearshore areas of the basin. To successfully address SOLEC indicators, monitoring guidelines may need to be developed.

Federal – USGS conducts two large-scale sediment contaminant monitoring programs. The *National Water-Quality Assessment (NAWQA) Program* has target sampling programs in western Lake Michigan drainages and the Lake Erie-Lake St. Clair basin. Among a host of other sampling media this project targets contaminants in bed sediments. In addition to the NAWQA program, USGS also conducts the *Nearshore Lake Ontario Ecosystem Study Plan* which also samples sediment chemistry in Lake Ontario nearshore regions.

The U.S. Army Corps of Engineers monitors sediment as it is related to navigation and dredging. *The Navigational Dredging Harbors* project is conducted by the Detroit District of the Corps to collect sediment

data on commercial and recreational harbors in Michigan and Wisconsin. This program monitors various nutrients and organic indicators on a 5 to 10 year rotating cycle. The *Monitoring Dredged Material* project collects and analyzes sediments from Federal navigation channels to determine proper methods for managing dredged material. This program measures grain size, moisture content, volatile organic content, and total organic carbon on a five year cycle. The *Operations and Maintenance of Federal Navigation Channels* project not only maintains channel depths but also monitors sediment quality in these locations.

US EPA conducts a number of programs that address sediment monitoring. The US EPA *Contaminated Sediment Monitoring* conducts monitoring in nearshore areas of the Great Lakes basin and focuses on biological and chemical sampling in bottom sediments. This sampling is focused in AOCs in the US. The US EPA *National Sediment Inventory (NSI)* is a repository for data on chemical contaminants in river, lake, ocean, and estuary bottoms. US EPA's *STORET (Storage and Retrieval)* is a database that contains state collected contaminated sediment data. STORET includes 8,898 stations in the Great Lakes basin but only a subset of these are sediment monitoring locations.

The U.S. National Oceanic and Atmospheric Administration manages the program *Contaminant fluxes into and out of sediments* that sampled sediment contaminant levels in Lake Erie.

Environment Canada reported on three sediment contamination monitoring projects. The *Great Lakes Sediment Assessment Program* assesses sediment quality in the Great Lakes basin by comparing current sediment contaminant levels to surveys conducted in the late 1960s and early 1970s. This dataset is being developed to determine the spatial and temporal trends in persistent toxics in Great Lakes sediments. Environment Canada conducts the *Lake St. Clair Bottom Sediment Contaminant Characterization* project as part of their *Great Lakes Sediment Assessment Program.* The *Sediment Quality in Canadian Great Lakes Tributaries* is a sediment chemistry survey in the St. Clair River, Lake St. Clair, the Detroit River, Lake Erie, the Niagara River, Lake Ontario, and the St. Lawrence River. The sediment samples are analyzed for organochlorine compounds, polycyclic aromatic hydrocarbons, metals, total organic carbon, dioxins, furans, in-use pesticides, and particle size distribution.

State/Provincial and local – Illinois reported on two sediment contamination monitoring programs. One of the many goals of the Illinois Environmental Protection Agency's *Illinois Clean Lakes Program (ICLP)* is to determine the presence of toxic materials in fish, water, and sediments and the sources of any contaminants. Specific information on parameters, sampling frequency; and funding sources was not reported. The Northeastern Illinois Planning Commission *Lake Water Quality Assessment Program* collects sediment quality data on non-routinely monitored, publicly-owned or publicly-accessed lakes within the northeastern Illinois region. In total 109 lakes are sampled for various nutrients, metals, and organics. This program is funded by the US EPA Lake Water Quality Assessment (Section 314) of the Clean Water Act. No information on specific sediment monitoring parameters was reported for either program.

Michigan reported a number of sediment monitoring programs. The Michigan Department of Environmental Quality (DEQ) *Sediment Contaminant Monitoring in Inland Lakes* measures the spatial and temporal trends in contaminant levels in inland lake sediments. A total of 22 lakes are sampled for nutrients, total organic carbon, PCBs, DDT, Mercury, and trace metals. These lakes are sampled on a ten-year rotating cycle. This program is funded by Clean Michigan Initiative. Michigan DEQ also conducts site specific sediment sampling as part of its *Water Quality Monitoring* program. Through this program sediment samples are tested in selected watersheds on a 5-year rotating cycle. Michigan DEQ does additional targeted sediment sampling as part of regulatory processes (e.g. dam removal). Other programs taking place at the local level are the Wayne County Department of Environment *Rouge River Project*, the Macomb County *Bear Creek Clean Water Initiative*, and the Macomb County *Lake St. Clair Water Quality Assessment*.

Three sediment monitoring programs were reported in New York. New York State Department of Environmental Conservation's *Sediment Sampling* program monitors surficial sediment contamination. In addition, the New York State Department of Environmental Conservation *Finger Lakes Sediment Core Investigation* assesses organic and inorganic chemical trends over time and determines sediment accumulation rates within each of the Finger Lakes. Parameters measured include organic chemicals (DDT, PCBs, etc.) and inorganic chemicals (primarily metals). Cornell University's *Characterize sediment* measures NO3-N, dissolved phosphorus, total phosphorus, alkalinity, sulfate, chloride, and pH at 20 sub-watersheds of Fall Creek and 10 monitoring wells at Animal Science Teaching and Research Center in Harford, New York. Funding information was not reported for either of these programs.

Ohio reported on three sediment monitoring programs. The Ohio Environmental Protection Agency *Ohio sediment inventory* samples for nutrients, metals and industrial contaminants (primarily PCBs and poly-aromatic hydrocarbons) at 21 locations. Ohio Environmental Protection Agency's *Cuyahoga River Old Channel Assessment* samples 25 sites for contaminated sediments in both core and ponar grab samples. Samples are analyzed for poly-aromatic hydrocarbons, PCBs, chlorinated pesticides, heavy metals, semi-volatile chemicals, total organic carbon and grain size. The Ohio Department of Natural Resources *Sediment cores* program takes core samples from Ohio waters. No more descriptive information is available for this program.

Wisconsin reported two sediment monitoring programs. The Wisconsin Department of Natural Resources *Sediment Core Data* samples sediment cores at 72 lakes. The Green Bay Metropolitan Sewerage District *Ambient Water Quality Monitoring Program* collects water and sediment quality data from the Lower Fox River and Green Bay. Sediment gravity cores are collected every other year for heavy metals and organics analysis.

Ontario Ministry of the Environment manages the *Great Lakes Index Station Network Monitoring.* This program has established a total of 66 core sites within the Great Lakes basin and a minimum of seven sites are visited each year. Each of the Great Lakes, except Lake Michigan, are monitored through this program. This network of stations is designed to provide information on where and how sediment quality conditions are changing over time. Ontario Ministry of the Environment also reported the *Nearshore Monitoring and Assessment* program which monitors sediment, water, and biota in near shore zones of the Great Lakes.

Ontario's Great Lakes Institute for Environmental Research monitors *Western Basin Contaminants* including organochlorine compounds, PCBs, and poly-aromatic hydrocarbons levels in sediment.

Sediment Available for Coastal Nourishment

The purpose of the Sediment Available for Coastal Nourishment (#8142) indicator is to assess the amount of water and suspended sediment entering the Great Lakes through major tributaries and connecting channels, and to estimate the amount of sediment available for transport to nourish coastal ecosystems. This indicator is measured through streamflow and suspended sediments at the mouth of major tributaries and connecting channels.

A limited number of programs were found that specifically address suspended sediment monitoring. Results of the inventory did report on at least 48 programs monitoring for turbidity. It is possible that these turbidity data may provide information needed to analyze suspended sediment transport in the region. This section will focus on discussion of the programs specifically addressing suspended sediment monitoring. For information on the programs monitoring turbidity please refer to the complete monitoring inventory database.

Federal – The USGS *National Water Information System (gaging stations)* collects streamflow data from roughly 75,000 locations in the basin. While the majority of the funding for this program comes from USGS, a large portion also comes from state agencies and universities. Environment Canada conducts two suspended sediment monitoring programs. The *Ontario Region Suspended Sediment Program* operates a network of 90 suspended sediment stations around the Great Lakes basin to allow computation of annual sediment loads to the Great Lakes. The suspended sediment network produces annual suspended sediment load calculations for most major tributaries around the Great Lakes. Environment Canada also manages the *St. Clair River, Lake St. Clair & Detroit River Suspended Sediment Characterization* program. No descriptive information was reported for this program.

State – Illinois State Water Survey's *Benchmark Sediment Monitoring Program* is a long-term database of suspended sediment transport at 15 locations in Illinois. Michigan Department of Environmental Quality collects total suspended sediments and total dissolved sediments in tributaries throughout the state as part of its *Water Quality Monitoring* program. Heidelberg College manages the *Sediment and Nutrient Concentrations in the River Raisin* Program. The level to which this program measures suspended sediments is unclear.

Findings – Sediment Quality

It appears as if a considerable amount of sediment monitoring is taking place at both the federal and state/provincial levels. Little information was available on specific parameters and sampling frequency at the federal level. A more in-depth examination of parameters and frequency at the federal level would more clearly determine if sampling coverage is adequate.

While a great deal of sediment sampling appears to be taking place in inland lakes and rivers, results of the inventory indicate that there may be a potential gap in sediment sampling in open waters and nearshore areas of the Great Lakes. Results of the monitoring inventory also indicate that while there is a considerable amount of issue driven sediment sampling more baseline sediment monitoring may be needed. Currently there is little guidance on baseline sampling for open waters and nearshore areas of the basin. To successfully address SOLEC indicators monitoring guidelines may need to be developed. Elements of sediment monitoring such as sampling frequency, spatial distribution of sampling site, and chemical parameters should be refined. All states and provinces, with the exception of Indiana, Minnesota and Pennsylvania, reported sediment monitoring programs. Not enough information was reported on funding sources to draw any specific conclusions but concerns were raised about potential reductions to sediment monitoring budgets. Inadequate budgets may affect the effectiveness of baseline sediment contamination monitoring programs and investigatory programs looking at new or historic sources of contaminants.

Only 3 programs reported monitoring suspended sediments or streamflow in Great Lakes basin. At the U.S. federal level, no suspended sediment monitoring programs were reported. Environment Canada conducts two suspended sediment monitoring programs. The *Ontario Region Suspended Sediment Program* operates a network of 90 suspended sediment stations around the Great Lakes basin to allow computation of annual sediment loads to the Great Lakes. Environment Canada also manages the *St. Clair River, Lake St. Clair & Detroit River Suspended Sediment Characterization* program for which descriptive information was available. Suspended sediment monitoring at the state level was lacking in all Great Lakes states except Illinois and Michigan. Results of the inventory indicate that 45 programs monitor turbidity. This may be appropriate for some level of analysis of suspended sediment loads; however more investigation is required to determine if these data are sufficient.

General Monitoring

c. Soil

Because of its fertile soil, the Great Lakes basin accounts for one of the most agriculturally rich areas of the country. These fertile soils also provide a rich template that allows the climatic expression of a diversity of natural habitats ranging from tallgrass prairies in the South to boreal forests in the North. The diverse array of habitats in turn provide for the overall ecological diversity and ecosystem health of the region. Changing land uses can alter soil characteristics and impact environmental processes involving the soil. For example, soil contamination can lead to ground, surface or drinking water contamination, along with other ecological threats. Although no SOLEC indicator specifically calls for soil monitoring, there are a number of monitoring programs collecting data on soil conditions.

Ten soil monitoring and identification programs were found in the Great Lakes basin. These programs range from local remediation monitoring to basinwide soil identification databases. The most detailed and comprehensive soil mapping program is the *Soil Survey Geographic Database (SSURGO)* managed by U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). The scale of this mapping effort generally ranges from 1:12,000 to 1:63,360 and is primarily designed for use by landowners, townships, and natural resource planning and management at the county level. This database will cover the entire U.S. when completed and is being developed at the county level. It is scheduled to be complete in 2008. Currently, only portions of the dataset are available in digital form.

Another soil database program, also managed by NRCS, is the *State Soil Geographic Database (STATSGO).* Through this program soil maps are produced for the entire U.S. The mapping scale for STATSGO is 1:250,000. The level of mapping is designed to be used for broad planning and management uses covering state, regional, and multi-state areas. NRCS also manages the *Soil Climate Analysis Network (SCAN)* that collects near real-time soil moisture and temperature at 4 locations in the Great Lakes basin and is planning to expand the program by adding 1,000 new sampling locations.

The US EPA *Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS)* tracks information on all Superfund sites, both the most hazardous and those where cleanup is easier or less urgent. In total there are over 153 CERCLIS monitoring sites in the Great Lakes basin. Many of these sites collect data on soil contamination. US EPA also manages the *Toxic Release Inventory (TRI)* which collects information on toxic chemicals that are being used, manufactured, treated, transported, or released into the environment, including soil resources.

HIGHLIGHT – Soil

- Currently, no SOLEC indicator specifically calls for soil monitoring. To develop baseline data on soil characteristics and the potential environmental impacts of alternations, SOLEC participants may want to consider adding an indicator to address soil composition and contamination.
- The US Dept. of Ag. National Resources Conservation Service manages the Soil Climate Analysis Network (SCAN). This program is the only basinwide program collecting real-time soil moisture and temperature locations in the Great Lakes basin. A need for additional sampling locations has been identified and consequently SCAN is seeking to expand its network.

Wisconsin reported three distinct soil sampling programs. This includes a registry of closed remediation sites for the state, a nutrient management program that addresses proper soil nutrient management, and the forestry compartment reconnaissance database which considers soil resources as part of an ecosystem management plan. A small scale site restoration project was also reported in New York State.

Other soil sampling programs include local remediation, contaminant monitoring and nutrient management programs.

Findings - Soil

The *Soil Survey Geographic Database (SSURGO)* managed by U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) is the most detailed and comprehensive soil mapping program in the basin. This database is being collected at the county level for the entire U.S. Currently only a portion of U.S. counties have been digitally mapped but the database is scheduled to be complete in 2008. A more general soil database also managed by NRCS is *State Soil Geographic Database (STATSGO).* These soil maps are produced for the entire U.S. by generalizing the detailed soil survey data. For most management issues involving soil, however, these data are too coarse to be of much use. NRCS also manages the *Soil Climate Analysis Network (SCAN)* that collects real-time soil moisture and temperature at 4 locations in the Great Lakes basin. A need for additional sampling locations has been identified and consequently *SCAN* is seeking to expand its network to include another 1,000 real-time sampling locations nationwide. SOLEC should consider adding an indicator to address soil composition and contamination. If contamination mapping becomes a need, more effort will be needed to join existing datasets and fill in numerous gaps in the coverage. Remediation and point source contaminant monitoring is funded by the responsible parties, while *SSURGO, STATSGO,* and *SCAN* rely on federal support.

General Monitoring
d. Groundwater

Monitoring groundwater contamination has become a key environmental issue as land use intensity across the Great Lakes basin increases. Groundwater is the safest and most reliable source of available freshwater. Ninety percent of the freshwater resources in the United States are stored as groundwater. Groundwater plays an important role in the hydrologic cycle and is an important resource in areas of limited precipitation. Results of the monitoring inventory indicate that 29 groundwater monitoring programs are conducted in the Great Lakes basin. Groundwater health and availability is addressed by four SOLEC indicators. Each of these indicators and relevant monitoring programs as reported to the monitoring inventory are discussed below. See the drinking water section for more information on drinking water monitoring

Groundwater Quality

The Natural Groundwater Quality and Human-Induced Changes (#7100) indicator assesses the quality of groundwater used for drinking water, agriculture, and ecosystem function. Measured parameters include atrazine, nitrate/nitrite, total coliform, E. coli, taste, odor, total organic carbon and other parameters of concern.

HIGHLIGHT – Groundwater

- More resources may need to be directed toward monitoring groundwater discharges in the region. No specific groundwater discharge monitoring programs were reported to the inventory.
- The USGS gaging station program monitors surface water, groundwater, and water quality extensively across the basin. Due to federal, state and non-governmental budget cuts, funding for this important program is threatened.

The US EPA *STORET (Storage and Retrieval)* database contains biological, chemical and physical ground water data collected and uploaded by federal, state and local agencies. STORET currently includes nearly 9,000 stations in the Great Lakes basin, the bulk of which are in Minnesota, Wisconsin, and Michigan. It is important to note that only a subset of these locations monitor chemical contaminants in groundwater. USGS conducts two sampling programs that also sample chemical composition of groundwater in the basin. The *National*

Water-Quality Assessment (NAWQA) Program has study area sampling programs in western Lake Michigan drainages and the Lake Erie-Lake St. Clair basin with a total of 171 sampling locations. Among other media this program monitors groundwater contaminants. Study areas are intensively monitored on a rotating basis across the U.S. The *National Water Information System*, also managed by USGS, historically has collected water quality and water level data at roughly 75,000 locations in the basin. Included in these sampling locations are ground water sampling sites collecting water chemistry data.

The Illinois Environmental Protection Agency conducts the *Groundwater* program, which provides an overview of the groundwater conditions in the state by establishing baselines and identifying trends in water quality. Parameters sampled at these sites include pH, conductivity, temperature, specific conductance, oxidation- reduction potential (Eh), pumpage rate, inorganic chemical analysis, volatile organic and aromatic chemical analysis.

Minnesota Pollution Control Agency's *Ambient Ground Water Quality Monitoring* consists of a network of 100 to 150 shallow monitoring wells and 100 to 150 deeper drinking water wells. The shallow wells provide an early warning network of changes in water quality. The deeper wells provide information about the quality of water that people are drinking. Each well is sampled biannually. Chemical parameters include nitrate, volatile organic compounds, chloride, and pesticides.

Ohio Environmental Protection Agency's *Ambient Ground Water Monitoring Program* provides state-wide ground water quality information to enhance water resource planning and protection activities. The sampling network includes 280 wells distributed across the state of Ohio that are sampled for a suite of 32 inorganic water quality parameters every six or eighteen months. Emphasis is placed on sampling aquifers used by public water systems. Funding for this program comes primarily from US EPA Clean Water Act programs.

Wisconsin Department of Natural Resources' *Groundwater & Environmental Monitoring System (GEMS)* monitors groundwater chemistry semiannually at over 640 sites in the state. Wisconsin's *Groundwater Retrieval Network (GRN)* links groundwater data residing in various program-related database systems to one central location for analysis. Included in this database are public drinking water supply wells, private drinking water supply wells, non-point source priority watershed projects, landfill wells, and special groundwater studies.

Groundwater programs found at the local level include the Kellogg Biological Station *Nutrient Monitoring* program and the Superior Environmental Corporation *Roger B. Chaffee Blvd site* and *54th and Clyde Park site.*

Groundwater Use

The Groundwater and Land Use and Intensity (#7101) indicator measures land use and water use intensity within political sub-divisions and supply and demand issues related to ground water. This indictor is used to infer the potential impact of land use practices on the quantity and quality of groundwater resources.

Only one program was found that directly measures groundwater use patterns. The *National Water Use Information* program managed by USGS is a compilation of site-specific data and water-use maps for each state in the U.S. Included in this database are water-use levels for public supply, domestic, irrigation, industrial, livestock, aquaculture, mining, and thermoelectric power. These data are collected and compiled for each state every five years. Additional information needed to evaluate this indicator is well-water permit and construction records. These data are likely available, but were not reported via the monitoring inventory. For more information on land use please refer to the land use section of this report.

Groundwater Discharge

Two SOLEC indicators investigate groundwater discharge in the basin. The Base Flow Due to Groundwater Discharge (#7102) indicator is used to help determine the impacts of surficial alterations on the quantity of groundwater resources. This indicator is a measure of the contribution from groundwater discharge made to surface water base flow. The Groundwater Dependent Animal and Plant Communities (#7103) indicator is a measure of the numbers and diversity of invertebrates, fish, wildlife, and plant communities dependent on groundwater discharges in tributaries and nearshore areas of the Great Lakes basin. This indicator assess the locations of groundwater inputs, contribution of groundwater to stream and nearshore flows; and trophic status, food web dynamics, and location of groundwater fed habitats and communities.

No information was reported directly on groundwater discharge monitoring programs but a number of monitoring programs may contribute some degree of relevant information. The USGS *National Water-Quality Assessment (NAWQA) Program* may provide some level of detail on groundwater discharge in the western Lake Michigan drainages and the Lake Erie-Lake St. Clair portion of the basin. Two state run surveys, including Illinois Environmental Protection Agency's *Intensive Basin Surveys* and the Ohio Department of Natural Resources *Water Inventory*, may also contribute to the groundwater discharge data available for those states but not enough information is available for these programs to evaluate their relevance. Additional monitoring programs relevant to the Groundwater Dependent Animal and Plant Communities indicator can be found in the wildlife and plant sections of this report.

Findings - Groundwater

Ground water quality monitoring is addressed by three large federal programs, the most comprehensive being the USGS *National Water Information System (gaging station)*. While a number of the Great Lakes states reported groundwater quality monitoring programs, Indiana, Michigan, New York, and Pennsylvania did not report any programs. It is difficult to evaluate shortcomings related to specific parameters because little to no sampling parameter information was provided for each program. The USGS *National Water Use Information* program is the most comprehensive water use inventory for the region. Additional information needed to evaluate the Groundwater and Land Use and Intensity indicator is well-water permit and construction records. These data are likely available but were not investigated through the monitoring inventory effort. It was also found that more investigation is needed on groundwater discharge monitoring in the region. While a few programs in the region may provide some level of groundwater discharge information, no specific groundwater discharge monitoring programs were reported. If this is an accurate assessment of the coverage of groundwater monitoring programs, additional resources will be needed to inform all SOLEC groundwater indicators. Additional monitoring programs relevant to the Groundwater Dependent Animal and Plant Communities indicator can be found in the wildlife and plant sections of this report. It should be noted that the U.S. Geological Survey gaging station program monitors surface water, groundwater, and water quality extensively across the basin. At present, funding for these sampling locations is threatened because a large portion of the operating budget comes from sources outside of USGS, such as state agencies and universities.

General Monitoring
e. Climate/Weather

Concerns regarding changes in climate and weather patterns have attracted a great deal of attention in recent years. Unnatural rates of climate changes have profound implications for natural ecosystems. Increasing temperatures may lead to changes in many aspects of weather, including wind patterns, amount and type of precipitation, and the occurrence of severe weather events. The suite of SOLEC indicators

includes two indicators directly addressing climate change. These include Climate Change: Effect of Crop Heat Units (#9003) and Climate Change: Ice Duration on the Great Lakes (#4858).

Crop Heat Units (#9003) are a measure of crop suitability used by farmers when selecting varieties or hybrids of crops suitable for their area. This indicator considers the effect of changes in atmospheric temperature on regional species diversity, spatial variability and crop yields. The primary measure of this indicator is daily maximum and minimum temperature averages using day and night readings. The second relevant indicator is Ice Duration on the Great Lakes (#4858) which aims to detect the impacts of climate change in the region by tracking ice on each lake over time. To interpret this indicator, data for maximum percentage of ice cover needs to be gathered each year.

Based on inventory results, the Great Lakes region has 18 operational weather and climate monitoring programs. These programs range from local precipitation monitoring programs to multiple parameter, federally funded, regional climate monitoring programs

HIGHLIGHT – Climate/Weather

- Overall monitoring for the climate change indicators appears to be quite complete, but the continuing need for this monitoring should be emphasized to those with budgetary oversight to ensure that monitoring coverage continues.

- A considerable amount of weather related data is collected at land based stations. While 47 marine buoys are present, they are not as widespread as land-based stations. These differences in spatial coverage may lead to accuracy differences between land and marine temperature models.

Land-based temperature averages across the Great Lakes basin are measured primarily by NOAA's *National Climatic Data Center* which measures daily air temperature averages in all Great Lakes states as well as other weather related parameters. Information on the specific number of monitoring locations was not available, but many locations are distributed throughout the basin. The Midwestern Regional Climate Center (MRCC) *Climate Data Sets* measures daily digital climate data for several thousand stations across the region as well. Measurements include high, low, and mean temperatures; hourly precipitation; dew point; pan evaporation; snowfall; modeled soil moisture data; and soil temperature. Numerous widely dispersed or local programs also monitor terrestrial atmospheric temperatures across the region. A few of these programs include southeastern *Michigan's Precipitation Data Network, Illinois' Climate Network Data*, and *Minnesota's Climate Monitor.*

NOAA also manages a set of 33 marine buoys monitoring air temperature as well as atmospheric pressure and wind in each of the Great Lakes. Environment Canada maintains fourteen *Marine Buoys* in the Great Lakes basin measuring air temperature and other parameters needed for weather forecasting. Other marine buoys measuring temperature and other weather and climate related data are the *Sterling Meteorological Station* located in southern Lake Ontario; the *Lake Michigan Monitoring Buoy* managed by University of Wisconsin, Milwaukee; and the *Lake St. Clair Weather Buoy* managed by University of Michigan.

NOAA *Great Lakes Ice Cover Climatology and Great Lakes CoastWatch Nodes* collect information on ice cover in the Great Lakes basin. The *Great Lakes Ice Cover Climatology* program collects ice cover information from many federal agencies to develop ice cover climatology reports and provides a benchmark of ice cover and ice cover variation of the Great Lakes since 1960. The *Great Lakes CoastWatch Nodes* collects near real-time information on various physical parameters including ice cover.

Findings – Climate/Weather

The results of the inventory show that data are gathered for both the 'Climate Change: Effect of Crop Heat Units' and the 'Climate Change: Ice Duration on the Great Lakes' indicators. NOAA's Great Lakes Ice

Cover Climatology provides the information needed to analyze changes in ice cover over time. Results of the inventory also show that a considerable amount of weather related data are collected at land based stations. While 47 marine buoys are present, they are not as widespread as land-based stations. These differences in spatial coverage may lead to accuracy differences between land and marine temperature models.

While we are unable to collect specific budget information for the weather and climate monitoring programs, the analysis shows that the primary weather and climate monitoring programs are large-scale data collection efforts managed by NOAA. Funding is generally consistent year-to-year, but can be subject to congressional cuts or outright elimination. While monitoring for the climate change indicators appears to be quite complete, the continuing need for this monitoring should be emphasized to those with budgetary oversight to ensure that monitoring coverage continues.

3. Habitat and Biodiversity
a. Fish Population Health

Fish population monitoring is necessary in order to measure the effect of anthropogenic factors, such as exotic species, over-fishing, predator stocking programs, habitat destruction, and habitat contamination on long-term fish population health and integrity. Also, because fish population composition and abundance can be an indicator of water quality, fish monitoring programs help to establish the overall environmental health of an ecosystem.

Based on inventory results, 107 fish monitoring programs are being conducted in the Great Lakes basin. These programs will be discussed in relation to relevant SOLEC indicators. Only those programs that directly address a specific SOLEC indicator will be mentioned. To see a complete listing of programs see the monitoring inventory. The monitoring programs were separated into three groups, based on program goals: fish contamination, species specific monitoring, and habitat and prey monitoring programs.

A U.S. Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state, and provincial organizations, has been developed to address fisheries related issues including instability of fish communities, over harvesting, sea lampreys, lost fishing opportunities, invasions and introductions, inadequate environmental quality, and competition and conflicts among users of the fishery resources. This Joint Strategic Plan has laid a framework necessary for organizations to coordinate and collaborate fisheries related monitoring activities across the Great Lakes basin. Through the Joint Strategic Plan, Lake Committees have been established for each of the five Great Lakes and Technical Committees have been established to advise these Lake Committees. Every five years formal "State of the Lake Reports" are prepared by the Lake Committees.

Fish Contamination

There are a number of SOLEC indicators that address fish contamination. This section focuses on fish contamination monitoring not related directly to human health. A number of monitoring programs collect data to assist in establishing fish consumption advisories for human health. For a discussion of these programs please refer to the Fish Consumption Advisory section of this report.

The SOLEC indicators addressing this monitoring need are Contaminants in Whole Fish (#121), Contaminants in Young-of-the-Year Spottail Shiners (#114), and External Anomaly Prevalence Index for Nearshore Fish (#124). The purpose of the Contaminants in Whole Fish indicator is to measure the concentration of persistent bioaccumulating toxic (PBT) chemicals in Great Lakes whole lake trout and

walleye as a general status and trend indicator. The Contaminants in Young-of-the-Year Spottail Shiners indicator monitors the concentration of PBT chemicals in young-of-the-year spottail shiners. This information is used to identify local areas of elevated contaminant levels that may pose a threat to piscivorous wildlife. External Anomaly Prevalence Index for Nearshore Fish is used to reflect external anomaly rates in nearshore fish. Anomalies include raised lesions and barbell abnormalities in brown bullhead catfish.

US EPA reported one fish contaminant monitoring program. The EPA Great Lakes National Program Office (GLNPO) manages the *Great Lakes Fish Monitoring Program* (GLFMP) that has annually monitored the toxic chemicals in Great Lakes fish since 1970. The GLFMP consists of two separate elements, an Open Lakes Trend Monitoring Program for whole fish (Element 1) and a Game Fish Fillet Monitoring Program (Element 2) to assess the risks of persistent and bioaccumulative contaminants on the health of the fishery and on the fish consuming wildlife. Element 1 of the GLFMP is directed at monitoring contaminant trends in the open water of the Great Lakes, and assisting in evaluating the impacts of contaminants on the fishery. The program provides for collection and analysis of whole-fish composites of lake trout in the size range from 600 mm to 700 mm from Lakes Michigan, Huron, Ontario, and Superior, and of walleye in the size range of 400 mm to 500 mm from Lake Erie. Composites of each species, consisting of five whole individual fish, are analyzed for contaminants to assess temporal trends in organic contaminants in the open waters of the Great Lakes, using fish as biomonitors. These data can also be used to assess the risks of such contaminants on the health of this important fishery and on the wildlife that consume them. Element 2 of the GLFMP is directed at monitoring potential human exposure to contaminants through consumption of popular sport species, as well as providing temporal trend data for top predator species, which have shorter exposures than the lake trout collected in Element 1. The GLFMP currently collects samples, for both elements of the program, from a set number of sites per lake. Collections alternate on a yearly basis, with even and odd year collections. Element 1 samples consist of 5 whole fish composites for a total of 50 fish collected per site. The GLFMP currently utilizes an established chemical parameter list for analysis that includes OC pesticides, PCBs, Mercury, and some emerging contaminants of concern. Funding for this program comes through the Clean Water Act sections 104 and 108.

The USGS *National Contaminant Biomonitoring Program* database, with 16 monitoring locations in the Great Lakes basin, seeks to document trends in occurrence of persistent toxic chemicals in fisheries. Parameters included in this program are PCB, dieldrin, mercury, DDT, and others. USGS also manages the *National Water Quality Assessment Program (NAWQA)* which includes some fish contaminant sampling. In the Great Lakes basin, NAWQA focuses study on western Lake Michigan and Lake Erie-Lake St. Clair drainages.

HIGHLIGHT – Fish Population Health

- A Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state and provincial organizations, has been developed to address fisheries related issues. This partnership framework is a strong example of effective coordination and collaboration and may be used as a model for other areas of Great Lakes monitoring.
- The Canadian Dept. of Fisheries and Oceans Great Lakes Fish Contaminants Surveillance Program has been collecting important fish contaminant data since 1977. Funding for this program was cut in the spring of 2005. This has created a large gap in regional fish contaminant monitoring and interrupts one of the few Great Lakes long-term fish contaminant monitoring programs capable of documenting trends and changes in the Great Lakes basin.
- Results of the inventory indicate that more fish habitat monitoring is needed in the Great Lakes basin at both the federal and state levels.

Illinois, Michigan, Minnesota, New York, and Wisconsin reported fish contaminant monitoring programs at the state level. Illinois Environmental Protection Agency manages three programs. The *Fish Contaminant Monitoring* program investigates the presence and build-up of toxic and potentially hazardous substances in fish, determines the impact of fish contaminants on aquatic environments, and provides information to aid in the location of contaminant discharge. Data are collected on mercury, PCBs, and a number of additional pesticides and contaminants in 17 locations. No specific information is available on sampling frequency or funding. The *Ambient Lake Monitoring Program (ALMP)* and the *Illinois Clean Lakes Program (ICLP)* both mention some fish contaminant monitoring, but no specific details were provided.

Another state level contaminant monitoring program is Michigan Department of Environmental Quality's *Fish Contaminant Monitoring Program* that has the objective of evaluating the need for sportfish consumption advisories and commercial fishing regulations, identifying spatial and temporal trends, and evaluating the effectiveness of existing programs. Twenty six fixed station sampling sites monitor whole fish for mercury, PCBs, and pesticides biennially. Edible portion samples are collected for analysis to support consumption advisory development. The number and location of these sites varies from year to year. Caged fish studies have been conducted to varying degrees in about 40 watersheds. Studies are repeated as needed in problematic watersheds. Primary funding for this project comes from Michigan's general state funds and the Clean Michigan Initiative.

The Minnesota Department of Natural Resources manages the state's *Fish Contaminant Monitoring Program*. Approximately every 5 years this program samples and analyzes for contaminants, including mercury and PCBs, in common fish species found in Lake Superior. In addition, this program collects 15 coho salmon and 15 chinook annually at French River on Lake Superior and monitors levels of mercury and PCBs. Funding for this program comes from state general funds and the state's game and fish fund.

The New York State Department of Environmental Conservation manages the *Lake Ontario Contaminant Trend Analysis* program that collects contaminant concentrations of PCBs, organochlorine pesticides, and mercury in salmonids at 11 Lake Ontario sampling locations. New York's *Sportfish Contamination* program monitors contaminant levels, including PCBs, organic carbon, mercury, dioxins and furans in Lake Erie and Lake Ontario fish. Funding for both of these programs is provided via state funds.

The objectives of Wisconsin Department of Natural Resources' Statewide *Fish Contaminant Program* include protection of fish consumers, resource management, and environmental protection. This program has been in place since the mid-1970s. Fish are collected from approximately 50 to 100 sites each year. Current analyses include about 600 samples analyzed for mercury, 350 for total PCBs, 30 for banned pesticides, 20 for dioxin/furan analysis and 10 for PBDEs. Monitoring consists of different components including baseline, advisory, Great Lakes, and trend monitoring. Baseline Fish Contaminant monitoring focuses on sampling new sites and sites where contaminant data are old or limited, or where existing data shows that concentrations may be high and additional data would be beneficial to determine advisory needs. Advisory Fish Contaminant Monitoring refers to monitoring of fish for contaminants where PCB based fish consumption advice is in place and monitoring is conducted to update consumption advice. This monitoring is generally conducted in major industrial rivers and locations where remediation may be necessary. Great Lakes contaminant monitoring consists of collection of fish for contaminant analysis on a biennial basis. Samples include both game fish and forage fish from Lake Superior and Lake Michigan. The final component of this program is to determine trends and geographic patterns of contamination for general DNR staff use. Funding for this program currently comes from a number of sources. Collection of fish is supported by fisheries staff sampling through other programs. Analysis of samples is supported by the Wisconsin State Laboratory of Hygiene and EPA Clean Water Act Performance Partnership Grant 106 funds. Other supplies and processing are also supported by Clean Water Act funds. Gaps include limits on the number of sites where fish can be collected each year, the number of fish that can be processed, and the number and types of analytes that can be assayed on each sample.

Canada reported a number of fish contaminant monitoring programs. The Department of Fisheries and Oceans (DFO) manages the *Great Lakes Fish Contaminants Surveillance Program* that has annually monitored the toxic chemicals in fish and fish communities throughout the Great Lakes since 1977. The program collects information at 10 Great Lakes sites, including 4 stations on Lake Ontario and 2 stations each on Lake Erie, Lake Superior, and Lake Huron. Approximately 450 fish samples are analyzed annually for routine pesticides, total PCBs and up to nine trace metals. A subset is also analyzed for dioxin and furan isomers, PCB isomers, toxaphene isomers and brominated flame retardant. DFO also manages the *Hamilton Harbor Contaminant Trend Monitoring Study*. The objective of this study is to generate fish community contaminants data to assist in describing the progress of remediation in the Hamilton Harbor ecosystem. The two previously mentioned DFO fish contaminant monitoring programs are facing funding concerns. Due to cuts in funding, these programs ceased operation April 1, 2005. DFO is currently in the process of refocusing its efforts to its core mandate of determining impacts of toxic chemicals on fish. Negotiations are currently underway between DFO and Environment Canada to shift responsibility for this monitoring program to Environment Canada but concerns have been raised that current financial resources could be a limiting factor in continuing this program.

Ontario Ministry of the Environment (OME) collects data through the *Ontario Sport Fish Contaminant Monitoring Program*. No descriptive information is available for this program. The Forage Fish Monitoring Program also run by OME collects forage fish samples around the Great Lakes and selected inland lakes and rivers and analyzes for a suite of contaminants including PCBs, mercury, mirex, DDT, and dioxins/furans. OME's *Tributary Mouth Biomonitoring* uses juvenile young-of-the-year fish to determine Canadian tributaries contributing significant loadings of BHC, chlordane, dieldrin, dioxin, HCB, mirex, OCS, PCBs, DDT, Pb, and Hg. Also Great Lakes Institute for Environmental Research *Western Basin Contaminants* study analyzes levels of contaminants (OCs, PCBs, PAHs) in fish.

While there are many fish contaminant monitoring programs throughout the Great Lakes, little information was collected on the methods employed. Therefore, it was difficult to assess the number of programs that directly address the Contaminants in Whole Fish indicator. *Michigan's Fish Contaminant Monitoring Program* and GLNPO's *Great Lakes Fish Monitoring Program* are the only active monitoring programs that specifically mention whole fish contaminant sampling. The Canadian monitoring program equivalent to GLNPO's *Great Lakes Fish Monitoring Program*, Department of Fisheries and Oceans (DFO) *Great Lakes Fish Contaminants Surveillance Program,* has collected fish contaminant data, including whole fish samples, since 1977. Funding for this program was cut in the spring of 2005.

The only organization that reported specifically conducting young-of-year contaminant sampling was the New York State Department of Environmental Conservation (NYSDEC). Their *Young of year (YOY) fish tissue sampling* program monitors contaminants, including organic carbon, PCB, mercury, and poly-aromatic hydrocarbons (PAH), in young-of-year spottail shiners in Lake Ontario and Lake Erie. Their *Monitoring Persistent Toxic Contaminant Trends in Young Fish in New York State Great Lakes Areas of Concern* program monitors contaminant levels, including mercury, PCB, and organochlorine pesticides, in young-of-year fish in order to assess spatial and temporal changes in contaminants within New York's Great Lakes basin. This program currently monitors eleven sites five times a year. Funding for this program comes through US EPA and the New York State Conservation Fund.

As an estimate of ecosystem health, the External Anomaly Prevalence Index for Nearshore Fish indicator is used to reflect external anomaly rates in nearshore fish. Anomalies include raised lesions and barbell abnormalities in brown bullhead catfish. While there are many general fish monitoring programs that may collect such data, only Pennsylvania Sea Grant reported monitoring anomalies in brown bullhead. The *Fish Tumors in Brown Bullhead Catfish* monitors liver and skin tumor rates in brown bullheads from seven sites in Presque Isle Bay, Lake Erie. Funding for this project comes for US EPA.

Species Specific

The following will be a brief discussion of monitoring programs related to specific fish species of interest in the Great Lakes basin. Many of the monitoring activities in this section are coordinated monitoring efforts by Technical Committees in support of the Joint Strategic Plan for Management of Great Lakes Fisheries.

More than twenty five general fish community assessment programs were reported in the Great Lakes basin. The larger scale general fish community assessment programs include the U.S. Geological Survey *Status and Trends of Prey Fish Populations in Lake Michigan, Fish Community Assessment*, and *Distribution, abundance, and biology of fish populations (Lake Ontario)*; Quebec Ministry of Natural Resources and Wildlife *St. Lawrence River Fish Monitoring Network*; Wisconsin Department of Natural Resources *Lake Michigan recreational fishing statistics*; Illinois Department of Natural Resources *Lakewide Assessment Plan*; Michigan Department of Natural Resources *Lake Michigan fish population, Assessment of the Fish Community of Lake St. Clair, Saginaw Bay Fish Community Survey, Les Cheneaux Islands Fish Community Assessment, St. Marys River Fish Community Assessment* and *Status and Trends in Aquatic Resources Michigan*; Ontario Ministry of the Environment Ontario *Young-of-the-year Monitoring Program*; Ohio Department of Natural Resources *Commercial Fishery Monitoring, Lake Erie Trawl and Gill Net Surveys*; Ohio Environmental Protection Agency Statewide *Biological and Water Quality Monitoring and Assessment*; and Ontario Ministry of Natural Resources *Monitoring and assessment of fish populations; Lake Superior Commercial Fish Program; Lake Superior Recreational Fish Program; Great Lakes Basin Rare Species Biodiversity Inforamtion for Ontario; Commercial Catch Sampling Program; Nearshore Fish Community Assessment Program; and Offshore Fish Community Index Program.* Because little specific information was presented on which species were being monitored each of these programs is not specifically discussed in this section, but it is important to note that these monitoring programs may contain information relevant to the indicators that address trout, salmon, walleye, and sturgeon monitoring. It is also important to recognize that natural heritage programs found in each state may provide additional information on fish populations in the Great Lakes basin.

Two SOLEC indicators address salmonid populations. The Lake Trout (#93) indicator measures the abundance and self-sustainability through natural reproduction of lake trout in the Great Lakes basin in order to determine status and trends. The Salmon and Trout (#8) indicator assesses population trends of introduced trout and salmon. This indicator is measured by the productivity, yield, or harvest of Pacific salmon, rainbow trout, and brown trout.

Lake Trout - The USGS Great Lakes Science Center conducts three Lake Trout restoration projects. The *Lake Trout Restoration in Eastern Lake Erie* and the *Lake Trout Restoration in Lakes Michigan and Lake Huron* programs look at population dynamics of lake trout to assess potential population rehabilitation. Abundance, age, growth rates, genetic strain, and lamprey wounding rates are monitored at twenty locations in Lake Erie, six locations in Lake Michigan, and six locations in Lake Huron. The program *Evaluate progress and identify impediments toward restoring lake trout populations in Lake Ontario* also managed by the USGS Great Lakes Science Center assesses the abundance of lake trout and investigates population biology of these species. Funding for these projects comes from federal budgets.

Illinois, Michigan, New York, and Wisconsin also conduct specific Lake Trout assessment programs. The Illinois Department of Natural Resources *Fall/Spawning Lake Trout Assessment* program monitors abundance of spawning lake trout at one stocked and two non-stocked sites in Lake Michigan. The Michigan Department of Natural Resources conducts two Lake Trout monitoring programs. *Assessment of Lake Huron Lake Trout* monitors trout growth, maturity, reproduction, abundance, mortalities, movement, diet, and estimated prey consumption at twelve sites in Lake Huron. The *Assessment of Lake Trout Populations in Michigan Waters of Lake Superior* program monitors relative abundance, length and age

composition, sex and maturity, sea lamprey wounding, growth, and mortality at 117 sites in Lake Superior. Both of Michigan's trout monitoring programs are federally funded. New York State Department of Environmental Conservation conducts the *Juvenile and adult Lake Trout Assessment* program. No specific information is available for this program. No specific information was reported on Wisconsin's Lake Trout monitoring projects. Ontario Ministry of Natural Resources conducts a number of general fish monitoring programs many of which identify Lake Trout as one of their focus species.

Through the Joint Strategic Plan for Management of Great Lakes Fisheries, a coordinated approach for monitoring the Lake Trout populations on Lake Michigan has been established. Through this coordinated approach, lake trout are sampled lake wide during two assessments which were designed by the Lake Michigan Lake Trout Task Group (Lake Michigan Technical Committee under the Joint Strategic Plan) and their coordinated implementation involves state, federal, and tribal entities. A spring lake trout sampling protocol for Lake Michigan is defined in the *Lake Wide Assessment Plan for Lake Trout* and includes sampling by four states, two federal, and tribal entities. All groups sample within a specific time frame at several locations around Lake Michigan to collect data on abundance, age, growth rates, genetic strain and stocking location, diet, fish health, recruitment of juvenile fish, and lamprey wounds. Mortality and growth indices are also developed from these data in Michigan waters. A fall/spawning assessment of lake trout is conducted by Illinois, Wisconsin and Indiana, US FWS, and USGS. The sampling design of this assessment, an offshoot of the *Lake Wide Assessment Plan for Lake Trout*, specifies sampling at stocking locations and other known historic spawning locations to collect data on abundance, age, growth rates, genetic strain and stocking location, diet, and lamprey wounds. Data from both of these assessments are summarized in the annual report to the Lake Michigan Committee. Summarized data and a database of coded-wire tag recoveries are managed by the US FWS Green Bay Fisheries Resource Office.

Salmon and Trout - Other more general salmon and trout monitoring programs include Illinois Department of Natural Resources *Fall Harbor Salmonid Assessment* that monitors abundance and population parameters of salmonids in four Illinois harbors of Lake Michigan. The Michigan Department of Natural Resources *Assessment of Lake Michigan fish populations* program emphasizes trout and salmon monitoring. This program monitors fish species, length, weight, age, sex, and maturity. Wisconsin Department of Natural Resources manages a number of data collection programs including *Lake Michigan Charter Boat Data*, *Lake Michigan Contest Data*, and *Lake Michigan Moored Boat Data*. Each of these programs collects data on recreational fisheries and salmon and trout harvests. Ontario Ministry of Natural Resources manages a *Coaster Brook Trout PIT Tagging Study* to monitor population health and also the *Rainbow Trout Population Assessment Using Fish Counter Technology* program to quantify the effect of current fishing regulations on rainbow trout numbers. Ontario Ministry of Natural Resources also conducts a number of general fish monitoring programs many of which identify Lake Trout as one of their focus species.

On Lake Michigan all four state management agencies working within the Joint Strategic Plan for Management of Great Lakes Fisheries fund a sport fishing creel survey which monitors recreational harvest of salmon and trout. Although the data collection methods employed differ because of differences in the fisheries, the data are comparable and data summary is coordinated through the Creel Working Group (Lake Michigan Technical Committee under the Joint Strategic Plan). USF&WS Green Bay Fisheries Resource Office houses a database of summarized lakewide catch, harvest, and effort data, which also includes charter boat information collected by the four states.

Wisconsin and Michigan also perform fall salmon and trout assessments at weirs during spawning. Data on species composition, abundance, age, growth rates, fish health, genetic strain, and lamprey wounds are recorded. Data from all salmon and trout (except lake trout) assessments are summarized and coordinated through the Lake Michigan Salmonid Task Group (Lake Michigan Technical Committee under the Joint Strategic Plan). Salmon and trout assessments data considered to be key indicators of population health are

summarized in the annual report of the Lake Michigan Salmonid Task Group to the Lake Michigan Committee.

Walleye - The Walleye (#9) indicator seeks to measure the relative abundance, biomass, or annual production of walleye populations in historical, warm-cool water habitats of the Great Lakes basin. Four programs were found that specifically include walleye population monitoring in the Great Lakes basin. The Michigan Department of Natural Resources conducts walleye monitoring in Lake Huron's Saginaw Bay. Through their *Saginaw Bay Fish Community Survey*, walleye population statistics are collected and through the *Vital Statistics of Walleye in Saginaw Bay* program, walleye are tagged to determine estimates of total annual mortality and survival, exploitation rates, and information on movement. Both of these programs are supported by the Sport Fish Restoration fund (75% Federal, 25% State). The Ohio Department of Natural Resources' *Walleye Tagging* program tags and tracks walleye in Ohio water of Lake Erie to estimate survival, exploitation, mortality rates, sex ratios and movement. Ontario Ministry of Natural Resources' also manages a walleye population monitoring program. The objective of this program, *A Preliminary Investigation of Walleye,* is to begin to assess the status of the walleye stock utilizing Lake Superior's Black Sturgeon River.

Lake Sturgeon - The Status of Lake Sturgeon in the Great Lakes (#125) indicator measures the population numbers of lake sturgeon in the Great Lakes basin as an indicator of ecosystem health. Two programs were found that specifically address lake sturgeon monitoring. The U.S. Fish & Wildlife Service *Lake Sturgeon Monitoring* program coordinates a multi-agency effort to assess the current status of lake sturgeon stocks in Lakes Huron, Erie, and the St. Clair System. This includes a tagging program, a qualitative and quantitative assessment of critical habitat, and an information transfer system that will provide valuable information accessible to interested parties, both inside and outside the Great Lakes basin. The Michigan Department of Natural Resources conducts a *Lake Sturgeon Assessment in Lake St. Clair and St. Clair River* program that monitors populations, spawning locations and movements within the St. Clair System. No specific location, frequency, or funding information was provided for these programs.

Habitat and Prey

The Fish Habitat (#6) indicator assesses the quality, quantity and location of aquatic habitat in the Great Lakes basin. Parameters within this indicator include quality, quantity, and distribution of aquatic habitat, percent of disturbed habitat, and population of fish species residing in each habitat. The Preyfish Populations and Communities (#17) indictor assesses the abundance and diversity of preyfish populations to infer the stability of predator species necessary to maintain the biotic integrity of each lake. Factors that are measured include abundance, diversity, and age and size distribution of preyfish species, including deepwater ciscoes, sculpins, lake herring, rainbow smelt, and alewives.

The U.S. Fish & Wildlife Service is collecting some level of habitat information through its *Lake Sturgeon Monitoring* program. This program includes a qualitative and quantitative assessment of critical habitat parameters associated with sturgeon populations. The U.S. Geological Survey *National Water-Quality Assessment (NAWQA)* program also collects some degree of habitat information in its study areas, which include a total of 171 sampling locations in western Lake Michigan drainages and the Lake Erie-Lake St. Clair basin.

The Michigan Department of Natural Resources *Status and Trends in Aquatic Resources* program includes some level of habitat monitoring but details on the habitat sampling section of the program are unavailable. Two local-level habitat monitoring programs are also found in Michigan. The *Clinton River Coldwater Conservation Project* is conducted by the Clinton River Watershed Council and Wayne County's *Rouge River Project.* The Wisconsin Department of Natural Resources' *Stream Habitat Evaluations* collects stream habitat and fish data at more than 30 locations throughout the streams of Wisconsin and tributaries of Lake

Michigan. This project is funded by the WDNR Watershed Management budget. More information on general habitat monitoring may be found in the coastal wetlands and stewardship sections of this report.

The USGS conducts three programs that collect data on prey fish populations. The *Status and Trends of Prey Fish Populations in Lake Michigan* program annually assesses prey fish populations in Lake Michigan utilizing bottom trawls to sample the prey species. *Status of Pelagic Prey Fish in Lake Michigan* is a cooperative program between the USGS and the four states that utilizes acoustics to provide a lakewide assessment of the prey population. Both assessments are coordinated through the Planktivore Working Group, a task group under the Lake Michigan Technical Committee and reports are given at the annual Lake Michigan Committee meeting. The USGS *Bottom Trawl Indices* collects data on sculpin populations in southern Lake Ontario. New York State Department of Environmental Conservation conducts the *Binational Prey Fish Hydroacoustic Survey* which monitors the abundance of preyfish at six transects across Lake Ontario. Funding for this program comes from state and federal government budgets.

Findings – Fish Population Health

More than one hundred fish monitoring programs are being conducted in the Great Lakes basin. A Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state, and provincial organizations, has been developed to address fisheries related issues including instability of fish communities, overharvesting, sea lampreys, lost fishing opportunities, invasions and introductions, inadequate environmental quality, and competition and conflicts among users of the fishery resources. This joint strategic plan has laid a framework necessary for organizations to coordinate and collaborate fisheries related monitoring activities across the Great Lakes basin. Through the Joint Strategic Plan, Lake Committees have been established for each of the five Great Lakes and Technical Committees have been established to advise these Lake Committees. Every five years formal "State of the Lake Reports" are prepared by the Lake Committees.

Fish Contaminants – While there are many fish contaminant monitoring programs throughout the Great Lakes, little information was collected on the methods employed. Therefore, it was difficult to assess the number of programs that directly address the Contaminants in Whole Fish indicator. While Illinois, Michigan, Minnesota, New York, and Wisconsin reported fish contaminant monitoring programs at the state level, Michigan's *Fish Contaminant Monitoring Program* and GLNPO's *Great Lakes Fish Monitoring Program* are the only active monitoring programs that specifically mention whole fish contaminant sampling. The Canadian monitoring program equivalent to GLNPO's Great Lakes Fish Monitoring Program, Department of Fisheries and Oceans (DFO) *Great Lakes Fish Contaminants Surveillance Program,* has collected fish contaminant data, including whole fish samples, since 1977. Funding for this program was cut in the spring of 2005. Elimination of this program creates a large gap in regional fish contaminant monitoring and interrupts one of the few long-term fish contaminant monitoring programs capable of documenting trends and changes in the Great Lakes basin. DFO is currently in the process of refocusing its efforts to its core mandate of determining impacts of toxic chemicals on fish. Negotiations are currently underway between DFO and Environment Canada to shift responsibility for this monitoring program but concerns have been raised that current financial resources could be a limiting factor in continuing this program.

The only U.S. agency that reported specifically on young-of-year contaminant sampling was New York State's Department of Environmental Conservation. Their young-of-year sampling programs rely on federal funding and may serve as good example for other U.S. states and federal agencies to follow. Ontario Ministry of the Environment's Tributary Mouth Biomonitoring also uses young-of-the year fish to determine Canadian tributaries contributing significant loadings. It should also be mentioned that the only program found in the basin that collects information relevant to the External Anomaly Presence in

Nearshore Fish indicator is Pennsylvania Sea Grant's *Brown Bullhead tumor monitoring* which is also funded by US EPA.

Species Specific – A Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state, and provincial organizations, has been developed to address fish community health for a number of species including lake trout. While coordinated activities may be occurring on other lakes, only Lake Michigan reported specific coordinated activities related to Joint Strategic Plan Lake Technical Committees. Coordinated monitoring approaches were reported for Lake Michigan for both Lake Trout and Salmon/Trout populations. The partnership framework set forth through the Join Strategic Plan for Management of Great Lakes Fisheries is a good example of effective coordination and collaboration in the Great Lakes monitoring community and may be used as an example for other areas of Great Lakes environmental monitoring.

More than twenty five general fish community assessment programs were reported in the Great Lakes basin. Because little specific information was presented on which species were being monitored, each of these programs is not specifically discussed. However, it is important to note that these monitoring programs may contain information relevant to the indicators that address trout, salmon, walleye, and sturgeon monitoring.

Lake Trout population monitoring is performed by USGS Great Lakes Science Center in Lake Michigan, Lake Huron, and Lake Erie. Illinois, Michigan, New York, Wisconsin also conduct specific Lake Trout assessment programs also. Ontario Ministry of Natural Resources conducts a number of general fish monitoring programs many of which identify Lake Trout as one of their focus species. As mentioned above, coordinated monitoring efforts through Joint Strategic Plan Technical Committees were reported for Lake Michigan for Lake Trout.

No specific information was reported on monitoring of introduced trout and salmon, but Illinois, Michigan, Wisconsin, and Ontario all reported general salmon and trout population monitoring which may include data on non-native salmon and trout populations. Coordinated monitoring efforts were reported for Lake Michigan for salmon and trout. No Lake Sturgeon monitoring programs were reported in Lake Michigan, Lake Superior, or Lake Ontario. Ohio, Michigan, and Ontario were the only states/provinces that reported specific walleye monitoring programs.

Habitat and Prey – The monitoring inventory results also indicate that minimal fish habitat monitoring is undertaken in the Great Lakes basin. The only program focused solely on fish habitat monitoring is Wisconsin's *Stream Habitat Evaluations* program. The fish habitat monitoring being conducted by other programs appears to be small in scale or narrowly focused on the habitat of specific target species. Results from the inventory indicate that more fish habitat monitoring is needed in the Great Lakes basin at both the federal and state levels. A limited amount of prey fish data are being collected across the basin. USGS is taking the lead in this effort in Lake Michigan. USGS and the state of New York are collecting prey fish data in Lake Ontario. Prey fish monitoring programs were not reported for Lake Superior, Lake Huron, or Lake Erie.

Habitat and Biodiversity
b. Aquatic Invasive Species

Aquatic Invasive Species (AIS) have threatened the Great Lakes ecosystem since the time of the first settlers. More than 180 non-native aquatic organisms of all types, including plants, fish, algae and mollusks, have

become established in the Great Lakes. As human activity and globalization increased in the Great Lakes basin, the rate of introduction of non-native species has increased as well.

There are a few key terms related to this topic that should be defined. The term `invasive species' means a nonindigenous species that when introduced into an ecosystem may cause harm to the economy, environment, human health, recreation, or public welfare.[6] 'Aquatic nuisance species (ANS)' refers to an organism that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquaculture or recreational activities dependent on such waters. The term 'exotic' or 'nonindigenous' or 'non-native' refers to any species or other viable biological material that enters an ecosystem beyond its historic range, including any such organism transferred from one country to another. [7]

The Great Lakes Panel on Aquatic Nuisance Species (ANS), established in 1991, is a key body in the Great Lakes basin working toward the prevention and control of the occurrence of aquatic nuisance species in the Great Lakes. The Great Lakes Panel on Aquatic Nuisance Species is directed to identify Great Lakes priorities; assist the National Task Force on Aquatic Nuisance Species; coordinate exotic species program activities in the region; advise public and private interests on control efforts; and report to the national task forces prevention, research and control activities in the Great Lakes basin.

Under Section 1204 of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), each state is encouraged to develop an Aquatic Nuisance Species (ANS) State Management Plan. The primary management plan goals focus on prevention efforts to stop ANS introduction and spread and mitigation of associated impacts. The development, implementation and coordination of detection and monitoring efforts are instrumental to achieving these goals. The state ANS management plans, upon approval of the national ANS Task Force, are eligible to receive funding for implementation as stipulated under Section 1204 of NANPCA.

HIGHLIGHT – Aquatic Invasive Species

- The region would benefit from development of a scientifically based early detection monitoring program. This early detection monitoring strategy should be coupled closely with a rapid response program. This type of sound monitoring program, which is able to effectively and efficiently detect invasions, is important when considering the limited funds currently available.
- The region would benefit from a coordinating body to organize and record AIS monitoring and management activities. A binational AIS monitoring office is needed to serve as a central location for coordinating monitoring activities and serve as a central resource for AIS related monitoring data.

The ANS Early Detection and Monitoring Lake Michigan Pilot Project managed by the Great Lakes Commission has recently been completed. The pilot project was conducted with guidance from the members of the Great Lakes Panel and the Lake Michigan Monitoring Coordination Council. The purpose of this project was to produce a set of guidelines and recommendations for a coordinated system to detect new ANS invasions and track the spread of established ANS populations in the Lake Michigan basin. Project recommendations will be used in efforts to advance the development of a Great Lakes region-wide ANS early detection and monitoring program. The full report on this project is available at http://www.glc.org/ans/initiatives.html. Selected recommendations from the report are listed below.

- Assess capability of current monitoring programs to detect and monitor ANS;
- Develop more programs which incorporate ANS detection and monitoring as a central purpose or goal;
- Financial support of ANS detection and monitoring should become more available for use by existing programs which do not currently collect ANS data;

- ANS reporting must be coordinated through a centralized data repository and information clearinghouse;
- Issues must be addressed that raise barriers and prevent monitoring programs from collecting and recording ANS data while they monitor other parameters;
- Resources for an early detection and monitoring network should be directed toward high risk and high probability areas for ANS invasions; and
- Programs that monitor fish populations or other parameters, such as water quality, should – to the extent possible – incorporate ANS early detection and monitoring protocols.

The Ontario Ministry of Natural Resources (MNR) is working on a similar effort to inventory and analyze monitoring efforts for the entire province of Ontario. MNR is compiling information about aquatic ecosystem monitoring and assessment activities occurring in Ontario waters that may detect aquatic invasive species. The information is being gathered through an on-line questionnaire and a workshop involving representatives from numerous agencies and organizations identified as being directly involved with the management or research of aquatic resources in Ontario even if they are not intended to detect aquatic invasive species (AIS). Monitoring in aquatic systems is critical to preventing, detecting and reducing the spread and impact of AIS which threaten Ontario species biodiversity. The information gathered is helping produce an initial assessment of current activities, needs and opportunities that could contribute to provincial detection and monitoring programs for AIS. It contributes to implementing the Ontario Biodiversity Strategy, the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem and the National Aquatic Invasive Species Action Plan. A report of the outcome of this work may be available by contacting Beth Brownson, Senior Invasive Species Biologist, Ontario Ministry of Natural Resources, at beth.brownson@mnr.gov.on.ca.

Two SOLEC indicators deal specifically with invasive species. The Sea Lamprey (#18) indicator seeks to estimate sea lamprey abundance and assess its overall impact on other fish populations in the Great Lakes basin. This is done by measuring the number of spawning-run adult sea lampreys and wounding rates on large salmonids. The Exotic Species (#9002) indicator will assess the presence, abundance and distribution of exotic invasive species in the Great Lakes basin ecosystem and their impacts on ecosystem functioning. This indicator is still under development and no specific species of interest have been identified and no monitoring protocols have been established.

The following discussion will focus on both sea lamprey and general aquatic invasive species monitoring as reported to the Great Lakes Monitoring Inventory. It should be noted that more than 20 general fish community assessment programs (please see Fish Ecology section of this report) and other invertebrate, plant and wildlife community assessment programs were reported in the Great Lakes basin. Each of these programs were not discussed specifically in this section, but many contain information on aquatic invasive species. Additionally, natural heritage programs in each state may provide additional information on aquatic invasive populations in the Great Lakes basin.

Sea Lamprey Monitoring

Results of the inventory indicate that sea lamprey monitoring is well-coordinated between the US and Canada. The Great Lakes Fishery Commission coordinates and conducts a *Sea Lamprey Management Program* in the Great Lakes basin, with a focus on Lake Michigan industrial ports. Field work is conducted for the Great Lakes Fishery Commission by the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada. The purpose of this program is to assess populations of sea lampreys in Great Lakes streams, control population levels, and detect new infestations. Monitoring includes lamprey abundance in larval and adult stages, stream habitat analysis, and water chemistry parameters (pH, alkalinity, temperature, conductivity). The *Fishway* project, employed by the New York State Department of Environmental Conservation, monitors lamprey control effectiveness at a site located on Cayuga Inlet in the

state of New York. Central Lake Superior Watershed Partnership's *Monitoring the Waters of Upper Michigan* also assesses sea lamprey populations as part of its baseline data collection focused in the water off Marquette.

A number of programs also reported collecting information on sea lamprey woundings on fish. The U.S. Geological Survey *Bottom Trawl Indices* program collects sea lamprey wounding data from species affected in waters along the southern shore of Lake Ontario. The Illinois Department of Natural Resources monitors sea lamprey woundings as part of their *Fall Harbor Salmonid Assessment*, *Spring Index Assessment*, *Fall/Spawning Lake Trout Assessment*, and *Lakewide Assessment Plan*. In total, the programs in Illinois collect data at nine locations along the Lake Michigan shoreline. The Indiana Department of Natural Resources, Division of Fish and Wildlife, monitors sea lamprey woundings as part of their Fall/Spawning Lake Trout assessment and Spring Lake-wide assessments. In total, the programs in Indiana collect data annually from 4 to 7 locations along the Lake Michigan shoreline. The Michigan Department of Natural Resources also collects sea lamprey wounding of fish species in Lake Superior and Lake Huron. The *Assessment of Lake Trout Populations in Michigan Waters of Lake Superior* monitors sea lamprey wounding on lake trout at 117 sites in southern Lake Superior. The *Assessment of Lake Huron lake trout* program monitors sea lamprey wounding rates and estimates sea lamprey induced mortality at 12 sites in Lake Huron. Ohio Department of Natural Resources, coordinating with U.S. Fish and Wildlife Service, conducts a sea lamprey survey on the Chagrin River. The Wisconsin Department of Natural Resources also monitors sea lamprey woundings though the *Lake Michigan Charter Boat Data* program. This program collects data on the number of lamprey attached to chinook salmon and lake trout along the Wisconsin shore of Lake Michigan. Two sea lamprey wounding programs taking place at the tribal level include the Grand Traverse Band of Ottawa and Chippewa Indians *Grand Traverse Band - Biological Services Program* and the Chippewa Ottawa Resource Authority *Inter Tribal Fisheries and Assessment Program*. Both of these programs monitor in the Grand Traverse Bay.

General Aquatic Invasive Species Monitoring

Results of the Great Lakes Monitoring Inventory indicate that sixty-seven programs perform some level of AIS monitoring. AIS monitoring was not the focus of the majority of these programs but rather these programs passively collected AIS information as part of a larger effort. No specific AIS information was supplied for these programs and therefore the following discussion will focus only on programs with AIS monitoring as their primary objective. This discussion excludes sea lamprey monitoring which was discussed previously.

The U.S. Fish and Wildlife Service reported comprehensive aquatic invasive species monitoring programs in each of the Great Lakes. The purpose of the U.S. Fish and Wildlife ANS monitoring program is to conduct assessments to detect new ANS populations, and monitor changes in abundance of ANS in each of the Great Lakes. The U.S. Geological Survey Great Lakes Science Center also conducts a number of routine monitoring programs in each of the Great Lakes, many of which collect some level of invasive species monitoring data.

The Indiana Department of Natural Resources Division of Fish and Wildlife conducts AIS monitoring programs under contract with Ball State University, while they conduct Yellow perch assessments at three locations along the Southern Lake Michigan shoreline. Round goby and alewife abundance is measured as non-target species during trawling and gill net activities during the collection and assessment of the yellow perch population. A joint monitoring program to conduct surveillance for snakehead is conducted in conjunction with field collections during the spring and fall as part of the GLNPO, fish consumption advisory program in Trail Creek and Burns waterway.

In Michigan, there were a number of aquatic invasive species monitoring programs reported. Michigan Sea Grant's *Zebra Mussel and Aquatic Nuisance Species Monitoring* collects Zebra Mussel sighting data for Michigan's inland lakes through citizen reports, personnel from various Great Lakes agencies, and Sea Grant staff. Specific details on this program were not available. Michigan Lakes & Streams Association, Inc. conducts three aquatic invasive species monitoring activities including the *Purple Loosestrife Watch, Eurasian Watermilfoil Watch* and *"Drop-a-Brick" (Zebra Mussel Watch).* These three programs are essentially one similar effort with three parts: document the introduction of these species, map the location and rate of spread, and monitor the success/failure of any local control or eradication programs. Michigan's Clinton River is the focus of the Nature Conservancy's *Interactions Between Freshwater Mussels and Zebra Mussels in the Upper Clinton River.* The goal of this project is to determine if chronic low levels of zebra mussel infestation on native mussels has a long-term impact on the native freshwater mussel populations. This program samples biannually at two locations in the Clinton River.

Ohio Department of Natural Resources reported a number of aquatic invasive species monitoring programs. Among these programs are the *Statewide Zebra Mussel Surveys, Statewide Asian Carp Surveys, ANS Plan Species Monitoring and Control,* and the *Lake Erie ANS Trawl Surveys.*

Other aquatic invasive species monitoring programs reported to the inventory include the Pennsylvania Department of Environmental Protection *Pennsylvania Zebra Mussel Monitoring Network* that collects Zebra Mussel presence/absence records for approximately 50 of the state's 67 counties. The objective of this program is to serve as an early warning signal for these areas. The Wisconsin Department of Natural Resources also conducts *Invasive Species Monitoring* to track the spread of invasive species in Wisconsin waters and to document presence/absence of aquatic invasive species in waters of the State. Wisconsin's Marinette County Land and Water Conservation Department conducts a *Purple loosestrife and Eurasian Watermilfoil Monitoring* to track the spread of these species. Specific details on this program were not available. Finally, the Inland Seas Education Association *Invasive Species Monitoring Program* is an educational program collecting data on the introduction or spread of invasive species in Lake Michigan. Sampling takes place at 6 sites in Lake Michigan including Suttons Bay, Lower West Arm of Grand Traverse Bay, Little Bay de Noc, Betsie Bay, Lake Charlevoix, Little Traverse Bay and Snail Shell Harbor.

Findings – Aquatic Invasive Species

Results of the inventory indicate that sea lamprey monitoring is well-coordinated between the US and Canada. The Great Lakes Fishery Commission coordinates and conducts a *Sea Lamprey Management Program* in the Great Lakes basin, with a focus on Lake Michigan industrial ports. Field work is conducted for the Great Lakes Fishery Commission by the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada. In addition, a number of shared concerns and potential gaps in the current Great Lakes AIS monitoring strategy, not related directly to the well coordinated sea lamprey monitoring program, were highlighted through the Great Lakes Monitoring Inventory and Gap Analysis project. A primary gap was seen to be lack of a coordinating body to organize and record AIS monitoring and management activities. A binational AIS monitoring office is needed to serve as a central location for coordinating monitoring activities and serve as a central resource for AIS related monitoring data. Another gap is the lack of a regional monitoring plan. The region needs to develop a scientifically based early detection monitoring program. A suggestion was made that this program should employ a probabilistic sampling approach to more closely look at hot spots for invasion. This early detection monitoring strategy should be coupled closely with a rapid response program. This type of sound monitoring program, which is able to effectively and efficiently detect invasions, is extremely important when considering the limited funds currently available. The set of recommendations developed through the ANS Early Detection and Monitoring Lake Michigan Pilot Project, managed by the Great Lakes Commission, may provide some of the direction needed for the development of an early detection monitoring program. Ontario Ministry of Natural Resources is

working on a similar effort to inventory and analyze monitoring efforts for the entire province of Ontario. This project will also provide information for developing an AIS early detection strategy. Other gaps related to funding levels are a lack of nearshore monitoring and also routine monitoring of non-sport fish species.

With over 180 non-native aquatic species in the Great Lakes basin alone, it would be difficult to perform a thoughtful analysis of invasive species monitoring efforts across the basin until the Exotic Species indicator is further defined. Due to the recognized priority of the Great Lakes aquatic invasion problem and the impact on native populations, SOLEC parties and others should focus effort on development of an appropriate indicator and recommended monitoring program. Without such a monitoring program, it will be difficult to quantify impacts, measure success of control programs and protect against invasions from new species.

Habitat and Biodiversity
c. Coastal Wetlands

Great Lakes coastal wetlands have critically important ecological values and functions. Great Lakes fisheries are dependent on wetlands for spawning, nurseries, and food sources. Coastal wetlands provide essential breeding, nesting, feeding and predator evasion habitats for fish and wildlife throughout the Great Lakes system. Over one-third of plant and animal species listed as threatened or endangered in the United States are dependant on wetland habitats during some portion of their life cycle. The natural water filtering, erosion control and sediment capture capabilities of wetlands contribute to the overall improvement of water quality.[8] Wetlands are also vital to the commercial and recreational sectors of the Great Lakes economy, with commercial sport-fishing and waterfowl hunting being dependent upon the continued productivity of wetlands. The diversity of plant and animal life in wetlands make them a valuable resource for non-consumptive fish- and wildlife-related recreation. Wetlands provide educational and research opportunities, as well as a perspective on historical and cultural values.

HIGHLIGHT – Coastal Wetlands

- Wetland ecosystem health is seen as a high priority in the region but additional resources may be needed to reach short and long-term goals set forth by the Great Lakes Strategy. In addition, implementation of state wetland monitoring plans called for by the US EPA Office of Wetlands, Oceans, and Watersheds may require additional resources.
- A comprehensive inventory of coastal wetlands has been completed, and landscape level changes can be computed at a course scale, but there are currently no programs to regularly update the finer scale wetland inventories.
- There are numerous efforts to restore coastal wetlands, but no programs have reported to be tracking restoration success basinwide.

Despite the significant ecological and economic value imparted by wetlands, there is no U.S. or Canadian national program to set monitoring guidelines for these important resources. However, a regional initiative titled the *Great Lakes Coastal Wetlands Consortium (GLCWC)* has been established to develop and implement a monitoring program for coastal wetlands. Only limited term pilot studies have been conducted by this group to date, but their goal is to develop a program to monitor all SOLEC coastal wetlands indicators. The Great Lakes Environmental Indicators (GLEI) program, funded by a US EPA STAR Grant, is another regional wetlands assessment program. The goal of this assessment program is to develop an integrated set of environmental indicators that can be used to assess the condition of the coastal margins of the US shoreline from Lake Superior to Lake Ontario. The GLEI program includes extensive testing of diagnostic indicators and to date results show that the indicators relate well to watershed-level stressors.

In addition to the coordination activities mentioned above, there is an effort underway by the US EPA Office of Wetlands, Oceans, and Watersheds to develop methodologies for comprehensive state wetlands monitoring and assessment plans. Great Lakes states are currently in the preliminary stage of setting up these monitoring programs. In many cases states are in the process of testing methodology on single watersheds and documenting results before implementing these programs on a larger scale. It should also be noted that the Great Lakes Strategy report identified wetland restoration as a high priority. Reaching the short and longer-term goals set forth by the Great Lakes Strategy report will require the continuation and potentially the expansion of current wetland monitoring efforts.

The analysis below discusses current monitoring efforts reported in the monitoring inventory that are specific to coastal wetlands monitoring. Coastal wetlands monitoring is described by three sets of indictors: landscape indicators, physical and chemical process indicators, and biological indicators.

Landscape Indicators

Several SOLEC indicators cover large-scale ecosystem monitoring. These monitoring efforts are conducted primarily using remote sensing tools such as satellite or airborne imagery and interpretation. One of the most critical indicators for wetland management is the measure of Coastal Wetland Area Extent by Type (#4510). There are several ongoing efforts that map wetland areas. The U.S. Fish and Wildlife Service (US FWS) operates the *National Wetlands Inventory (NWI)* project, which delineates wetland polygons from aerial photographs for all U.S. wetlands, except Wisconsin. US FWS has also been working on a project to develop methodology for monitoring and assessing wetland function as a way of gaining a better understanding of ecosystem health. Wisconsin has developed the *Wisconsin Wetlands Inventory* that uses a somewhat different classification scheme than the NWI. The state of Ohio uses the *Ohio Wetlands Inventory* as a supplement to the NWI maps. The Ontario Ministry of Natural Resources developed the *Ontario Great Lakes Coastal Wetland Atlas* using similar methods, but a different classification scheme from the U.S. inventories. The GLCWC recently compiled all coastal wetlands inventories into a unified *Great Lakes Coastal Wetland Inventory* with a single classification system.

None of the inventory efforts tracks changes in area over time. NOAA's *Coastal Change Analysis Program (C-CAP)* tracks land-use change over time, however, using satellite data. Wetland classification at this coarse scale includes four classes. The program revisits the Great Lakes every five years. Along with coarse scale wetland area, this program also tracks Land Cover Adjacent to Coastal Wetlands (#4863). Fine scale land cover and use maps are also generated by each of the Great Lakes states and provinces, while the USGS maintains the *National Land Cover Dataset* at a course scale for the entire U.S. These map products can be used to assess land use change adjacent to wetlands. No current programs were listed in the monitoring inventory database that track Restored Area of coastal wetlands (#4511). However, there are numerous local programs that seek to restore wetland area or function, such as the USGS Great Lakes Science Center's *Metzgar Marsh Wetland Restoration project* and *New York states Buckhorn Island Marsh Habitat Restoration, Tifft Preserve Marsh Habitat Restoration and Hamlin Beach Marsh Erosion Prevention projects* . Human Impact Measures (#4864) are not systematically monitored either.

Physical and Chemical Process Indicators

Several programs monitor local sediment and chemical conditions in wetlands, such as *Nutrient Dynamics in Salmon Creek, NY.* However, nutrient concentrations such as Phosphorus and Nitrogen Levels (#4860) and Sediment Flowing into Coastal Wetlands (#4516) change rapidly over time. No programs were listed that track nutrient or sediment loadings into wetlands. There are programs to monitor water levels in the Great Lakes with tools such as the lake level gauges maintained by NOAA and Canada's Department of Fisheries and Oceans (DFO). The GLCWC has determined that the Effect of Water Level Fluctuations

(#4861) can best be measured through the response of biological indicators. The Canadian Wildlife Service administers a program to study Contaminants in Snapping Turtle Eggs (#4506), focusing primarily on Canadian and binational Areas of Concern (AOCs). There is no comparable U.S. program. New York did report having five marsh monitoring program sites within Areas of Concern including Oswego River, Rochester Embayment; Eighteen Mile Creek, Niagara River, and Buffalo River.

Biological Indicators

There are a number of programs that monitor the biological characteristics of coastal wetlands in the basin. Some programs such as the *Durham Region Coastal Wetland Monitoring* and the *Critical Trends Assessment Program* for the state of Illinois are tracking a number of biological indicators for a small group of wetlands. Ohio's *Wetland Bioassessment Program* similarly seeks to develop measures and assess the biological health and integrity of Ohio's wetlands across several biological indicators such as Indices of Biotic Integrity (IBIs) for plant, invertebrate, fish, and amphibian communities. Methods in the Ohio program are similar to those specified in the SOLEC's Coastal Wetland Plant Community Health (#4862), Coastal Wetland Invertebrate Community Health (#4501), Coastal Wetland Fish Community Health (#4502), and Coastal Wetland Amphibian Diversity and Abundance (#4504) indicators. It is unclear whether there will be ongoing funding to support these programs. Wisconsin's *Mapping Wetlands Dominated by Reed Canary Grass* program identifies wetlands dominated by the invasive Reed Canary Grass using satellite data. The methodology could be transferred to other areas of the Great Lakes basin. The Ontario *Wetland Evaluation System (OWES)* is a science-based ranking system that was developed primarily to meet the policy needs of Ontario's Planning Act. The OMNR is responsible for determining which wetlands and wetland complexes (groups of individual wetland units which are functionally related in some important manner) are provincially significant, whether OMNR or other qualified individuals conducts the evaluations. The wetland evaluation system does not produce a detailed biophysical inventory of each wetland. Rather, it assists trained evaluators in ranking the relative importance of different wetlands based on a numerical ranking of wetland values or functions. Bird Studies Canada runs a basin-wide program to track marsh amphibians and Wetland-Dependent Bird Diversity and Abundance (#4507) through its *Marsh Monitoring Program*. Monitoring routes for this program are located more prevalently in Ontario. This seems to be the only basinwide set of biological information for Great Lakes Coastal Wetlands. Several state programs, such as the *Michigan Frog and Toad Survey* and *Wisconsin Frog and Toad Survey* use similar methods for amphibians, as does *Frogwatch USA*. The State of New York runs a number of bird, amphibian, and reptile monitoring programs intended to provide some baseline data distribution and habitat health. Some of these programs include *New York State's Breeding Bird Atlas, Bird Conservation Area Program, Amphibian and Reptile Atlas Project*, and *Important Bird Area (IBA) program* of Audubon New York.

Findings – Coastal Wetlands

There are a number of programs that reported monitoring in coastal wetlands in the Great Lakes basin, however there is currently no comprehensive program to cover all critical indicators at this broad scale. A comprehensive inventory of coastal wetlands has been completed, and landscape level changes can be computed at a coarse scale, but there are no current programs to regularly update the finer scale wetland inventories. Additionally, while there are numerous efforts to restore coastal wetlands, no programs have reported to be tracking restoration success basinwide. There is an effort underway by the US EPA Office of Wetlands, Oceans, and Watersheds to develop methodologies for comprehensive state monitoring and assessment plans for wetlands. Great Lakes states are currently in the preliminary stage of setting up these monitoring programs but more testing is needed before large scale implementation can occur. While there appear to be several short-term studies examining the effects of nutrients and sediments on wetlands, there is no program to systematically track nutrient or sediment loads to coastal wetlands. Biologically, amphibian abundance and diversity seems to be well tracked, but an examination of program overlap and

methodological consistency needs to be conducted. Finally, assessments of most other biological indicators (including those covering plant, invertebrates and fish communities) are not being conducted consistently across the basin, however, the GLCWC is currently developing plans to address this gap. Wetland ecosystem health is seen as a high priority in the region but additional resources may be needed to reach short and long-term goals set forth by the Great Lakes Strategy. In addition, implementation of state wetland monitoring plans called for by the US EPA Office of Wetlands, Oceans, and Watersheds may require additional resources.

Habitat and Biodiversity
d. Wildlife Ecology

The Great Lakes basin's wildlife populations are threatened by disappearing and fragmented habitat area; pressure from invasive species; and contaminant levels in air, food, and water. These pressures are largely due to the region's increasing human population, industry, and intensive agricultural practices. To ensure the future sustainability of the region's wildlife, it is important to develop an understanding of healthy population levels and monitor population trends, contaminant levels, and overall wildlife health.

Throughout the Great Lakes basin there are many data collection activities that monitor various aspects of wildlife populations. A total of 51 programs were found that collect some level of monitoring data on wildlife populations. A number of these programs are discussed in more detail below, including those with broad scopes, large geographic ranges, and those that directly address wildlife-related SOLEC indicators.

General Wildlife Ecology Monitoring

Each Great Lakes' state manages a *Natural Heritage Program*, though in Michigan, this program is called *Michigan Natural Features Inventory (MNFI). Natural Heritage Programs* collect information on biological diversity, including species occurrence in both terrestrial and aquatic ecosystems. The goal of the *Natural Heritage Program* is to build, maintain, and provide accurate and accessible ecological information needed for conservation, planning, and natural resource management and also to provide information for management of threatened and endangered species. The national *NatureServe* program compliments the state run *Natural Heritage Programs* by establishing standards for biological inventories and data management procedures, developing comprehensive species and ecological community databases, and making these data available to the public through online resources.

HIGHLIGHT – Wildlife Ecology

- Results indicate that the state run Natural Heritage Inventory Programs and related state run biological community surveys may collect data needed to evaluate the nearshore species diversity indicator. Two potential limitations:
  - Datasets are primarily land based and
  - Scope may not be focused enough.
- Wildlife managers in the region and SOLEC decision makers should re-evaluate the wildlife monitoring needs of the Great Lakes basin to determine how best to fill in potential monitoring gaps and coordinate individual species monitoring programs.

The U.S. Geological Survey runs the *Gap Analysis Program*. The goal of the program is to keep common species common by identifying those species and plant communities that are not adequately represented in existing conservation lands. This program focuses on common species rather than those considered threatened or endangered, which are managed through other programs such as the ones listed above. By identifying the habitats of common species, and the conservation status of those habitats, the Gap Analysis

Program gives land managers, planners, scientists, and policy makers the information they need to make better-informed decisions when identifying priority areas for conservation.

A number of wildlife monitoring programs in the basin have state-wide scopes. These programs are generally managed by each State's Department of Natural Resources. Wisconsin manages the *Wildlife Health Disease Surveillance Database*, *Biotics*, *Wildlife Health Contaminant Database*, *Checklist of Wisconsin Vertebrates*, and *Big Game Hunting Data*. Michigan's Department of Natural Resources manages *Wildlife Surveys*, *Wildlife Contaminant Monitoring*, and *Evaluation of impacts of toxic substances on nontarget wildlife*. Additional state-wide general wildlife monitoring programs include the *Minnesota County Biological Survey* and *Ohio Population Surveys*.

A number of SOLEC indicators address general wildlife monitoring.

The purpose of the Threatened Species (#8161) indicator is to assess the number, extent and viability of threatened species and use this information to infer the integrity of ecological processes and systems in the Great Lakes basin. The state run *Natural Heritage Inventory Programs* collect information on individual species, such as known and observed ranges, habitat preferences and population dynamics. This information may be used to analyze the viability of threatened species in specific areas. Additional state run community surveys conducted in Wisconsin, Michigan, Minnesota, and Ohio may provide data useful for assessing threatened species populations. Results of the inventory also include many individual species monitoring programs. Please refer to the results of the monitoring inventory for a complete list of these programs.

Nearshore Species Diversity and Stability (#8137) measures the type and number of plant and wildlife species within 1 kilometer of the shoreline to better understand the composition and abundance of nearshore plant and wildlife species over time. The state run Natural Heritage Inventory Programs and additional state run biological community surveys collect some of the information needed to evaluate this indicator. Two potential limitations of these datasets are that they are primarily land-based, which may limit the availability of nearshore population data, and the information within the nearshore zone may not be complete enough to offer a full evaluation.

The following is a discussion of targeted mammal and bird monitoring programs that directly address specific SOLEC indicators. Additionally, although no indicators directly address amphibian monitoring outside of the one discussed in the wetlands section, there will be a brief discussion on this topic.

Mammals

The only SOLEC indicator addressing mammal specific species is Contaminants Affecting the American Otter (#8147). The goal of this indicator is to assess the contaminant concentration found in American otter populations and to infer the presence and severity of contaminants in the aquatic food web. No programs reported monitoring of American Otters. Wisconsin Department of Natural Resources Wildlife *Health Contaminant Database* may include American otter monitoring, but details on individual species was not provided for this project. According to the results from the monitoring inventory, there is little to no monitoring taking place to measure the Contaminants Affecting the American Otter indicator.

Birds

The goal of the Breeding Bird Diversity and Abundance (#8150) indicator is to assess the status of breeding bird populations and to infer the health of breeding bird habitat by measuring the diversity and abundance of breeding bird populations and communities in selected habitat types. Results of the inventory show that 24 monitoring programs monitor bird populations in the Great Lakes basin. Of these 24 programs, nine are

basinwide or state-wide general wildlife population surveys not focused on individual species. Results of the monitoring inventory indicate that a considerable amount of breeding bird monitoring data are being collected throughout the Great Lakes basin with no obvious gaps present.

The Contaminants in Colonial Nesting Waterbirds (#115) indicator assesses the chemical levels, including DDT, PCBs, Polychlorinated dibenzo-p-dioxin (PCDD), and polychlorinated dibenzofurans (PCDF), mercury and other organic contaminants, in a representative sample of colonial waterbirds. The Michigan Department of Natural Resource *Michigan Wildlife Contaminant Monitoring* measures spatial and temporal trends in bioaccumulative contaminant levels in herring gull eggs. This program measures PCBs, DDT, pesticides, and mercury annually for some nests, less frequently for others. This program is funded by Clean Michigan Initiative bond funds. Wisconsin Department of Natural Resources Wildlife *Health Contaminant Database* may include waterbird contaminant monitoring, but details on specific species were not given for this project. The Canadian Wildlife Service manages the *Great Lakes Herring Gull Egg Monitoring Program.* No descriptive information is available for this program.

The purpose of the Contaminants Affecting Productivity of Bald Eagle (#8135) indicator is to assess the number of fledged young, developmental deformities, and concentration of organic and heavy metal contamination, including DDT, PCB, PCDD, PCDF, mercury and other organic contaminants, in Bald Eagle eggs, blood, and feathers. The Michigan Department of Natural Resources' *Michigan Wildlife Contaminant Monitoring* measures spatial and temporal trends in bioaccumulative contaminant levels in bald eagles. This programs measures PCBs, DDT, pesticides, and mercury annually for some nests, less frequent for others. This program is funded by Clean Michigan Initiative bond funds. Wisconsin Department of Natural Resources *Wildlife Health Contaminant Database* may include Bald Eagle contaminant monitoring, but details on individual species was not provided for this project. The Canadian Wildlife Service manages the *Southern Ontario Bald Eagle Monitoring Program.* No descriptive information was provided for this program.

Amphibians

The only SOLEC indicator directly addressing monitoring of amphibian populations is Coastal Wetland Amphibian Diversity and Abundance (#4504). Programs relating to this indicator are discussed in the Coastal Wetlands section of this report. Bird Studies Canada runs a basin-wide program to track marsh amphibians through the Marsh Monitoring Program. The National Wildlife Federation manages *Frogwatch USA.* Frogwatch USA is a long-term frog and toad monitoring program managed by the National Wildlife Federation in partnership with the U.S. Geological Survey to collect information about frog and toad populations in the U.S. This program is driven by volunteers who collect frog occurrence information at more than 1,000 locations throughout the Great Lakes basin. Michigan Department of Natural Resources' *Frog and Toad Survey* monitors the long-term abundance and distribution of frog and toad populations. Volunteers monitor frog and toad occurrence at more than 4,800 locations three times a year throughout the state. This project is funded by a State Wildlife Grant. *Wisconsin Frog and Toad Survey* also collects amphibian abundance data.

Findings – Wildlife Ecology

The state run *Natural Heritage Inventory Programs* collect specific species information as well as habitat information that may be used to analyze the viability of threatened species in specific areas. While Wisconsin, Michigan, Minnesota, and Ohio manage additional population surveying programs that may collect information on threatened species, results of the inventory indicate that other Great Lakes states do not have broad wildlife population monitoring programs.

When evaluating Nearshore Species Diversity and Stability (#8137), results indicate that the state run *Natural Heritage Inventory Programs* and additional state run biological community surveys may collect information needed to evaluate this indicator. Two potential limitations of these datasets is that they are primarily land based, which may limit the availability of nearshore population data, and the scope may not be focused enough to evaluate this indicator.

Results of the monitoring inventory indicate that a considerable amount of breeding bird monitoring data are being collected throughout the Great Lakes basin. Inventory results also show that Michigan was the only Great Lakes state that reported monitoring programs specifically addressing contaminants in colonial nesting birds and Bald Eagles. According to results of the monitoring inventory, there is very little to no monitoring taking place to measure the Contaminants Affecting the American Otter indicator. Wildlife managers in the region and SOLEC leaders should re-evaluate the wildlife monitoring needs of the Great Lakes basin and determine how best to fill in these identified gaps and coordinate individual species monitoring programs.

Habitat and Biodiversity
e. Benthic and Invertebrate Ecology

Benthic and other invertebrate communities are variable and diverse throughout the Great Lakes ecosystem. Invertebrates in the Great Lakes system vary from microscopic organisms suspended in a lake's water column to large mussels attached to substrate along a river-bottom. Invertebrates serve many important functions in a sustainable ecosystem. They serve as a food source for larger species and are vital to the success of fish populations. They consume nutrient inputs and filter pollutants and other chemical constituents. Invertebrates offer a good measure of aquatic health, as they can be found in all habitats. Their composition reflects the physical and chemical structure of a habitat and individual species respond quickly and differently to changes in nutrient and pollutant levels and other pressures.

HIGHLIGHT – Benthic and Invertebrate Ecology

- General monitoring for benthic and macroinvertebrate abundance and diversity may be sufficient (except in the Lake Superior basin), but native species may be being overlooked.
- Zooplankton and phytoplankton are regularly collected at only eleven sites throughout the basin. Also, monitoring for Diporeia and Hexagenia is limited to only a few programs in single lake basins. These programs may need to be evaluated for expansion if a better understanding of the population dynamics of these species is desired.
- There are a number of programs monitoring mussel populations, but further investigation may be needed to determine if this provides a thorough enough investigation into these sensitive native species that may be in decline.

The analysis that follows examines the current monitoring capacity to detect status and trends of benthic and other invertebrate communities in basin habitats across a variety of SOLEC indicators. Zoo- and phytoplankton populations are considered, as well as more complex invertebrates. Monitoring of several important individual native species or families are examined, as well as general measures of diversity and abundance. In all, 32 separate programs were found to be monitoring aspects of benthic or invertebrate ecology. Most of these were federal, state or university programs in the United States, with only one program included from the Canadian side of the basin.

Three programs engage in monitoring of plankton populations in the open Great Lakes or large inland lakes. Zooplankton Population (#116) samples are collected by the *Lake Michigan Biological Station* of the Illinois

Natural History Survey in the southern basin of Lake Michigan, the *Open Lake Surveillance* Program of US EPA-GLNPO using their research vessel at eleven sites below 85 m in all Great Lakes, and the *Finger Lakes Biomonitoring* program of New York State Department of Environment and Conservation for the inland Finger Lakes. Only the *Open Lake Surveillance* program also collects Phytoplankton Populations (#109).

The only one program that specifically indicated monitoring the Benthic Amphipod (Diporeia spp.) (#123) is the *Benthic Community Change* program administered by the USGS at a target depth of 130 m near Oswego, Rochester, and Olcott in Lake Ontario. There are a number of programs that monitor Benthos Diversity and Abundance (#104), and some of these programs may also collect Diporeia samples. The *Long-Term Trends in Benthic Populations* of NOAA-GLERL and a program by the Illinois Natural History Survey monitor benthic community populations in southern Lake Michigan, the NYSDEC at the mouth of the Buffalo River, GLERL's *Assessments of Benthic Macroinvertebrate Communities in the Great Lakes* at 80 sites in Lakes Huron and Ontario, the *Benthic Community Change* at sites in Lake Ontario, GLNPO's *Open Water Surveillance Program* at twenty open-water sites throughout the Great Lakes, and the USGS Great Lakes Science Center's *Benthos for western Lake Erie* every ten years at 60 sites in Lake Erie. This indicates that only Lake Superior is lacking in some form of benthic invertebrate community monitoring.

Specific Hexagenia (#122) or mayfly monitoring is conducted by three programs in the basin. The *Mayfly Recovery in Lake Erie* program run by Pennsylvania Sea Grant tracked the nightly emergence of mayflies at six locations, but this program ended in 1993. The *Hexagenia Populations* program of Heidelberg College studies various characteristics of Hexagenia populations and interactions with the surrounding environment. No information was available about monitoring locations or the program's current status. Finally, NOAA-GLERL studies *Temporal and Spatial Variation in Lipid Content of the Mayfly Hexagenia* in Western Lake Erie, Lake St. Clair, and the Straits of Mackinac. Most of these programs are monitoring in nearshore aquatic habitats so may be able to provide data to assess Nearshore Species Diversity and Stability (#8137).

An important sentinel of stream and nearshore aquatic integrity is the abundance and diversity of Native Freshwater Mussels (#68). Monitoring programs approach this indicator from a variety of directions. The Nature Conservancy runs a program to study the *Interactions between freshwater mussels and zebra mussels in the Upper Clinton River.* This program collects and identifies mussel data biannually from two sites in the Upper Clinton River. Environment Canada administers the *Lake St. Clair/St. Clair Delta Native Freshwater Mussel Study.* Specific locations and parameters were not reported for this program. In its *Assessments of Benthic Macroinvertebrate Communities in the Great Lakes* program, GLERL samples dreissenid mussels (along with other benthic macroinvertebrates) at 80 sites in Lakes Huron and Ontario. The *Benthic Community Change* program of USGS tracks various mussel counts at sites in the Lake Ontario basin. NOAA's National Centers for Coastal Ocean Science runs the *US Mussel Watch Project* that samples bivalves – mostly for contaminants – biennially at 24 sites evenly distributed along the shores of Lakes Michigan, Huron, St. Clair, Erie, and Ontario.

Finally, a large number of programs have been initiated to sample and measure the diversity and abundance of macroinvertebrates in tributary streams and wetlands. Programs in wetlands are covered in the section on Coastal Wetlands. Each of the states of Indiana, New York, Wisconsin, Ohio, and the Oneida Tribe of Wisconsin operate biomonitoring programs to help assess the biotic integrity of the streams in their states. These programs may differ significantly from one state to another. Additionally, USGS's *National Water Quality Assessment (NAWQA)* program collects macroinvertebrates in a set of their sampling locations along Western Lake Michigan and Lake Erie drainages. SOLEC does not include this type of monitoring as an indicator, but it can reasonably be argued to be important enough to justify the addition of such an indicator.

Findings – Benthic and Invertebrate Ecology

While there are a fair number of programs monitoring invertebrates and benthic communities in the Great Lakes basin, there may be some significant gaps to address. Specifically, while general monitoring for benthic and macroinvertebrate abundance and diversity may be sufficient (except in the Lake Superior basin), several important native species may be being overlooked. Zooplankton and phytoplankton are regularly collected at only eleven sites throughout the basin. It needs to be determined if this is enough information to reasonably estimate the status and trends in these populations. Also, monitoring for Diporeia and Hexagenia is limited to only a few programs in single lake basins. These programs may need to be evaluated for expansion if a better understanding of the population dynamics of these species is desired. Finally, while there are a number of programs monitoring mussel populations, further investigation may be needed to determine if this provides a thorough enough investigation into these sensitive native species that may be in decline.

Habitat and Biodiversity
f. Plant Ecology

The Great Lakes basin has lost much of its original natural landscape to agriculture, urban development and industry. For example, approximately 65 percent of Illinois was originally tallgrass prairie. Today, less than 0.01 percent of the original prairie remains. The Great Lakes region has also lost more than two-thirds of its natural wetlands to agriculture, urban uses, shoreline development, and recreation.[9] In order to maintain the remaining botanical wealth of the region, careful conservation and monitoring efforts are needed.

Terrestrial Plant Communities

There are four Great Lakes basinwide terrestrial plant monitoring programs taking place at the federal level. The U.S. Department of Agriculture's *National Forest Inventory and Analysis Data Base System* is the national forest census database. This program reports on status and trends in forest area and location, species, size, health of trees, total tree growth, mortality, removals by harvest, wood production and utilization rates by various products, and forest-land ownership. The USGS-National Park Service *Vegetation Mapping Program* is a cooperative effort by the USGS and the National Park Service (NPS) to classify, describe, and map vegetation communities in the national parks across the United States. The U.S. Environmental Protection Agency's *Great Lakes Basin Vegetation Change Analysis* relates vegetation change to global climate change by analyzing vegetation changes in the basin over a 20-year period using satellite imagery. Another Great Lakes regional program is the binational *North American Maple Project* which monitors sugar maple health in the Great Lakes basin.

Results of the inventory show a number of forest monitoring programs managed at the state level. The Wisconsin Department of Natural Resources Forestry Department manages the *Champion Trees of Wisconsin* database as well as the *Forestry Compartment Reconnaissance* database. While the champion trees program keeps track of exceptional examples of trees in the state, the Forestry Compartment Reconnaissance program assesses forest resource information at the property level. The Ohio Division of Forestry *Forest Monitoring* project monitors a series of randomly located forest plots to collect data on trees, saplings, seedlings, and herbaceous plants.

HIGHLIGHT – Plant Ecology

- Forest age-class and forest successional stage data collection appears to be limited.
- Little monitoring data is available regarding insect or disease monitoring in terrestrial plant communities.
- A number of SOLEC indicators need to be further defined in order to assess data availability.

In addition to these programs, several others that remotely collect land cover data are described in the land use section of this report.

Four relatively new SOLEC indicators focus specifically on forest health. Of these four indicators, only one has a complete description. The goal of the Forest Health Criterion #1: Conservation of Biological Diversity (#8500) is to describe the extent, composition and structure of the Great Lakes basin forests by measuring the 1) extent of area by forest type relative to total forest area, 2) extent of area by forest type and by age-class or successional stage, and 3) extent of area by forest type in protected area categories. Forest Health Criterion #2: Maintenance and Productive Capacity of Forest Ecosystems (#8501), Forest Health Criterion #3: Maintenance of Forest Ecosystem Health and Vitality (#8502), and Forest Health Criterion #4: Conservation and Maintenance of Soil and Water Resources (#8503) have yet to be described.

The most comprehensive forest monitoring program in the Great Lakes basin is the U.S. Department of Agriculture's *National Forest Inventory and Analysis Data Base Systems.* This database provides the information needed to evaluate extent of area by forest type, the first measure of the Forest Health Criterion #1, and the extent of area of protected areas, the third measure of the Forest Health Criterion #1. It appears as if no data are currently available to analyze forest type by age-class or successional stage, the second measure of the Forest Health Criterion #1.

The other indicator that addresses terrestrial plant communities is Health of Terrestrial Plant Communities (#8162) which seeks to measure trends in time and space of 1) non-native insect or disease infestation of plants and 2) plant mortality or damage (including deformities) throughout the Great Lakes basin. No information was available in the monitoring inventory regarding insect or disease monitoring in terrestrial plant communities. The North American Maple Project does collect data on health of individual sugar maple trees throughout the basin.

Aquatic Plant Communities

Results of the inventory show four programs dedicated to aquatic plant monitoring projects. The Wisconsin Department of Natural Resources runs the *Wisconsin Lakes - Aquatic Plant Database,* which is a unique program in the basin that collects information on aquatic plants collected in Wisconsin. An estimate of plant density is determined at each point and water depth and substrate information is available for many sampling points.

Other aquatic plant monitoring programs include *Monitoring and Event Response for Harmful Algal Blooms* and the *Aquatic Macrophyte Abundance Diversity* managed by State University of New York (SUNY) and Cornell University, respectively, and focused in New York state waters of the Great Lakes basin. The U.S. Geological Survey manages a program in the Detroit River monitoring *Status and Trends of wild celery tubers.*

For additional information on terrestrial and aquatic plant communities please refer to the wetlands, stewardship, and land-use sections of this report.

Findings – Plant Ecology

The most comprehensive forest monitoring program in the Great Lakes basin is the U.S. Department of Agriculture's *National Forest Inventory and Analysis Data Base System.* This database provides much of the data needed to evaluate forest health. A potential gap has been identified in forest age-class and forest successional stage data collection. These data are needed to complete a full analysis of Forest Health Criterion #1. Also, very little information was available in the monitoring inventory regarding insect or

disease monitoring in terrestrial plant communities. This missing information may represent a gap in the monitoring inventory rather than in monitoring efforts in the region. The final three forest health SOLEC indicators must be described before monitoring data availability for these areas can be assessed.

Habitat and Biodiversity
g. Habitat and Community

The natural resources and ecological wealth of the Great Lakes basin require responsible management and protection. The Great Lakes basin's habitats, communities, and, therefore, natural processes are threatened by the region's high population densities, intensive agricultural practices, and ever increasing pressure on its fresh water resources from inside and outside of the basin. Well designed and managed stewardship efforts will help to insure the health of Great Lakes communities and ecosystems for future generations.

In total, 20 programs were found that generally address issues related to habitats and communities. Of these programs, eight belong to state run *Natural Heritage Programs* managed by each of the Great Lakes states. In Michigan, the complimentary program is called *Michigan Natural Features Inventory (MNFI). Natural Heritage Programs* collect information on biological diversity, including significant natural areas and species occurrences in both terrestrial and aquatic ecosystems. The goal of the *Natural Heritage Program* is to build, maintain, and provide accurate and accessible ecological information needed for conservation, urban planning, and natural resource management and also to provide information to the Threatened and Endangered Species Act. The *NatureServe* program works with the *Natural Heritage programs* throughout the country to establish standards for biological inventories and data management procedures, develop comprehensive species and ecological community databases, and make these data available to the public through online resources.

The State of Illinois is a leader in advancing ecological stewardship goals in the region. In addition to the state run *Natural Heritage Program* collecting information on habitat and species occurrence, the Illinois Department of Natural Resources has designed the *Critical Trends Assessment Program (CTAP)* to monitor the specific condition of habitats, including forests, wetlands, grasslands, and streams, throughout the state. *Ecowatch*, a complimentary state run volunteer program, collects scientific data on streams, forests, prairies, and urban green spaces to measure the quality and quantity of habitats in the state.

HIGHLIGHT – Habitat and Community

- A standardized habitat classification map for the entire Great Lakes basin would be highly useful for bringing habitat monitoring together for basinwide assessment and for focusing stewardship efforts.
- The Illinois Department of Natural Resources Critical Trends Assessment Program provides a strong example of using species and habitat occurrence data as a foundation for assessing habitat conditions and ecological health. Expansion of this type of program throughout the entire Great Lakes basin would drastically improve availability of important habitat quality information.

The U.S. Geological Survey runs the *Gap Analysis Program*. The goal of *Gap Analysis Program* is to keep common species common by identifying those species and plant communities that are not adequately represented in existing conservation lands. This program focuses on common species rather than those considered threatened or endangered. By identifying the habitats of common species, the *Gap Analysis Program* gives land managers, planners, scientists, and policy makers the information they need to make better-informed decisions when identifying priority areas for conservation.

Colorado State University has established a unique program called the *Interagency Monitoring of Protected Visual Environments*. This program currently has two sampling locations in the Great Lakes basin, Seney National Wildlife Refuge and Isle Royal National Park. The goal of this program is to identify chemicals and emission sources responsible for existing man-made visibility impairments and to assess progress towards visibility goals.

A number of SOLEC indicators address habitats and communities. Those most directly related to habitats and communities will be discussed in this section while others including land use, wetlands and specific animal and plant communities will be discussed in greater detail in other sections of this report.

Area, Quality, and Protection of Lakeshore Communities (#8129) seeks to measure the area, quality, and protection status of designated communities within one kilometer of the shoreline. The purpose of this indicator is to assess changes in area and quality of these communities. The state run *Natural Heritage Inventory Programs* may collect much of the species and habitat information needed to evaluate this indicator. The *Gap Analysis Program* collects additional information on species distribution across the basin and provides information on the protection status of these designated communities. A limitation of both the *Natural Heritage Program* and the *Gap Analysis Program* is that they may not collect data at the appropriate spatial resolution throughout the entire one kilometer coastal zone of the Great Lakes basin. The Illinois *Critical Trends Assessment* program, which analyzes species and habitat information to determine specific conditions of habitats, provides a valuable set of information on habitat quality. Expansion of this type of program throughout the entire Great Lakes basin may be extremely valuable.

Nearshore Species Diversity and Stability (#8137) seeks to measure the number and type of plant and wildlife species within one kilometer of the shoreline to better understand the composition and abundance of nearshore plant and wildlife species over time. The state run *Natural Heritage Inventory Programs* may collect much of the information needed to evaluate this indicator. A limitation of the Natural Heritage database is that it may not include all shoreline areas.

A related indicator, the Protected Nearshore Areas (#8149) indicator assesses the amount of protected shoreline in the Great Lakes basin. Data to evaluate this indicator may be available through various sources including the *Gap Analysis Program*, the U.S. National Parks Service, and state and local planning agencies. Results from this inventory do not include enough detail to provide a thoughtful analysis of this indicator.

Status and Protection of Special Places and Species (#8163) seeks to determine the area, quality, and protected status of landscapes and species with special cultural or spiritual significance to the people of the Great Lakes basin. A first step in evaluating this indicator would be to examine an inventory of such places. No such inventory was reported to the Great Lakes Monitoring Inventory. Once a place and species inventory is completed, this indicator may still be difficult to evaluate because it may not be possible to use remote sensing data or other strictly scientific data collection method to evaluate the quality of special places. The state run *Natural Heritage Inventory Programs* collect individual species and community information that may produce some of the data needed to evaluate the status of the designated special species.

Additional information on various issues related to habitat and community can be found throughout this report. For additional information on land use and land cover patterns please refer to the land use section of this report. Information on specific animals and plants can be found in the wildlife and plant communities sections of this report. Please refer to the wetlands section for more information on coastal wetland issues.

Findings – Habitat and Community

The state run *Natural Heritage Programs* collect extremely valuable information on biological diversity, including significant natural areas and species occurrences in both terrestrial and aquatic ecosystems. This information should provide the basis for analysis of habitats and communities in the Great Lakes basin. The USGS *Gap Analysis Program* takes this information a step further by evaluating the quality of specific habitats across the region and their protection status. A potential limitation of both these datasets is that they may not collect data at a fine enough resolution to satisfy the needs of all related SOLEC indicators. *Illinois' Critical Trends Assessment Program* provides a fine example of using species and habitat occurrence data as a foundation for assessing habitat conditions and ecological health. Expansion of this type of program throughout the entire Great Lakes basin would drastically improve availability of important habitat quality information. Additionally, a standardized habitat classification map for the entire Great Lakes basin would be highly useful for bringing habitat monitoring together for basinwide assessment and for focusing stewardship efforts.

4. Land Use and Human Impact
a. Atmospheric Deposition

The primary causes of acid rain are elevated levels of sulfur dioxide (SO2) and nitrogen oxides (NOx) in the atmosphere. In the U.S., a large percentage of the SO2 and NOx come from electric power generation that relies on burning coal, which releases contaminants into the air. The effects of acid deposition on the environment include acidification of lakes and streams, nutrient enrichment of coastal waters and large river basins, soil nutrient depletion and decline of sensitive forests, agricultural crop damage, and impacts on ecosystem biodiversity. Acid rain is measured primarily by tracking the acidity in precipitation using the pH scale.

The SOLEC Acid Rain (#9000) indicator seeks to assess the pH levels in precipitation and loadings of sulfate to the Great Lakes basin. Issues related to this indicator that are still being addressed are target pH levels, monitoring frequency requirements, and spatial patterns of monitoring sites. Identification of methods to effectively reduce of the levels of sulfur and nitrogen acidic compounds in the atmosphere is the long-term goal set by this indicator. Another indicator related to acid rain is Atmospheric Deposition of Toxic Chemicals (#117). This indicator reports loading estimates of PCBs, dieldrin, chlordane, DDT, and metabolites as well as other chemicals based on measured atmospheric concentrations of chemicals and wet and dry deposition rates.

HIGHLIGHT – Atmospheric Deposition

- Integrated Atmospheric Deposition Network (IADN) appears to be the only program collecting information on the parameters necessary to evaluate SOLEC's Atmospheric Deposition of Toxic Chemicals indicator. A potential limitation of IADN lies in the distribution of sampling stations and in the corresponding activities at each station.

- The necessary spatial frequency of sampling locations remains unknown and because atmospheric monitoring is particularly costly when considering measurements of dioxin and mercury more research needs to be conducted to determine the appropriate spatial distribution of atmospheric deposition sampling locations.

A total of eight programs were reported in the inventory that address acid rain deposition, specifically pH and sulfate, in the Great Lakes basin. Of these programs, two are conducted at the federal level and measure both wet and dry deposition.

A joint US EPA and Environment Canada program, *Integrated Atmospheric Deposition Network (IADN)*, was developed in 1990 to monitor atmospheric deposition of toxic chemicals to the Great Lakes. This program measures wet and/or dry atmospheric deposition at 15 locations on

shores of the Great Lakes basin. Five of these stations (3 sites in the US and 2 Canadian sites) are master stations where all IADN chemicals are measured in air and precipitation. The program monitors 80 toxic chemicals, including PCBs, dieldrin, chlordane, and DDT. The remaining 10 stations measure a limited number of the IADN chemicals. The US has 2 of these satellite stations located in urban areas. These stations measure concentrations in both air and precipitation. Canada has 8 satellite stations. One of these stations measures only air concentrations while the other 7 measure only precipitation concentrations.

The US EPA also manages the *Clean Air Status and Trends Network (CASTNET)* focusing on dry deposition monitoring at five locations in the Great Lakes basin. In addition, the Great Lakes Research Consortium manages the *Semivolatile Air Monitoring Network* that collects concentration and loading of organics (including dioxin) in air. The *National Atmospheric Deposition Program (NADP),* which is a cooperative research support program of federal, state, and non-governmental research agencies, measures wet deposition at 31 locations across the Great Lakes basin through the *National Trends Network* program. Other programs managed by NADP are *Atmospheric Integrated Research Monitoring Network* (AIRMON) and *Mercury Deposition Network* (MDN). The MDN measures mercury deposition in rainfall at approximately 20 sites within the Great Lakes region. NADP in partnership with Lake Michigan Air Directors Consortium (LADCO) and Central Regional Air Planning Association (CENRAP) operate an ammonia monitoring network at 13 sites across the Midwest and the Plains states. This network has been measuring ammonia/ammonium, nitrate/nitric acid and SO2/sulfate since 2003. Each of these programs collects information needed to evaluate the Acid Rain indicator, but only *IADN* measures the parameters for the Atmospheric Deposition of Toxic Chemicals indicator.

Three additional atmospheric deposition monitoring programs were found at the state level. The Wisconsin Department of Natural Resources manages the *Long Term Lake Monitoring Program,* which measures the surface water chemistry of 13 lakes in Wisconsin and 8 in the Upper Peninsula of Michigan three times a year in order to determine chemical responses of lakes to changes in the deposition of acidic rain. Pennsylvania Department of Environmental Protection has one *Atmospheric Deposition Monitoring Network* station in the Lake Erie basin measuring acid rain and mercury deposition into the atmosphere. New York State Department of Environmental Conservation manages eight *Atmospheric Deposition Monitoring Sites* within the Lake Erie and Lake Ontario basins. These sites measure both wet and dry samples.

For further information on other types of air monitoring programs please refer to the air monitoring section of this report.

Findings – Atmospheric Deposition

Eight programs were found that specifically address atmospheric deposition. While there appears to be a number of federal and state programs collecting information on atmospheric deposition, *Integrated Atmospheric Deposition Network (IADN)* appears to be the only program collecting information on the parameters necessary (PCBs, dieldrin, chlordane, and DDT) to evaluate SOLEC's Atmospheric Deposition of Toxic Chemicals indicator. A potential limitation of *IADN* lies in the distribution of sampling stations and in the corresponding activities at each station. This network may need to be evaluated to determine if five master stations (one per lake) are sufficient to characterize atmospheric deposition. Currently, both wet and dry deposition monitoring sampling locations are sparsely distributed throughout the basin. The necessary spatial frequency of sampling locations remains unknown and because atmospheric monitoring is particularly costly when considering measurements of dioxin and mercury more research needs to be conducted to determine the appropriate spatial distribution of atmospheric deposition sampling locations. The combined distribution of current atmospheric deposition monitoring sites should be evaluated to determine if it is sufficient to provide enough information to assess the atmospheric deposition patterns and

loadings in the Great Lakes basin. No specific budget information is available for these programs but if the need arises for an increase in sampling locations additional funding will be needed in this area.

Land Use and Human Impact
b. Nutrient Management

The Great Lakes basin is one of the highest yielding agricultural regions of the U.S. To achieve these yields, large amounts of nutrients (such as nitrogen and phosphorus) are added to the soil in the form of fertilizers. These nutrients flow off the land through surface or ground water and threaten water quality. In order to limit these environmental impacts, nutrient management plans are being developed to describe how nutrients are to be applied to agricultural land and how runoff from these lands is to be minimized.

The goal of the Nutrient Management Plan (#7061) indicator is to determine the number of nutrient management plans and environmentally friendly practices in place to prevent ground and surface water contamination through agricultural practices, particularly livestock operations. This indicator is measured by the number of nutrient management plans (NMP) in place and the percent of municipalities with nutrient management standards for intensive livestock operations. A slightly less specific but related indicator is Sustainable Agricultural Practices (#7028). The goal of this indicator is to assess the number of environmental and conservation farm plans in place and to examine to what extent environmentally friendly practices, such as integrated pest management, zero tillage and other soil preservation practices, are being used to prevent ground and surface water contamination. Both these indicators are process measures in that they measure processes being put into place rather than outcome measures that directly measure the impact on the environment. The purpose of the Great Lakes Monitoring Inventory is to collect information about programs that primarily monitor environmental outcomes, so it is possible that programs addressing these indicators were missed by the inventory.

HIGHLIGHT – Nutrient Management

- Additional effort should be made to compare results from nutrient and pesticide management programs (i.e. rates of growth in implementation) with direct monitoring of nutrients and pesticides in surface waters.

Three monitoring programs were reported to the Great Lakes Monitoring Inventory that directly address agricultural nutrient management in the Great Lakes basin. The US EPA's *Permit Compliance System (PCS)* tracks permit compliance and enforcement status of dischargers who are required to file National Pollution Discharge Elimination System (NPDES) permits. This set of dischargers includes agricultural operations. The PCS includes more than 3,500 sites in the Great Lakes basin but information was not available on exactly how many of these sites are directly related to agricultural operations or how many permits were directly related to nutrient management. The state of Wisconsin reported on two nutrient management programs. The University Wisconsin Extension's *Nutrient Management Program* addresses proper nutrient management on farm and home soils. This program focuses on Marinette County Wisconsin, and Menominee County Michigan. The Land Conservation district in Racine County, Wisconsin manages the *Land and Water Resource Management Program* working to prevent direct discharge of agricultural waste products from entering surface and groundwater. The purpose of this program is to develop environmental farm planning procedures and implement proper conservation practices.

Another similar SOLEC process-focused indicator is the Integrated Pest Management (#7062) indicator. The purpose of this indicator is to assess the adoption and uptake of Integrated Pest Management practices by farmers and to infer environmentally friendly practices in place to prevent ground and surface water contamination. No organizations in the Great Lakes basin reported on integrated pest management plans.

Findings – Nutrient Management

Nutrient management planning is a relatively new practice in the Great Lakes basin. Only a few counties in Wisconsin and Michigan reported formal nutrient management programs. No specific nutrient management monitoring programs were reported by other states or counties. It is possible that state and local agencies do not see these types of programs as monitoring programs and thus did not submit information on them into the inventory. Further efforts should be made to ensure all nutrient management programs are included in the inventory in the future. While US EPA's *Permit Compliance System (PCS)* tracks nutrient releases of some agricultural operations, little information is available on which agricultural operations have reporting requirements and the extent of these reporting requirements. No information was reported on integrated pest management plans in the Great Lakes basin. An additional effort should be made to compare results from nutrient and pesticide management programs (i.e. rates of growth in implementation) with direct monitoring of nutrients and pesticides in surface waters. An analysis of water quality monitoring is included in a separate section of this report.

Land Use and Human Impact
c. Land Use

Understanding the relationship between land use and ecosystem health is important to the long-term preservation of the environmental integrity of the Great Lakes basin. Industrial development, population growth, and expanding residential communities, coupled with deteriorating conditions and abandonment in older city cores create environmental pressures that can lead to detrimental effects on water quality, air quality, and overall ecosystem health. By identifying and tracking measurable land use criteria (in combination with environmental condition monitoring), trends and patterns can be analyzed to project impacts on the environment.

HIGHLIGHT – Land Use

- Potential limitations to the USGS National Land Cover Characterization Project and the NOAA Coastal Change Analysis Program (C-CAP) are the time periods between dataset development, the spatial resolution of the imagery, and the level of detail of the classification system.
- A more detailed analysis, focused on evaluating specific GIS data needs and availability should be conducted to identify specific gaps or overlaps in land use and land cover data.

Based on inventory results, 32 monitoring programs collect data on land use characteristics. The USGS *National Land Cover Characterization Project* has developed nationally consistent land cover data sets. Datasets are currently available for 1995 and 2001. These land cover datasets are being used for watershed management, environmental inventories, and land management. This information is all available through the USGS *National Map* project, which is a mapping tool available on the Internet. USGS's *Geographic Analysis and Monitoring Program (GAM)* supports geographic assessments to improve the understanding of land surface change in the United States. Another federal project focusing on land use issues is NOAA's *Coastal Change Analysis Program (C-CAP)*. The objective of this program is to complete a national baseline dataset of land cover and land use change for the coastal regions of the U.S., including the Great Lakes coastal zones. Based on Landsat Thematic Mapper imagery, this dataset provides a coarse-scale classification of habitat types.

Inventory results show that each Great Lakes state has a Geographic Information System (GIS) repository. Each of these repositories may contain a host of data relevant to land use analysis. In many cases, state land use/land cover data sets are based on higher resolution airborne imagery which can contribute to a finer

scale analysis of land use change. It was beyond the scope of this project to identify each GIS dataset available. Therefore, the description of land use presented in this report may not represent all available data. Also, the U.S. Census Bureau collects demographic data at the county level throughout the Great Lakes basin. Although it may not be considered environmental monitoring data, these demographic data may contribute to a more comprehensive land use analysis. A number of other land use monitoring projects were found to be conducted by local organizations.

A number of SOLEC indicators address issues associated with land use. These indicators and their relation to the results of the monitoring inventory are discussed in more detail below.

The Land Cover-Land Conversion (#7002) indicator is measured as the percent change in land use from agriculture, urban development, forest, marsh and other natural cover. High rates of land conversion from natural covers are generally associated with rapid rates of urban development. The USGS *National Land Cover Characterization Project* provides information on national land cover for 1995 and 2001 by using remotely sensed data and classifying it by land cover type. NOAA's *Coastal Change Analysis Program (C-CAP)* provides even more detailed information on land cover and land use change in the Great Lakes region. One potential limitation of both of these datasets may be the time between dataset development. Another potential limitation is the spatial resolution of the imagery and the level of detail of the classification system. The U.S. Census Bureau's demographic data may also provide additional valuable information on land use, namely urban growth.

Ground Surface Hardening (#7054) is a measure of the percent of land in a watershed that is covered by buildings, roads, parking lots and other hardened surfaces. Results from the inventory do not include any basin wide monitoring programs that provide data detailed enough to assess hardening rates due to specific buildings, roads, and parking lots, but there are regional datasets available for such analysis, including the USGS Digital Ortho Quarter Quads (DOQQ) and Digital Raster Graphics (DRG). A limitation of these data sources is the frequency with which they are updated. Additionally, a large amount of time would be needed to process these datasets to provide the information needed to assess hardening rates.

Habitat Fragmentation (#8114) is a landscape indicator that measures the pattern of natural habitats. This indicator requires an analysis of habitat patch size, percent intact cover, and area to perimeter ratio. The objective of this indicator is to assess the amount and distribution of "core" natural habitat remaining within each Great Lakes ecoregion and determine the effect land use changes are having on fragmenting large natural habitat patches. The USGS *National Land Cover Characterization Project* described above may provide information needed to analyze habitat fragmentation. Perhaps a more relevant data set is *C-CAP*, which provides a more detailed habitat classification scheme and change analysis. The necessary spatial extent of such an analysis and specific habitat types has not been clearly defined for the Great Lakes region.

The purpose of the Extent of Hardened Shoreline (#8131) indicator is to assess the amount of shoreline habitat altered by the construction of shoreline edge hardening devises used for erosion or storm protection. A similar indicator, Artificial Coastal Structures (#8146), measures the density of artificial coastal structures on the Great Lakes shoreline that extend into waters from the shoreline or are placed offshore to dampen the force of waves. Currently, limited data are available on the geographic extent of shoreline hardening devises, both along the coastline and extending into the waters. USGS *Digital Ortho Quarter Quads (DOQQ)* and *Digital Raster Graphics (DRG)* as well as other available satellite imagery, may provide some of the necessary information. Again, limitations of these data sources are their resolution and frequency with which they are updated. States may have more detailed information on hardened shorelines and artificial coastal structures. Results from the inventory show that the Ohio Department of Natural Resources manages a *Shore Structure Inventory* that assesses the presence of man-made shoreline hardening devices. These types of data are very valuable and would be useful for each state in the Great Lakes basin.

Nearshore Land Use (#8132) seeks to evaluate land use types throughout the basin as related to special lakeshore communities identified by SOLEC. Land use types of interest include urban residential, commercial, industrial, non-urban residential, intensive agriculture, extensive agriculture, abandoned agriculture, closed canopy forest, harvested forest, and wetlands and other natural areas. Again, the *National Land Cover Characterization Project* and *C-CAP,* described above may provide the information needed to analyze land use in the nearshore zone. Results from the inventory show that the Ohio Department of Natural Resources manages a *Nearshore Habitat Dynamics* program that tracks substrate changes. These types of data are needed to analyze nearshore landuse patterns and could be expanded into other states.

Extent and Quality of Nearshore Natural Land Cover (#8136) is a measure of the amount of natural land cover that falls within 1 km of the shoreline and seeks to determine the potential impact of artificial coastal structures on the extent and quality of nearshore ecosystems. Again, the *National Land Cover Characterization Project* and *C-CAP,* described above may provide the best data needed to analyze this indicator.

Findings – Land Use

The extent of land use monitoring in the region is difficult to evaluate due to several factors. It was beyond the scope of this project to analyze all GIS data available at the local, state, and federal levels. Therefore, the description of land use presented in this report may not represent all available data. Also there are a few potential limitations to the nationwide dataset collected through USGS's *National Land Cover Characterization Project* and NOAA's *Coastal Change Analysis Program (C-CAP).* One potential limitation of both of these datasets may be the time scale between dataset development. Other potential limitations are the spatial resolution of the imagery and the level of detail of the classification system. A more detailed analysis, focused on evaluating specific GIS data needs and availability should be conducted to identify specific gaps or overlaps in land use and land cover data.

Land Use and Human Impact
d. Erosion

Erosion is defined as the wearing away of land by the action of natural forces. The primary forces of erosion are waves, currents, and wind. Most of the Great Lakes coast is comprised of erodible, glacially deposited sand, gravel, clay, and clay-like material. Though erosion is a natural process, it can be influenced by a variety of human activities, including coastal navigation, agriculture, and shore protection structures. [10] Although no SOLEC indicator calls for erosion monitoring directly, there are a number of programs that monitor these processes, so it warrants a brief discussion.

HIGHLIGHT – Erosion

- Comprehensive coastal erosion monitoring programs like Pennsylvania's Bluff Recession Monitoring project and Ohio's Lake Erie Coastal Erosion Study are valuable examples of coastal erosion monitoring. It may be valuable for other states in the basin to implement such monitoring programs.

Two state-run programs monitor coastal erosion along the Great Lakes shoreline. Pennsylvania Coastal Zone Management's *Bluff Recession Monitoring* project physically measures bluff erosion rates at established control points along Pennsylvania's Lake Erie shoreline. The Ohio Department of Natural Resources' *Lake Erie Coastal Erosion Study* computes erosion rates and identifies the factors controlling the temporal and spatial variation in these rates along Ohio's shoreline to improve the

predictive models of future shoreline recession. These comprehensive databases provide important data for coastal management decision making.

A number of other programs contribute to erosion monitoring in the Great Lakes basin. The Wisconsin Department of Natural Resources manages a *Sensitive Area Designations* program that identifies areas that provide a high level of erosion control benefits as well as other ecologically desirable characteristics. Wisconsin's Racine County conducts a *Land & Water Resource Management Program* that monitors soil erosion from cropland. Illinois State Water Survey *Benchmark Sediment Monitoring Program* is a long-term database of suspended sediment transport in the rivers and streams of Illinois. Another program monitoring sediment transport is the *Study of sediment sources in streams of the glaciated Allegheny Plateau* conducted by Cornell University. These data are valuable for predicting erosion rates and identifying areas sensitive to erosion. Ohio Department of Natural Resources' *Shore Structure Inventory* assesses man-made shoreline hardening devises. These data are valuable for identifying alterations and assessing their impact on natural erosion regimes and would be valuable for each Great Lakes state. Erosion control programs such as the Traverse City, Michigan *River Care Program* work toward improving erosion control.

The land use section of this report also offers information relevant to erosion in the Great Lakes basin.

Findings - Erosion

Comprehensive coastal erosion monitoring programs like Pennsylvania's Bluff Recession Monitoring project and Ohio's Lake Erie Coastal Erosion Study are valuable examples of coastal erosion monitoring. It may be valuable for other states in the basin to implement such monitoring programs. Ohio Department of Natural Resources' shore structure inventory is another example of a program that may warrant implementation throughout the basin. One area in need of monitoring resources in the region is agricultural soil erosion monitoring.

Land Use and Human Impact
e. Urban Issues

Issues related to urban development and population growth and expansion place a large environmental strain on the Great Lakes basin. Wastewater treatment, municipal runoff, energy consumption, vehicle use, eco-efficiency measures, and solid waste generation are just a few of the issues that need to be addressed in this area. While the monitoring inventory didn't specifically target urban environmental concerns, the SOLEC indicators focusing on urban issues will be addressed below.

The newly developed Municipal Wastewater Treatment (#7063) indicator does not yet have a written description. A number of Great Lakes organizations reported wastewater pollution and treatment monitoring programs. These programs appear to be taking place primarily at the county or municipal level with a few exceptions. Because no specific information is available on the purpose and measurement methods for the Municipal Wastewater Treatment indicator, the following will be a general discussion of wastewater monitoring programs reported via the monitoring inventory.

HIGHLIGHT – Urban Issues

- Results indicate that wastewater treatment programs are focused primarily at the local and municipal level. The focus of the Great Lakes Monitoring Inventory did not make it possible to evaluate waste water treatment monitoring efforts because the inventory focused primarily on federal and state programs. Additional effort is needed to fill in these informational gaps in the inventory.

The US EPA's *Permit Compliance System (PCS)* tracks the permit, compliance and enforcement status of dischargers required to file a National Pollution Discharge Elimination System (NPDES) permit. This set of dischargers includes municipalities and waste water treatment operations. The PCS includes more than 3,500 sites in the Great Lakes basin but information was not available on exactly how many of these sites are directly related to wastewater treatment operations. The Illinois Environmental Protection Agency *Whole Effluent Biomonitoring Program* objectives are to conduct whole effluent toxicity tests (bioassays) on representative aquatic organisms in a variety of wastewater effluents from municipal and industrial sources; assess the success of wastewater treatment processes to remove toxic components; determine the relative toxicity of these effluents using common end points; and determine the nature of receiving waters upstream of effluent discharges. The Michigan Department of Environmental Quality *Source Water Assessment Program* identifies the origination point of source water going into municipal water treatment plants in southeast Michigan. The Fisheries and Oceans Canada also manages the *Municipal Drain Classification Project*. No descriptive information was reported for this project.

At the local level, Milwaukee Metropolitan Sewerage District's *WATERBase - Milwaukee Metropolitan Sewerage District Water Quality Monitoring Data* program maintains an extensive water quality monitoring program to aid in pollution abatement, facilities planning, and flood control. The Northeastern Illinois Planning Commission manages the *Evaluation of Urban Storm water Pollutant Loads to Lake Michigan from Lake County, IL* project. No descriptive information is available for this project. Other local waste water monitoring programs were submitted by the North Shore Sanitary District, Illinois; Saint Clair County, Michigan; Oakland County, Michigan; Macomb County, Michigan; and Center Line Township, Michigan. These are likely just a sample of the communities in the region monitoring waste water.

There are another eight SOLEC indicators that address urban issues. These indicators include Urban Density (#7000), Brownfield Redevelopment (#7006), Water Withdrawal (#7056), Energy Consumption (#7057), Solid Waste Generation (#7060), Vehicle Use (#7064), Commercial/Industrial Eco-Efficiency Measures (#3514), and Household Stormwater Recycling (#3516). No monitoring programs were reported that address any of these indicators. It is possible that agencies monitoring for information related to these indicators did not submit surveys to the monitoring inventory since they may not view their programs as monitoring.

Findings – Urban Issues

Because no written description was available for the Municipal Wastewater Treatment indicator, it is difficult to address specific deficiencies in this area. Results do indicate that wastewater treatment programs are focused primarily at the local and municipal level. Very few municipalities and counties reported monitoring in this area. Extra effort should be made to include additional wastewater monitoring programs. No monitoring programs were reported that address Urban Density (#7000), Brownfield Redevelopment (#7006), Water Withdrawal (#7056), Energy Consumption (#7057), Solid Waste Generation (#7060), Vehicle Use (#7064), Commercial/Industrial Eco-Efficiency Measures (#3514), and Household Stormwater Recycling (#3516). Lack of monitoring program information for this section may be the result of a low emphasis on the part of monitoring inventory data collectors rather than actual gaps in regional monitoring efforts in these areas. Additional effort is needed to fill in these informational gaps before assessing them as potential monitoring gaps.

Section VI. Conclusions and Recommendations

The Great Lakes Monitoring Inventory and Gap Analysis is the first comprehensive resource developed to report on monitoring activities in the basin and how these activities meet previously set goals to protect the environmental health of the Great Lakes basin. Recommendations have been developed based on results from the inventory and the analysis of gaps and overlaps in monitoring efforts. These recommendations are divided into two categories: recommendations for improving the Great Lakes basin monitoring network and recommendations for improving the Great Lakes Monitoring Inventory.

A. Monitoring Community Recommendations

These recommendations, based on the results of the monitoring inventory and gap analysis, are general recommendations directed at improving the monitoring network in the region.

1. Form coordinating bodies to organize monitoring efforts in each main issue area. Formation of such coordinating bodies was suggested as a necessary element for effective management of monitoring efforts. An example of such a partnership can be seen in the Joint Strategic Plan for Management of Great Lakes Fisheries, supported by fourteen federal, tribal, state and provincial organizations, that has been developed to address fisheries related issues. This partnership framework is a strong example of effective coordination and collaboration and may be used as a model for other areas of Great Lakes monitoring.

2. Encourage regular discussions among individuals managing similar monitoring programs. There is currently limited interaction between program managers managing similar monitoring efforts in different parts of the Great Lakes basin within a number of monitoring areas. Conference calls conducted as part of this project led to a number of sideline discussions among program managers about the discrepancies of individual monitoring protocols across the basin. These types of open discussions will increase coordination and collaboration potential across monitoring programs, leading to more comparable datasets to evaluate basin wide trends.

3. The monitoring inventory should be used by the SOLEC indicator working groups as a resource for information on monitoring efforts currently taking place in the region. Currently there is no systematic process in place for identifying monitoring efforts that address each SOLEC indicator. The Great Lakes Monitoring Inventory and Gap Analysis provides the foundation for identifying relevant monitoring efforts. During the next review of SOLEC indicators, reviewers should examine the inventory and this report to better document monitoring programs under each indicator.

4. Evaluate monitoring needs, costs, and current regulations prior to establishing funding levels. Funding levels should be based on resources needed to meet previously set monitoring objectives and regulatory requirements. Funding levels also need to account for constantly changing monitoring costs.

5. Monitoring programs need to be assessed for compatibility. Reporting on SOLEC indicators requires an assessment of programs collecting data and a comparison of results across these programs. In many cases, monitoring for a given indicator is accomplished by a number of programs at various organizations, and often for purposes other than reporting for basinwide indicators. Before summarizing data together from these disparate datasets, it is critical that a compatibility analysis be conducted to determine if the monitoring methods, data analysis and

reporting elements are comparable between programs. If it is not, steps will need to be taken to better coordinate programs to allow for direct comparison and aggregation of data.

6. Federal and state monitoring directives and mandates should more carefully look at regional basinwide monitoring needs. Many of the programs included in the inventory are national in scope and are thus designed to meet national objectives. Often, these objectives are not compatible with the informational needs of the Great Lakes or other regions. Regional offices of federal agencies need to work to encourage program administrators to allow greater discretion and flexibility to address regional needs. Similarly, state and provincial and critical local or non-governmental programs need to have the flexibility to be altered to address regional information needs. Without this flexibility, data generated by more narrowly defined monitoring programs may not be useable in a regional context, resulting in monitoring inefficiencies or ineffectiveness.

7. Encourage regional and local level participation at planned monitoring coordination meetings. Regional and local agencies perform a great deal of monitoring in the basin, as evidenced by the results from the monitoring inventory. Their experience and data can be extremely valuable to basinwide monitoring coordination efforts and, if included, could lead to greater monitoring efficiency and effectiveness. Monitoring program managers at state/provincial and key local or non-governmental organizations should be included in monitoring coordination meetings and conferences so that they can take part in monitoring network design.

8. Short-term, small-scale monitoring programs should be balanced with basinwide monitoring initiatives. Monitoring is needed at a variety of levels to address numerous objectives. Both small-scale and basinwide monitoring programs are taking place widely across the basin. Each of these levels of monitoring can provide a great deal of value, and when analyzed in conjunction with one another to provide a deeper understanding of the Great Lakes ecosystem. The Great Lakes monitoring community needs to engage in a direct assessment of monitoring needs and capacities to determine how best to balance the needs for narrowly targeted monitoring with the needs for broad-based, long-term monitoring. When data are not compatible and cannot be made to be compatible, the region needs the ability to set priorities between competing needs.

9. State and regional monitoring programs should better utilize citizen-based or volunteer resources. The monitoring inventory includes a number of examples of citizen or volunteer based monitoring programs. Often these programs are designed to raise the public's awareness of environmental issues, but in many cases, the programs include thorough quality assurance designed to generate credible data. The vast availability of volunteer resources should not be overlooked, as they may provide a cost-effective way to collect broad-scale status and trends data. State/provincial, regional, and federal programs should assess the viability of using volunteer data to enhance the effective monitoring breadth of their programs.

B. Great Lakes Monitoring Inventory Improvements

The value of the Great Lakes Monitoring Inventory is directly tied to its accuracy and completeness. Development of a comprehensive monitoring inventory is a large-scale, regional effort that takes into account many factors, including participation by the full range of monitoring organizations, as well as information accuracy and completeness. The authors of this report made extensive efforts to collect complete information on the full range of monitoring programs in the basin, but, as this was the first attempt at an initiative of this scale, it is likely that a number of programs were overlooked. In order to improve the utility and the validity of this tool and the associated recommendations for improving

monitoring coverage and coordination, steps need to be taken to insure that the Great Lakes Monitoring Inventory accurately and completely reflects monitoring activities in the Great Lakes basin.

The following is a list of recommendations for addressing potential gaps in the monitoring inventory data collection efforts.

1. More detailed information is needed on monitoring efforts in the Canadian portion of the Great Lakes basin. Currently, the representation of Canadian programs in the Great Lakes Monitoring Inventory is limited. The Binational Executive Committee (BEC) monitoring inventory development team focused primarily on collecting information on Canadian monitoring programs, while the Great Lakes Monitoring Inventory focused primarily on U.S. monitoring activities. This split was made to avoid duplication of effort. It was agreed that all program information collected by both parties would be mutually exchanged. The lack of Canadian monitoring program information in the Great Lakes Monitoring Inventory may be the result of a few factors, including 1) the BEC inventory timeline for data collection didn't match the Great Lakes Monitoring Inventory timeline; 2) a more passive data collection effort was employed by the BEC monitoring inventory; or 3) limited monitoring efforts in the Canadian portion of the basin. It should be noted that the Canadian entries that have been submitted into the inventory lack the depth needed to analyze monitoring efforts in sufficient detail. This makes it difficult to perform a valid comparison across monitoring efforts in both Canada and the United States in many cases.

2. The completeness and accuracy of monitoring inventory needs to be regularly evaluated by the Great Lakes monitoring community. While every attempt was made to include all current monitoring programs into the monitoring inventory, programs may have been missed or incompletely represented. A thorough review was conducted prior to publication of this report but it will be important to regularly review the inventory throughout its life so that entries remain current and new programs are added.

3. More information on specific monitoring locations is needed. While programs were asked to submit specific sampling station locations, a minority of program managers provided this level of detail. The result is that the geographic analysis included in the gap analysis is based in large part on general geographic descriptions. The analysis would be much improved with a complete set of monitoring locations included for each program in the database. As the inventory is updated, it is important that particular emphasis be placed on obtaining monitoring location information.

4. More information is needed on the funding sources that support monitoring programs. This information is necessary to perform an accurate and complete analysis of current funding patterns, reliability of these funding sources and funding needs to address monitoring gaps. While the authors of this report made an effort to include a level of analysis of the reliability and sustainability of funding for monitoring in each analytical section of the gap analysis, in most cases, the funding information was too incomplete to draw realistic conclusions. As the inventory is updated, it is important that emphasis be placed on documenting funding sources and amounts for each monitoring program.

5. Program descriptive information needs to be expanded. For many monitoring program entries, only a subset of the requested information was submitted or available. Much of the information contained in the database was collected from public resources and this information is incomplete. These information gaps were described in each section of the gap analysis. It is important to complete entries for those programs in the inventory with missing information.

6. Active, ongoing data collection efforts should be continued through the Binational Executive Committee (BEC) monitoring inventory effort. As noted above, the entire database of monitoring programs collected through this initiative was shared with the BEC monitoring inventory team. As the parties to the BEC have been called upon to complete this inventory and use it for further planning and coordination of monitoring activities, it may be incumbent upon the BEC's representative agencies to continue management of the inventory.

7. Binational Executive Committee (BEC) Monitoring Inventory field list should be expanded. Expansion of the field list included in the BEC inventory is necessary to capture important elements associated with monitoring efforts, many of which have been captured by the Great Lakes Monitoring Inventory effort. Some of these include funding source, budget, sampling protocol, sampling parameters, sampling station locations, and staff description. Without this information, it is difficult to use the BEC inventory for assessment or coordination purposes.

C. Conclusions

The Great Lakes Monitoring Inventory includes hundreds of important monitoring programs that each contribute to our overall knowledge about the Great Lakes ecosystem. Each program, in its own way, enhances the effectiveness of resource management in the region. However, few of these programs are designed to yield broad information about the status and trends of the Great Lakes resources as a whole. This gap analysis illustrates many, but not all, of the gaps in environmental monitoring at the basinwide level. It is imperative that the monitoring community and the resource managers that they serve seek out ways to coordinate and combine their knowledge so that Great Lakes resources may be effectively managed as an integrated system. In this way, the monitoring community may make the whole system truly greater than the sum of its parts.

Findings from the Great Lakes Monitoring Inventory and Gap Analysis are being disseminated to the monitoring community, resource managers, and federal and state legislators. Efforts will also be made to integrate the inventory and gap analysis into larger Great Lakes monitoring coordination initiatives. The Great Lakes Observing System (GLOS) is an integrated observing system being developed to provide critical real-time data to the region. This system will serve as a regional node of NOAA's National Integrated Ocean Observing System (IOOS), which supports research on populations, species, communities, and ecosystems. Coordination with initiatives such as the Great Lakes Observing System (GLOS) will further enhance data sharing, reporting, and outreach efforts.

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Appendix A:

Great Lakes Monitoring Programs

Organization	Department	Title	Description
U.S. Federal			
Center for Disease Control and Prevention	Agency of Toxic Substances and Disease Registry	Great Lakes Human Health Effects of Research Program	Great Lakes Human Health Effects Research Program (GLHHERP) is designed to characterize exposure to contaminants via consumption of Great Lakes fish, and investigate the potential for short- and long-term adverse health effects.
Midwestern Regional Climate Center		Midwestern Regional Climate Center (MRCC) Climate Data Sets	Daily digital climate data for several thousand stations that date back as far as 1948 (turn of century for some). Includes high, low and mean temperatures, hourly precipitation, dew point, pan evaporation, snowfall, modeled soil moisture data, soil temperature. Surface hourly observations for over 100 sites include wind speed and direction. Solar radiation data for select sites are available on daily, monthly, or annual basis.
National Atmospheric Deposition Program	Illinois State Water Survey	National Trends Network	The National Atmospheric Deposition Program monitors wet atmospheric deposition at sites throughout the United States.
National Centers for Coastal Ocean Science		National Status and Trends Program - Mussel Watch	The project analyzes chemical and biological contaminant trends in sediment and bivalve tissue collected at over 280 coastal sites from 1986 to present. The database includes: sediment and bivalve tissue chemistry for over 100 organic and inorganic contaminants; bivalve histology; and Clostridium perfringens data.
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Laboratory	Assessments of Benthic Macroinvertebrate Communities in the Great Lakes	Spatial and temporal distributions in benthic macroinvertebrate populations, including dreissenid mussels, in various regions of the Great Lakes are monitored thought this project. These data will be used to determine trends in abundances and, in some cases, used to establish a baseline for future comparisons.
National Oceanic and Atmospheric Administration		Coastal Change Analysis Program (C-CAP)	An immediate objective for C-CAP is to expeditiously complete a national baseline of land cover and change data, from which additional dates of imagery may be used to track coastal trends over time.
National Oceanic and Atmospheric Administration		Commercial Catch (COMCAT)	Daily fishing records for US water of the Great Lakes
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Laboratory	Contaminant fluxes into and out of sediments	
National Oceanic and Atmospheric Administration	National Geophysical Data Center (NGDC)	Great Lakes Bathymetry	NOAA is engaged in a program to compile Great Lakes bathymetric data and make them readily available to the public, especially to the communities concerned with Great Lakes science, pollution, coastal erosion, response to climate changes, threats to lake ecosystems, and health of the fishing industry. This program is managed by NGDC and it relies on the cooperation of NOAA/Great Lakes Environmental Research Laboratory, NOAA/National Ocean Service, the Canadian Hydrographic Service, other agencies, and academic laboratories.

Organization	Department	Title	Description
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Lab	Long Term Trends in Benthic Populations in Lake Michigan	The purpose of the program is to monitor changes in the abundance and species composition of the benthic macroinvertebrate community of Lake Michigan. By examining trends over time, an evaluation of lake status can be achieved.
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Laboratory	Long-Term Trends in Benthic Populations	This is a long term monitoring project that documents changes in the benthic macroinvertebrate community in the southern basin of Lake Michigan. The project was designed so that samples are collected at 40 sites for two consecutive years every 5 years.
National Oceanic and Atmospheric Administration		National Climatic Data Center	NCDC's mission is to manage the Nation's resource of global climatological in-situ and remotely sensed data and information to promote global environmental stewardship; to describe, monitor and assess the climate; and to support efforts to predict changes in the Earth's environment. This effort requires the acquisition, quality control, processing, summarization, dissemination, and preservation of a vast array of climatological data generated by the national and international meteorological services. NCDC's mission is global in nature and provides the U.S. climate representative to the World Meteorological Organization, the World Data Center System, and other international scientific programs.
National Oceanic and Atmospheric Administration	National Data Buoy Center	National Data Buoy Center	Collection of weather related data.
National Oceanic and Atmospheric Administration	National Observing System	National Water Level Observation Program	The Program provides basic tidal datums to determine U.S. coastal marine boundaries and for nautical chart datums. It also provides support for NOAA's tsunami and storm surge warning programs, climate monitoring, coastal processes and tectonic research. The Program also contributes to safe vessel navigation and the increased efficiency of maritime transportation. In the Great Lakes the Program supports water management and regulation, navigation and charting, river and harbor improvement, power generation, scientific studies and adjustment for vertical movement of the Earth's crust in the Great Lakes Basin.
National Oceanic and Atmospheric Administration	National Weather Service	National Weather Service Remote Sensing Data	The National Operational Hydrologic Remote Sensing Center (NOHRSC) provides remotely-sensed and modeled hydrology products for the coterminous U.S. and Alaska for the protection of life and property and the enhancement of the national economy.
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Laboratory	Temporal and Spatial Variation in Lipid Content of the Mayfly Hexagenia	The objectives of this project are to: 1)determine seasonal changes in lipid content and lipid class composition in Hexagenia at several different sites with contrasting environmental conditions (western Lake Erie, Lake St. Clair, and the Straits of Mackinac); 2) document changes in lipid content as individuals develop through the various life stages; 3) assess populations in the vicinity of the Straits of Mackinac.

Organization	Department	Title	Description
National Oceanic and Atmospheric Administration	Great Lakes Environmental Research Laboratory	Thermal Structure Monitoring	The main objectives of this project are: to develop improved climatological information by means of observations, new instrumentation, and improved analyses of the distribution and variability of coastal and offshore temperatures and by studying their dependence on meteorological and hydrological forces, with emphasis on potential changes in climate; to concurrently provide data for improving numerical models that can simulate and predict the thermal structure in the lakes.
National Oceanic and Atmospheric Administration	National Centers for Coastal Ocean Science	US Mussel Watch Project	Chemical contaminants in bivalve mollusks have been monitored throughout US coastal waters, estuaries and the Great Lakes by the National Status and Trends Mussel Watch Project since 1986. Mussel Watch sites are selected to be representative of large coastal areas. The Great Lakes portion of the US Mussel Watch began with the sampling of five sites in 1992. The first sites sampled were in Saginaw Bay, Lake St. Clair, and Western Lake Erie. The monitoring effort has expanded to sampling from Green Bay in the west to Cape St. Vincent in the east. Sampling occurs on a biennial basis with Lakes Michigan and Huron, and Green Bay sampled in alternating years with the sites in Lakes St. Clair, Erie, and Ontario. Each year, half of the approximately 280 Mussel Watch sites are sampled. Twenty five of those sites are in the US portion of the Great Lakes. Samples are analyzed for a suite of PAHs, PCBs, DDT and its breakdown products, other chlorinated pesticides, as well as a number of major and trace elements.
Nicolet National Forest Bird Survey		Nicolet National Forest Bird Survey	The Nicolet National Forest Bird Survey is the longest running volunteer bird monitoring program in a U.S. national forest. The Nicolet National Forest encompasses 360,000 hectares of mixed hardwood-conifer forests, lowland swamps, glacial lakes, and wetlands in northeastern Wisconsin. It comprises the eastern portion of the Chequamegon-Nicolet National Forest, with headquarters in Rhinelander and Park Falls, Wisconsin. The Bird Survey takes place each year during the second weekend in June. Everyone with an interest in birds and a desire for adventure is invited to participate in the Bird Survey. Volunteers work in small groups led by at least one expert in bird song identification. Computerized results are used to guide forest management policies and have been the subject of numerous scientific research articles and master's theses. Results also provide visitors with information about habitat preferences and "hot-spots" for northern Wisconsin's bird species.
NOAA Great Lakes Environmental Research Laboratory		Great Lakes CoastWatch Node	CoastWatch is a nationwide National Oceanic and Atmospheric Administration (NOAA) program that delivers environmental data and products for near real-time monitoring of the Great Lakes to support environmental science, decision making, and research. CoastWatch data is used in a variety of ways including monitoring (algal blooms, plumes, ice cover, water intake temperatures at fish hatcheries, etc.), two and three dimensional modeling of Great Lakes physical parameters such as wave height and currents, damage assessment modeling, research, and educational activities.

Organization	Department	Title	Description
NOAA Great Lakes Environmental Research Laboratory		Great Lakes Ice Cover Climatology	We collect operational ice charts of the Great Lakes produced by several U.S. and Canadian Government Agencies over the years. We used these data to develop and update ice cover climatology of the Great Lakes and for other research applications. We have digitized historical ice charts from 1960-1979 and produced a NOAA ice Atlas. These data are available from the National Snow and Ice Data Center in Bolder CO. We have digitized historical ice charts for the winters of 1983 to 2000. These data are being used to update our data base and ice cover climatology.
U.S. Army Corps of Engineers	Detroit District	Great Lakes Water Levels	Tables of daily lake averages in feet or meters.
U.S. Army Corps of Engineers		Monitoring Dredged Material	Collect and analyze sediments from Federal navigation channels to determine proper methods for managing dredged material.
U.S. Army Corps of Engineers		Navigational Dredging Harbours	Detroit District of Corps collects sediment data on commercial and recreational harbors in Michigan and Wisconsin.
U.S. Department of Agriculture	Forest Service; North Central Research Station	National Forest Inventory and Analysis Data Base Systems	This program produces tables and maps from the USDA Forest Service's Forest Inventory and Analysis Data Base (FIADB). The user inputs the following information: 1) geographic area of interest (state/county retrieval or radius retrieval) 2) attribute of interest (timberland area, number of trees, growing-stock volume, etc.) 3) optional filters (for restricting the query to a specific ownership, species, etc.) 4) classification variables to be used for columns and rows and the web application generates the resulting table.
U.S. Department of Agriculture	Natural Resources Conservation Service	National Resource Inventory	The National Resources Inventory (NRI) program is the Federal Government's principal source of information on the status, condition, and trends of soil, water, and related resources in the United States.
U.S. Department of Agriculture	Natural Resources Conservation Service	Soil Climate Analysis Network	Provides real-time soil/climate data in agricultural areas of the US.
U.S. Department of Agriculture	Natural Resources Conservation Service	Soil Survey Geographic (SSURGO) Database	SSURGO is the most detailed level of soil mapping done by the Natural Resources Conservation Service (NRCS). SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships, and county natural resource planning and management. The user should be knowledgeable of soils data and their characteristics.
U.S. Department of Agriculture	Natural Resources Conservation Service	State Soil Geographic (STATSGO) Database	Soil maps for the State Soil Geographic (STATSGO) database are produced by generalizing the detailed soil survey data. The mapping scale for STATSGO is 1:250,000 (with the exception of Alaska, which is 1:1,000,000). The level of mapping is designed to be used for broad planning and management uses covering state, regional, and multi-state areas.
U.S. Environmental Protection Agency		Air Quality System (AQS)	The Aerometric Information Retrieval System (AIRS)/Air Facility Subsystem (AFS) contains compliance and permit data for stationary sources regulated by the U.S. EPA and state and local air pollution agencies.
U.S. Environmental Protection Agency		AirData	The AirData website provides access to yearly summaries of U.S. air pollution data. AirData has information about where air pollution comes from (emissions) and how much pollution is in the air outside our homes and work places (monitoring).

Organization	Department	Title	Description
U.S. Environmental Protection Agency		BEACON - Beach Advisory and Closing On-line Notification	BEACON is EPA's application to make state beach advisory and closing data available to the public. Data included in this database are contact information, monitoring and notification program information, general beach characteristics, advisory and closing data, and location data.
U.S. Environmental Protection Agency		Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)	BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) is a multipurpose environmental analysis system for use by regional, state, and local agencies in performing watershed and water quality based studies. It integrates a geographic information system (GIS), national watershed and meteorological data, and state-of-the-art environmental assessment and modeling tools into one convenient package. Included in the database are water quality monitoring, bacteria monitoring, weather stations, USGS gaging stations, fish consumption advisories, national sediment inventory, shellfish classifications, GIS data, and point source data.
U.S. Environmental Protection Agency		Clean Air Status and Trends Network (CASTNET)	CASTNET, established in 1987, provides atmospheric data on the dry deposition component of total acid deposition, ground-level ozone and other forms of atmospheric pollution. CASTNET is considered the nation's primary source for atmospheric data to estimate dry acidic deposition and to provide data on rural ozone levels. Used in conjunction with other national monitoring networks, CASTNET can help determine the effectiveness of national emission control programs.
U.S. Environmental Protection Agency		Comprehensive Environmental Response, Compensation and Liability Act Information System (CERCLIS)	The system tracks information on all Superfund sites -- both the most hazardous (the National Priorities List) and those where cleanup is easier or less urgent. Data from other Federal agencies' sites (Federal Facilities) are also included.
U.S. Environmental Protection Agency	Great Lakes National Program Office	Contaminated Sediment Monitoring	Sediment monitoring conducted in nearshore areas of the Great Lakes focses on biological and chemical sampling for benthic-bottom soil-contamination. Sampling focused in Areas of Concern (AOCs).
U.S. Environmental Protection Agency		Environmental Monitoring and Assessment Program (EMAP)	Monitoring to estimate current status and trends in selected indicators of ecological health in Great Lakes (pollutants, exotic species, benthos, etc.)
U.S. Environmental Protection Agency		Fish Consumption Advisories	The National Listing of Fish and Wildlife Advisories (NLFWA) database includes all available information describing state, tribal, and federally issued fish consumption advisories in the United States for the 50 States, the District of Columbia, and four U.S. Territories, and in Canada for the 12 provinces and territories. The database contains information provided to EPA by the states, tribes, territories and Canada.
U.S. Environmental Protection Agency		Great Lakes Basin Vegetation Change Analysis	In general, changes in the growth of vegetation in the Great Lakes Region is constrained by biophysical conditions (e.g. geology, temperature, and humidity). Research suggests that such changes in vegetation cover may be a consequence of global-scale climatic change.

Organization	Department	Title	Description
U.S. Environmental Protection Agency	Great Lakes National Program Office	Great Lakes Fish Monitoring Program	Monitoring of fish contaminants for long-term trends and human health implications
U.S. Environmental Protection Agency	Great Lakes National Program Office	Lake Erie Dissolved Oxygen Depletion	The EPA Great Lakes National Program Office (GLNPO) monitors the status of dissolved oxygen in the waters of the Central Basin of Lake Erie at a fixed network of stations several times each summer. These data are then used to assess the timing, extent and severity of reduced oxygen conditions. Over several years, trends in the rate of oxygen depletion over the summer should reflect the impact of management programs to limit both point sources and non-point sources of phosphorus loadings. Ten sampling stations for the dissolved oxygen monitoring program were selected to cover most of the affected area. In most years, each station is visited in early June, late June, mid-July, early August, late August and mid-September. The most severe oxygen depletion is observed in late August and/or mid-September. Vertical profiles of water temperature, dissolved oxygen and other characteristics are obtained from a SeaBird (brand) instrument cluster deployed onsite from the R/V Lake Guardian or other research vessel. Quality Assurance checks are also performed at each station visit using modified Standard Methods for Winkler "wet lab" titrations. At the end of the sampling season, the data are analyzed and summarized, and a "normalized" rate of dissolved oxygen depletion is calculated.
U.S. Environmental Protection Agency	Great Lakes National Program Office	Limnology Program	This summary will present an overview of results for the annual limnology program for the Great Lakes which began in 1983. The limnology program provides information on key environmental factors that influence the food chain and fish of the Great Lakes. The annual monitoring of the Great Lakes began in 1983 for Lakes Michigan, Huron, and Erie; in 1986 in Lake Ontario; and in 1992 for Lake Superior. The sampling strategy is to collect water and biota samples at specific water depths from a limited number of locations in each lake twice every year. Objectives of the annual program are: 1. assess the state of water quality in the open lake basins (water greater than 30 meters in depth, or greater than than 3 miles from shore.) 2. provide data to detect and evaluate trends and annual changes in chloride, nitrate nitrogen, silica, phytoplankton, total phosphorus, chlorophyll a, and secchi disc depth. 3. provide data sufficient to verify or modify water quality models. 4. provide data to calculate the Trophic Index of each lake
U.S. Environmental Protection Agency	Great Lakes National Program Office	Long-Term Open Lakes Monitoring Program	This biannual monitoring program visits all of the Great Lakes, and consists of Spring (April) and Summer (August) sampling of a network of fixed stations in the open waters of the lakes. Nutrients samples for: Total Phosphorus, Total Dissolved Phosphorus, Nitrate & Nitrite, Dissolved Reactive Silica. Other parameters: pH, total alkalinity, specific conductance, turbidity. Sampling began in 1983 in Lakes Erie, Huron and Michigan, in 1986 in Lake Ontario and in 1992 in Lake Superior.
U.S. Environmental Protection Agency		National Air Toxic Trend Site (NATTS)	A National Air Toxic Trend Site (NATTS) network was launched in early 2003.The central goal of the NATTS network is to detect trends in high-risk air toxics such as benzene, formaldehyde, 1,3-butadiene, acrolein, and chromium.

Organization	Department	Title	Description
U.S. Environmental Protection Agency		National Emissions Inventory	EPA's Emission Inventory Group prepares a national database of air emissions information with input from numerous State and local air agencies, from tribes, and from industry. The US EPA prepares a national emissions inventory with input from numerous State and local air agencies. These data are used for air dispersion modeling, regional strategy development, regulation setting, air toxics risk assessment, and tracking trends in emissions over time.
U.S. Environmental Protection Agency		National Sediment Inventory (NSI)	This dataset describes the accumulation of chemical contaminants in river, lake, ocean, and estuary bottoms and includes a screening assessment of the potential for associated adverse effects on human and environmental health.
U.S. Environmental Protection Agency	Great Lakes National Program Office	Open lake benthos surveillance	Benthos species identification
U.S. Environmental Protection Agency	Great Lakes National Program Office	Open lake surveillance - phytoplankton (sub-project of open lake surveillance - water)	To assess the state of plankton communities in the open waters of the Great Lakes, and the benthos communities in offshore and neashore locations.
U.S. Environmental Protection Agency	GLNPO	Open Water Surveillance Program	To monitor trends over time of the phytoplankton, zooplankton, and benthic communities in the offshore waters of the Great Lakes.
U.S. Environmental Protection Agency		Permit Compliance System (PCS)	The Permit Compliance System (PCS) database tracks permit, compliance and enforcement status, to meet the informational needs of the NPDES program under the Clean Water Act. It is a dynamic system that supports the NPDES program at the state, regional and national levels.
U.S. Environmental Protection Agency		Photochemical Assessment Monitoring Stations (PAMS) Network	In accordance with the 1990 Clean Air Act Amendments, EPA has required more extensive monitoring of ozone and its precursors in areas with persistently high ozone levels (mostly large metropolitan areas). In these areas, the States have established ambient air monitoring sites called Photochemical Assessment Monitoring Stations (PAMS) which collect and report detailed data for volatile organic compounds, nitrogen oxides, ozone and meteorological parameters. Analyses of these data are helping the Environmental Protection Agency and the States to better understand the underlying causes of ozone pollution, to devise effective remedies and to measure environmental improvement.The chief objective of the enhanced ozone monitoring revisions is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS.
U.S. Environmental Protection Agency		Resource Conservation and Recovery Act Information	Hazardous waste information is contained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system about hazardous waste handlers. All generators, transporters, treaters, storers, and disposers of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies, in turn pass on the information to regional and national EPA offices.

Organization	Department	Title	Description
U.S. Environmental Protection Agency		Safe Drinking Water Information System (SDWIS)	The Safe Drinking Water Information System (SDWIS) contains information about public water systems and their violations of EPA's drinking water regulations, as reported to EPA by the states. These regulations establish maximum contaminant levels, treatment techniques, and monitoring and reporting requirements to ensure that water systems provide safe water to their customers. This query will help you to find your drinking water supplier and view its violations and enforcement history since 1993.
U.S. Environmental Protection Agency		STORET (Storage and Retrieval)	STORET (storage and retrieval) contains raw biological, chemical, and physical surface and ground water data collected by federal, state and local agencies, Indian Tribes, volunteer groups, academics, and others. STORET contains information on why the data were gathered; sampling location; sampling and analytical methods used; the laboratory used to analyze the samples; the quality control checks used when sampling, handling the samples, and analyzing the data; and the personnel responsible for the data.
U.S. Environmental Protection Agency		Toxic Release Inventory (TRI)	The Toxics Release Inventory (TRI) is a publicly available EPA database that contains information on specific toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities.
U.S. Fish & Wildlife Service	Alpena Fishery Resources Office	Lake Sturgeon Monitoring	Main objectives of the program are to: 1) develop a coordinated, multi-agency effort to assess the current status of lake sturgeon stocks in Lakes Huron, Erie, and the St. Clair System; 2) continue and expand a tagging program to better define relative abundance and seasonal movement of lake sturgeon within the system; 3) conduct a qualitative and quantitative assessment of critical habitat parameters associated with remnant stocks of sturgeon; 4) develop a standardized database for the storage, management, and sharing of biotic and abiotic information important for the development of effective restoration and management plans; and 5) create an information transfer system that will provide valuable information accessible to interested parties, both inside and outside the Great Lakes basin.
U.S. Fish and Wildlife Agency		National Wetland Inventory Maps	The National Wetland Inventory is an on-going program to map and update all wetlands and surface waters in the USA using the Cowardin Classification System.
U.S. Fish and Wildlife Service		Detection and monitoring in Lake Huron	Conduct assessments to detect new ANS populations, and monitor changes in abundance of ANS in Lake Huron
U.S. Fish and Wildlife Service		Detection and monitoring in Lake Michigan	Conduct assessments to detect new ANS populations, and monitor changes in abundance of ANS in Lake Michigan
U.S. Fish and Wildlife Service		Detection and monitoring in Lake Superior	Conduct assessments to detect new ANS populations, and monitor changes in abundance of ANS in Lake Superior
U.S. Fish and Wildlife Service		Detection and monitoring in Lakes Erie and Ontario	Conduct assessments to detect new ANS populations, and monitor changes in abundance of ANS in Lakes Erie and Ontario
U.S. Geological Survey	Great Lakes Science Center; Deepwater Science Program	Annual young of year index, western Lk Erie	Summer and fall summaries of young of year fish populations

Organization	Department	Title	Description
U.S. Geological Survey		Benthic Community Change	55 m and 95 m depth for Benthic community and diporia. Targeting 130 m depth for diporia. Sampling in May, July and October for Zebra Mussels, quagga mussels and anthropods. Targeting Rochester and Olcott basin for sediment type and diporia composition (completed August 2002).
U.S. Geological Survey	Great Lakes Science Center; Freshwater Ecosystems	Benthos for western Lake Erie	Species diversity of benthic organisms in western Lake Erie
U.S. Geological Survey	Patuxent Wildlife Research Center	Bird Point Count Database	The Partners in Flight (PIF) bird conservation initiative has organized a number of point count surveys to obtain information on the status and trends of songbird populations.
U.S. Geological Survey		Bottom Trawl Indices	1984—biomonitoring and TP at 4 stations; 1994 – 1995 – look at changes in sculpin and seasonality; 1992 – 1995 9 index stations per year for benthic sampling; 1999 and 2002 – look at food habits in fish; Fall 2002 – fish stomach contents to look at mysid densities – stations are to coincide with Ora's Fall 2002 sampling of mysids.; Also looking at sea lamprey woundings. Look at adult lake trout once per year.
U.S. Geological Survey	Great Lakes Science Center, Deepwater Science Program	Distribution, abundance, and biology of fish populations - Lake Ontario	Assess abundance and describe population biology of Lake Ontario fishes
U.S. Geological Survey	Biological Resources Division	Effects of double-crested cormorant predation on Fish populations in Lake Ontario and St. Lawrence River	Examines diet composition, fish consumption and potential impacts on native species (ie: smallmouth bass, yellow perch) on the lower Great Lakes largest cormorant nesting colony on Little Galloo Island.
U.S. Geological Survey	Great Lakes Science Center, Deepwater Science Program	Evaluate progress and identify impediments toward restoring lake trout populations in Lake Ontario	Assess abundance and describe population biology of lake trout
U.S. Geological Survey	Biological Resources Division	Expansion of invading mussel assemblages on soft substrates	To investigate the recent expansion of Dreissena populations into the soft substrate habitats of Lake Erie; to interpret the relative fitness (recruitment, growth, and survival) and population characteristics (density, size frequency) of Driessena assemblages on hard and soft substrates.
U.S. Geological Survey	Great Lakes Science Center; Deepwater Science Program	Fish Community Assessment	To perform annual assessments of the benthic and pelagic fish communities in the Great Lakes

Organization	Department	Title	Description
U.S. Geological Survey	Biological Resources Division	Gap Analysis Program	The mission of the Gap Analysis Program (GAP) is to provide regional assessments of the conservation status of native vertebrate species and natural land cover types and to facilitate the application of this information to land management activities. This is accomplished through the following five objectives: map the land cover of the United States; map predicted distributions of vertebrate species for the U.S.; document the representation of vertebrate species and land cover types in areas managed for the long-term maintenance of biodiversity; provide this information to the public and those entities charged with land use research, policy, planning, and management, and; build institutional cooperation in the application of this information to state and regional management activities.
U.S. Geological Survey		Geographic Analysis and Monitoring Program (GAM)	To establish a baseline of land surface change throught the United States.
U.S. Geological Survey		Ground Water Climate Response Network	The USGS maintains a network of wells to monitor the effects of droughts and other climate variability on ground-water levels. The network consists of a national network of about 150 wells monitored as part of the Ground Water Resources Program, supplemented by wells in some States monitored as part of the Cooperative Water Program.
U.S. Geological Survey	Biological Resources Division	Habitat use and movements of staging American black ducks and mallards in Ohio	Complements earlier study (1990-93); for black duck conservation on local, regional and flyway levels
U.S. Geological Survey	Great Lakes Science Center; Deepwater Science Program	Interagency accoustic forage assessment, central Lk Erie	Assessment of forage fish using hydro-acoustics
U.S. Geological Survey	Great Lakes Science Center; Deepwater Science Program	Lake Trout Restoration in eastern Lake Erie	Rehabilitation of lake trout populations. Population dynamics of lake trout. Populations are surveyed with regard to spawning stock density/presence of age-0 fish/genetic strain eval.
U.S. Geological Survey	Great Lakes Science Center; Deepwater Science Program	Lake Trout Restoration in Lakes Mich/Huron	Rehabilitation of lake trout populations. Population dynamics of lake trout. Populations are surveyed with regard to spawning stock density/presence of age-0 fish/genetic strain eval.
U.S. Geological Survey	Great Lakes Science Center; Coastal Wetlands	Metzgar Marsh Wetland Restoration	Restoration of coastal wetlands along Lake Erie
U.S. Geological Survey	Snake River Field Station	Mid-winter eagle survey	To obtain information on the distribution, status, and trends of wintering eagle populations on the continent.
U.S. Geological Survey		National Contaminant Biomonitoring Program Database	Monitoring to document trends in occurrence of persistent toxic chemicals in fisheries.

Organization	Department	Title	Description
U.S. Geological Survey		National Land Cover Characterization Project	The Land Cover Characterization Program (LCCP) was started in 1995 to address National and International requirements for land cover data that were becoming increasingly sophisticated and diverse. The goal of the land cover program is to be a national and international center for excellence in land cover characterization. To accomplish that goal, the program: Develops state-of-the-art multiscale land cover characteristics data bases used by scientists, resource managers, planners, and educators. (Global Land Cover & National Land Cover); Contributes to the understanding of the patterns, characteristics, and dynamics of land cover across the Nation and the Earth.(Urban Dynamics & Land Cover Trends); Pursues research that improves the utility and efficiency of large-area land cover characterization and land cover characteristics databases; Serves as a central facility for access to, or information about, land cover data.(Land Cover Applications Center)
U.S. Geological Survey		National Water Information System (gaging stations)	The USGS investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters and disseminates the data to the public, State and local governments, public and private utilities, and other Federal agencies involved with managing our water resources. Online access to this data inlcudes the following categories: real-time, site information, surface water, ground water, and water quality.
U.S. Geological Survey		National Water Use Information	The USGS maintains national digital databases (1985 & 1990) of water use information compiled from State site-specific data, as well as water-use maps and graphcs. The data are collected and compiled every five years for each State.
U.S. Geological Survey	National Water Quality Assessment Program	National Water-Quality Assessment (NAWQA) Program	The U. S. Geological Survey implemented the National Water-Quality Assessment (NAWQA) Program to support national, regional, and local information needs and decisions related to surface and ground water-quality management and policy. By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues and priorities. Sampling includes general water chemistry, pesticides, contaminants in bed sediments, and contaminants in fish and benthic invertebrates.
U.S. Geological Survey	Tunison	Nearshore Lake Ontario Ecosystem Study Plan	Trawling -- uses fish and benthos as indicators Sediment, water chemistry and in-situ conditions (pH, temperature)
U.S. Geological Survey	Patuxent Wildlife Research Center	North American Breeding Bird Survey (BBS)	To monitor the status and trends of bird populations across the U.S. and Canada. The survey is based on randomly selected raodside routes that are surveyed once annually during the breeding season. The counts obtained along BBS routes are used as indicies of population change.
U.S. Geological Survey	Great Lakes Science Center	Patterns in population dynamics of Hexagenia	Sampling mayfly nymphs

Organization	Department	Title	Description
U.S. Geological Survey	Great Lakes Science Center; Freshwater Ecosystems	Status and Trends of wild celery tubers in the Detroit River	Assess abundance of wild celery per square meter
U.S. Geological Survey		The National Map	The National Map provides public access to high-quality, geospatial data and information from multiple partners to help support decisionmaking by resource managers and the public.
U.S. Geological Survey	Network Operations Section	Water Quality Sampling in Cooperation with State of Michigan (2001 - present)	Water quality information is collected at 30 stream locations and 200 lakes around the state. Data has been collected since 2001. A website is being developed to distribute the data.
U.S. Geological Survey	Patuxent Wildlife Research Center	Waterbird Monitoring Partnership	This database serves as a clearinghouse for data obtained from surveys of breeding colonial waterbirds across the U.S. and Canada. These surveys are used to establish the status and trends of continental colonial waterbird populations
U.S. Geological Survey		Waterwatch	Current water resources conditions
U.S. Geological Survey	Water Resources Discipline	Western Lake Michigan Drainages NAWQA Study Unit	Water quality monitoring.
U.S. Geological Survey Great Lakes Science Center		Status and Trends of Prey Fish Populations in Lake Michigan	To survey and assess prey fish populations in Lake Michigan, and then use the survey findings to improve our understanding of the Lake Michigan ecosystem and to better manage the Lake Michigan fisheries.
U.S. Geological Survey Great Lakes Science Center		Status of Pelagic Prey Fish in Lake Michigan	Status of Pelagic Prey Fish in Lake Michigan is a cooperative program between the USGS and the four states that utilizes acoustics to provide a lakewide assessment of the prey population.
U.S. Geological Survey/National Park Service		Vegetation Mapping Program	The USGS-NPS Vegetation Mapping Program is a cooperative effort by the U.S. Geological Survey (USGS) and the National Park Service (NPS) to classify, describe, and map vegetation communities in more than 270 national park units across the United States.
United States Army Corps of Engineers, Detroit District	Great Lakes Hydraulics & Hydrology Office	Hydraulic Discharge Measurements	The U.S. Geological Survey Detroit District collects river velocity, magnitude and direction in the St. Clair and Detroit Rivers on a recurring basis. This information is used to verify the inflow and outflow for Lake St. Clair, to provide information for net basin supplies and water level forecasting, and for monitoring of flood and ice conditions.
United States Army Corps of Engineers, Detroit District	Environmental Analysis Branch	Operations and Maintenance of Federal Navigation Channels	Maintain project depths and monitor sediment quality.
U.S. State			

Organization	Department	Title	Description
Coastal Zone Management	Dept of Environmental Protection	Bluff Recession Monitoring	Pennsylvania's Bluff Recession Monitoring Program - The Department of Environmental Protection (Coastal Zone Management Program) currently monitors 130 established control points along Pennsylvania's Lake Erie shoreline. These control points are used to determine annual rates of bluff recession, identify Bluff Recession Hazard Areas (BRHA), and determine minimum setbacks in the eight municipalities with identified BRHA's. For the most part these control points are fixed monuments (steel pins) in the ground or somewhat permanent points such as existing utility poles or corners of houses or outbuildings, from which direct measurements to the bluff crest are made. The control points are located approximately every one half kilometer along the bluff crest from the Ohio to the New York borders. These control points are geographically fixed using Global Positioning System (GPS) technology. Using the GPS, field staff navigate to the control points and direct measurements are taken from the control points to the bluff crest using compass direction and survey tapes.
Hoosier Riverwatch	IN Department of Natural Resources	Hoosier Riverwatch	We are statewide volunteer stream/river monitoring program for schools, citizens, watershed groups, and governmental agencies.
IL DNR	Restoration Ecology	Restoration Ecology	Restoration Ecology is not a specific monitoring project, but an office of ecologists performing a multitude of monitoring projects to determine condition state managed resources. I am listing general monitoring that is being done by Restoration Ecologists in NE IL, Lake, Cook counties. These are mostly in data collection stages.
IL Water Resources Center		Assessment of Electric Fish Barrier	To improve an electric fish barrier that is located in the Chicago Sanitary & Ship Canal at Romeoville.
Illinois Department of Natural Resources	Illinois Natural History Survey	Critical Trends Assessment Program	The Critical Trends Assessment Program (CTAP) is a long-term endeavor, which monitors the condition of forests, wetlands, grasslands, and streams throughout the state of Illinois. This project seeks to assess changes in ecological conditions as well as to serve as a baseline from which to compare regional and site-specific patterns throughout Illinois.
Illinois Department of Natural Resources	Office of Realty and Environmental Planning	EcoWatch Network	Through EcoWatch Network programs volunteers are trained to monitor the biodiversity of Illinois ecosystems. Data collected by Citizen Scientists are used to comprehensively assess Illinois' environment. Data quality is a cornerstone of the EcoWatch programs. Since 1994, when the first EcoWatch program was being designed, quality assurance (QA) has been a crucial part of the program. The EW program has placed a series of standardized checks and balances along the entire data collection, data entry and data analysis process, which helps the program meet stated data quality objectives. EcoWatch is a part of a much larger data gathering framework of the Critical Trends Assessment Program (CTAP). CTAP combines compatible citizen scientist and professional scientist monitoring data to establish a statistically valid sample of major natural ecosystems within Illinois. CTAP assesses both condition and extent of natural resources. These assessments establish baseline conditions against which future changes in ecological conditions can be measured. They also provide enhanced opportunities for ecosystem, habitat or species-specific research.

Organization	Department	Title	Description
Illinois Department of Natural Resources	Lake Michigan Program	Fall Harbor Salmonid Assessment	Monitor abundance and population parameters of salmonids in fall sampled by electrofishing.
Illinois Department of Natural Resources	Lake Michigan Program	Fall/Spawning Lake Trout Assessment	Monitor abundance of spawning lake trout at one stocked and two non-stocked sites. Assess homing of stocked fish to stocking locations, effectiveness of different strains of lake trout, and monitor population parameters (e.g., age composition and sex ratio).
Illinois Department of Natural Resources		Illinois Natural Heritage Database	The Division maintains a Natural Heritage Database that tracks the location and status of undisturbed natural communities and endangered species habitats. This computer-assisted system includes data from the statewide Illinois Natural Areas Inventory and endangered species information generated by field surveys and other discoveries. This information is used to guide public land acquisition and other preservation efforts. It also aids site and species protection through the review of publicly regulated projects and helps determine the status of potential endangered species. The Division identifies lands for protection with funds the Department receives from the Illinois Real Estate Transfer tax, a tax on land transfers that often result in development and habitat loss.
Illinois Department of Natural Resources	Lake Michigan Program	Lakewide Assessment Plan	Monitor abundance and population parameters of predators sampled with gill nets.
Illinois Department of Natural Resources	Illinois Nature Preserves Commission	Nature Preserve Directory	Directory of nature preserves in Illinois organized by county
Illinois Department of Natural Resources	Lake Michigan Program	Spring Index Assessment	Monitor abundance and age composition of all species sampled with gill nets set at depths of 3m to 45m. Sampling alternates between Chicago and Waukegan.
Illinois Department of Natural Resources	Lake Michigan Program	Summer Harbor Non-Salmonid Assessment	Monitor abundance and population parameters of non-salmonid, game fish species in summer sampled by electrofishing.
Illinois Department of Natural Resources	Lake Michigan Program	Yellow Perch Assessment	Monitor abundance and population parameters of yellow perch sampled with gill nets.
Illinois Department of Natural Resources	Lake Michigan Program	YOY Yellow Perch Assessment	Monitor abundance and population parameters of juvenile (YOY) yellow perch sampled by seining.
Illinois Department of Public Health	Division of Environmental Health	Beach Monitoring	To prevent illnesses associated with swimming at Illinois beaches, each licensed beach is inspected annually to determine that required safety features are in place and there are no sources of possible pollution such as sewage discharges. These inspections are done either by the Illinois Department of Public Health or a local health department, or, in Chicago, by the Chicago Park District. The Department also requires that each of the 335 licensed public beaches be sampled every two weeks to determine that bacterial levels in the water are within limits established in the Swimming Pool and Bathing Beach Code (77 Ill. Admin. Code 820). The maximum E. coli level allowed – 235 colony-forming units per 100 milliliters (cfu/100mL) – is based on guidelines established by the U.S. Environmental Protection Agency for recreational waters.
Illinois Environmental Protection Agency	Bureau of Air	Air Monitoring	Air monitoring throughout Illinois.

Organization	Department	Title	Description
Illinois Environmental Protection Agency	Surface Water Section	Ambient Lake Monitoring Program (ALMP)	The chemical, physical, and biological quality of selected Illinois lakes and reservoirs are assessed statewide through this annual program conducted by the Illinois EPA. Objectives of the Ambient Lake Monitoring Program (ALMP) are: provide baseline information for the restoration and protection of Illinois lakes; determine long-term trends in Illinois lakes; identify areas with significant water quality problems that need further investigations or remediation; assess the level of attainment of designated use support categories in Illinois lakes and the causes and sources of any impairment for reporting required under sections 305(b) and 303(d) of the Clean Water Act; determine the presence of toxic materials in fish, water, and sediments and the sources of any contaminants; communicate assessment results and recommendations for water resource managers to provide support and direction to water programs.
Illinois Environmental Protection Agency	Surface Water Section	Ambient Water Quality Monitoring Network (AWQMN)	The goals of the Illinois EPA surface water monitoring programs are to identify causes of pollution (toxics, nutrients, sedimentation) and sources (point or nonpoint) of surface water impairments, determine the overall effectiveness of pollution control programs and identify long term resource quality trends. The AWQMN is utilized by the Illinois EPA to provide baseline water quality information, to characterize and define trends in the physical, chemical and biological conditions of the state's waters, identify new or existing water quality problems and to act as a triggering mechanism for special studies or other appropriate actions. Additional uses of the data collected by the Illinois EPA through the AWQMN program include the review of existing water quality standards and establishment of water quality based effluent limits for NPDES permits. The AWQMN is integrated with other Illinois EPA chemical and biological stream monitoring programs which are more regionally based and cover shorter span of time to evaluate compliance with water quality standards and determine designated use support.
Illinois Environmental Protection Agency	Surface Water Section	Facility-Related Stream Surveys	The Facility-Related Stream Survey (FRSS) Program provides stream quality assessment information for wadeable streams that receive point source discharge. These surveys are conducted primarily to evaluate water quality impacts from municipal wastewater treatment facilities, determine the need for additional wastewater treatment controls, or document stream quality improvements following the upgrading or construction of a new treatment facility.
Illinois Environmental Protection Agency	Toxicity Assessment Unit	Fish Contaminant Monitoring	The objectives of the Illinois Fish Contaminant Monitoring Program are to: investigate and detect the presence and build-up of toxic and potentially hazardous substances in fish, encompassing both fish toxicity and public health implications; determine the impact of fish contaminants upon the suitability of aquatic environments for supporting abundant, useful, and diverse communities of fish in streams and impoundments of Illinois; aid in the location of toxic material discharges and evaluate long-term effects of source controls and land use changes.

Organization	Department	Title	Description
Illinois Environmental Protection Agency	Ground Water Section	Groundwater	The Illinois EPA operates an Ambient Network or Community Water Supply Wells (CWS Network) as well as a Rotating Monitoring Network. The CWS Network is designed to provide an overview of the groundwater conditions in the CWS Wells in Illinois; provide an overview of the groundwater conditions in the major aquifers in Illinois; establish baselines of water quality within the major aquifers in Illinois; identify trends in groundwater quality in the major aquifers in Illinois; and evaluate the long-term effectiveness of Clean Water and Safe Drinking Water Act program activities in protecting groundwater in Illinois. The Illinois EPA has operated a Pesticide Monitoring Subnetwork of the CWS Network since 1993. The Illinois EPA selects 50 percent of the CWS Network wells for analysis for synthetic organic chemicals (SOCs) using standard laboratory test methods. The purpose of the Rotating Monitoring Network is to maximize resources and increase groundwater quality monitoring coverage at CWS wells.
Illinois Environmental Protection Agency	Surface Water Section	Illinois Clean Lakes Program (ICLP)	The chemical, physical and biological quality of selected Illinois lakes and reservoirs are assessed statewide by this annual program conducted by the Illinois EPA. Objectives of the Illinois Clean Lakes Program (ICLP) are: provide baseline information for the restoration and protection of Illinois lakes; diagnose current lake water quality problems; assess the level of attainment of designated use support categories in Illinois lakes and the cause(s) and source(s) of any impairment; determine the presence of toxic materials in fish, water and sediments and the sources of any contaminants; provide a basis for identifying alternative solutions to the current water quality problems; evaluate the progress and success of lake protection/restoration projects; judge effectiveness of applied protection/management measures and determine applicability/transferability to other lakes; communicate assessment results and recommendations for water resource managers to provide support and direction to water programs.
Illinois Environmental Protection Agency	Division of Water Pollution Control-Lakes Unit	Illinois Volunteer Lake Monitoring Program	The VLMP serves as an educational program for citizens to learn about lake ecosystems, as well as a cost-effective method of gathering fundamental information on Illinois inland lakes. The VLMP utilizes funds provided by the federal Clean Water Act and the state-funded Conservation 2000 Program to achieve the following objectives: Increase citizen knowledge and awareness of the factors that affect lake quality so they can understand the lake/watershed/ecosystem and make informed decisions; Encourage development and implementation of sound lake protection and management plans; Develop local grass roots support for environmental programs and foster cooperation among citizens, organizations and various units of government; Provide historic data to help document water quality impacts and support lake management decision-making; and Provide a guide for the implementation of lake protection/restoration and a framework for technical assistance for cooperative lake and watershed management projects.

Organization	Department	Title	Description
Illinois Environmental Protection Agency	Surface Water Section	Intensive Basin Surveys	The chemical, physical and biological quality of selected Illinois streams are assessed statewide by an annual stream monitoring program conducted by the Illinois Environmental Protection Agency and the Illinois Department of Natural Resources. As the Intensive Basin Survey Program (INTB) is a cooperative interagency monitoring program, it is designed to meet the needs of both agencies. Major Illinois EPA and IDNR basin survey objectives include the following: assess the level of attainment of designated use support categories in the Illinois streams and the cause and source of impairments for reporting required under Section 305(b) of the Clean Water Act; assess the success of Agency water pollution control programs to achieve CWA healthy biological community, safe fish, swimming and drinking water goals; determine the presence of contaminants in fish tissue to facilitate the development of fish consumption advisories for applicable Illinois streams; facilitate planning and prudent allocation of limited state resources in the monitoring and evaluation of all significant interior Illinois river systems; determine the potential for sport fishing opportunities and fisheries management, assess the status of Illinois lotic resources, identify where those resources exist, and determine the need for legislation for their protection; establish an aquatic resource database for agencies with regulatory authority and responsibility for environmental management and focus greater emphasis on the importance of Illinois aquatic resources via Biological Stream Characterization (BSC) system activities.
Illinois Environmental Protection Agency	Bureau of Water, Surface Water Section	Lake Michigan Monitoring Program	1. Lake Michigan water quality monitoring is required by Illinois statute. 2. Meet mandate of Clean Water Act Section 305(b).
Illinois Environmental Protection Agency	Field Operations Section	Point Source Monitoring	The Illinois EPA's point source program provides inspections and monitoring of NPDES discharges and other wastewater sources (e.g., livestock and storm water sources) to verify compliance with applicable permit limits and water pollution control laws and regulations.
Illinois Environmental Protection Agency	Field Operations Section	Whole Effluent Biomonitoring	A whole effluent biomonitoring program conducted by the Illinois EPA assesses the biological quality of NPDES permitted effluents statewide. Major objectives include the following: conduct whole effluent toxicity tests (bioassays) on representative aquatic organisms in a variety of wastewater effluents from municipal and industrial sources for purposes of determining which facilities require permit limitations or monitoring conditions; assess the success of wastewater treatment processes to remove toxic components and thereby meet the directives of whole effluent toxicity-based water quality standards at 35 IAC 302 subparts B and F; determine the relative toxicity of these effluents using common end points; determine the relative toxicity of these effluents using common end points, determine the nature of receiving waters upstream of effluent discharges regarding toxicity to test organisms.
Illinois Natural History Survey	Lake Michigan Biological Station	Fish, Zooplankton, Benthic Invertebrates - Nearshore Lake Michigan	

Organization	Department	Title	Description
Illinois State Water Survey	Southern Regional Office	Benchmark Sediment Monitoring Program	The Water Survey initiated a Benchmark Sediment Monitoring Program in 1981 to develop a long-term database of suspended sediment transport. A long-term database such as this can be used to: determine long-term trends in sediment transport in Illinois; estimate sediment loads for unmonitored streams; evaluate the effectiveness of watershed management programs; and identify watersheds with high soil erosion and sediment delivery rates.
Illinois State Water Survey	Water and Atmospheric Resources Monitoring Program	Illinois Climate Network Data	The Illinois Climate Network is a 19-station array of automated weather sites across Illinois. The network provides hourly and daily weather data.
Indiana Department of Environmental Management	Office of Air Quality - Air Monitoring Branch	Ambient Air Monitoring	Collection of ambient air quality data throughout Indiana.
Indiana Department of Environmental Management	Disease Control Laboratories	Indiana Beach Monitoring	Bathing beach monitoring for microbiological contaminants.
Indiana Department of Environmental Management		Public Water Supply Information	The primary goal of Indiana's regulatory program for public water systems is to assure citizens that they are provided with adequate and safe supplies of high quality drinking water.
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section	Fish Tissue Contaminants Monitoring Program	Fish tissue contaminants monitoring to support issuance of fish consumption advisories, monitor for trends, support information on effects to wildlife
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section	Sediment Contaminants Monitoring Program	Surficial aquatic sediment contaminants monitoring to locate areas of contamination, monitor for trends, support information on effects to wildlife, support the National Sediment contaminants inventory.
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section		To conduct biological community assessments of Indiana's rivers and streams through collection, study, and assessment of macroinvertebrate communities.
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section		To conduct physical, chemical, and biological assessments of Indiana's rivers and streams through the collection of concurrent data sets to identify environmental stressors on biological communities.
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section		To sample a statistically valid number of randomly selected sites to assess and characterize the overall water quality and biological integrity of the state.
Indiana Department of Environmental Management, Office of Water Management	Assessment Branch, Biological Studies Section		To Provide basic information to reveal water quality trends and provide data for existing and prospective users of Indiana Surface Water.
Indiana Department of Natural Resources	Division of Fish and Wildlife	Fall/Spawning assessment for Lake Trout	Includes invasive speceis detection.
Indiana Department of Natural Resources	Division of Soil Conservation	Lake and River Enhancement Program	Monitoring is incidental to various program elements, but is integral to certain elements such as lake diagnostic studies.

Organization	Department	Title	Description
Indiana Department of Natural Resources	Division of Nature Preserves	Nature Preserves	protection and management of state significant natural areas
Indiana Department of Natural Resources	Division of Fish and Wildlife	Snakehead suveillance	Snakehead suveillance in conjuction with GLMPO contaminant program.
Indiana Department of Natural Resources	Division of Fish and Wildlife	Spring Lakewide Assessment	Includes invasive speceis detection.
Indiana Department of Natural Resources	Division of Fish and Wildlife	Tributary Monitoring	Species diversity and habitat changes. Includes invasive speceis detection.
Indiana Department of Natural Resources	Division of Fish and Wildlife	Yellow Perch Assessment	Yellow Perch assessment includes abundance of other non-target species (goby, alewife, shiner, and darter). Includes invasive speceis detection.
Indiana Dept. of Natural Resources	Indiana Natural Heritage Data Center	Natural Heritage Network	The Indiana Natural Heritage Data Center, set up in 1978, represents a comprehensive attempt to determine the state's most significant natural areas through an intensive statewide inventory. The Indiana Natural Heritage Data Center is part of the Natural Heritage Network, a worldwide system of Heritage Programs. This program is designed to provide information about Indiana's diversity of natural ecosystems, species, landscape features, and outdoor amenities, and to assure adequate methods for evaluating this information and setting sound land protection priorities. The inventory is a continuous process, becoming an increasingly valuable tool for decision makers and scientists as it progresses.
Indiana Geological Survey	Indiana University	GIS Atlas for Indiana	This online atlas allows you to construct custom maps with layers showing information about coal, environment/biology, geology, hydrology, and infrastructure/demographics. New layers will be added each month through April 2004. The information available in two previously built online GIS atlases for specific regions of Indiana (see below) eventually will be incorporated into the statewide atlas.
Indiana Geological Survey	Indiana University	Lake Rim GIS	Personnel of the Center for Geospatial Data Analysis at the Indiana Geological Survey (IGS) and Indiana University (IU) were contracted to (1) compile data pertaining to land-use and environmental conditions, (2) assemble graphical, statistical, and numeric information, as it becomes available, (3) construct a GIS to facilitate rapid retrieval and efficient analysis of this information, (4) make the GIS available in an accessible format to the widest possible audience, and (5) post the results of ongoing bacterial monitoring within the region.
Michigan Department of Agriculture	Environmental Stewardship Division	Groundwater levels of in-use Pesticides - Michigan	Collecting WQ info on rural wells where certain pesticides have been used. Also, trying to collect info on a baseline level of WQ statewide. Scan for 52 pesticides, partial chemical, & volatile organic chemicals
Michigan Department of Environmental Quality	Air Quality Division	Air Quality Index Reporting	
Michigan Department of Environmental Quality	Air Quality Division	Air Toxics Monitoring Network	

Organization	Department	Title	Description
Michigan Department of Environmental Quality	Air Quality Division	Ambient Air Monitoring	To demonstrate the attainment status with regard to National Ambient Air Quality Standards.
Michigan Department of Environmental Quality	Water Division	Beach Monitoring	Grants awarded to county health departments to monitor beaches. DEQ developed a database of county collected beach monitoring information. The web site contains information about Michigan public beaches and recreational-use waterways, including beach closings.
Michigan Department of Environmental Quality	Water Division	Cooperative Lakes Monitoring Program (CLMP)	The CLMP is a citizen's volunteer lakes monitoring program designed to obtain baseline data on lake productivity indicators for Michigan's inland lakes.
Michigan Department of Environmental Quality		Drinking Water Contamination Investigation Program	Conducts drinking water testing in areas with known or suspected environmental contamination.
Michigan Department of Environmental Quality	Water Division	Fish Contaminant Monitoring Program	The principal objectives of Michigan's Fish Contaminant Monitoring Program are to evaluate the need for sportfish consumption advisories and commercial fishing regulations; identify spatial and temporal trends, and; evaluate the effectiveness of existing programs.
Michigan Department of Environmental Quality	Water Division	Lake Quality Assessment Project	This purpose of this project is to assess water quality and trophic conditions in randomly selected lakes consistent with the DEQ's 5-year rotating basin cycle.
Michigan Department of Environmental Quality	Water Division	Michigan Sediment Remediation	To identify hot spots requiring sediment remediation
Michigan Department of Environmental Quality		Michigan Source Water Assessment Program	Identify the areas that supply public drinking water; inventory contaminants and assess water susceptibility to contamination; inform the public of the results.
Michigan Department of Environmental Quality	Water Division	Michigan Water Quality Standards	developing standards for protection of water quality in Michigan, monitor water; sediments and aquatic life to ensure standards are being met.
Michigan Department of Environmental Quality	Water Division	Michigan Wildlife Contaminant Monitoring	To measure spatial and temporal trends in bioaccumulative contaminant levels in bald eagles and herring gull eggs.
Michigan Department of Environmental Quality	Nonpoint Source Unit	Nonpoint source effectiveness monitoring	DEQ conducts and sponsors monitoring of the nonpoint source projects it funds; BMP effectiveness, social monitoring, etc.; both for specific projects and on a statewide basis. Survey designs and parameters measured vary widely.
Michigan Department of Environmental Quality		Public Drinking Water Chemical Data Base	
Michigan Department of Environmental Quality	Water Division	River and Stream Volunteer Monitoring	This program provides grants, training, and technical assistance to volunteer organizations for monitoring water quality in selected watersheds. Monitoring primarily includes benthic invertebrate community structure and assessment of stream habitat.
Michigan Department of Environmental Quality		Round Goby Monitoring	
Michigan Department of Environmental Quality		Ruffe Monitoring	
Michigan Department of Environmental Quality	Water Division	Sediment Contaminant Monitoring in Inland Lakes	To measure spatial and temporal trends in contaminant levels in inland lake sediments

Organization	Department	Title	Description
Michigan Department of Environmental Quality	Geological and Land Management Division	Stream Flow	Funds are provided to the U.S. Geological Survey to establish and maintain gages to measure stream/river flow.
Michigan Department of Environmental Quality	Water Division	Water Chemistry Monitoring Project	The purpose of the Water Chemistry Monitoring Project (WCMP) is to assess temporal and spatial trends in surface water contaminant levels; assess the current status and condition of individual waters of the state and determine whether Michigan Water Quality
Michigan Department of Environmental Quality	Water Division	Water Quality Monitoring	to determine whether waterbodies are attaining water quality standards and meeting designated uses
Michigan Department of Environmental Quality Protection Division	Water Division	Source Water Assessment Program	Identifying where the source water comes from that supplies public water to 16 municipal water treatment plants in southeast Michigan using a two dimensional, transient flow model of the St. Clair-Detroit River waterway
Michigan Department of Information Technology	Center for Geographic Information	Geographic Data Library	The Geographic Data Library catalogs the available GIS data that the State of Michigan provides for Internet access. Access to data within the Library is based upon geographic extent and theme type.
Michigan Department of Natural Resources	Fisheries Division	Assessment of Lake Huron lake trout	Purposes of this program include the follows: (1) to conduct a fishery independent survey using gill net; (2) Monitor sea lamprey wounding rate and estimate sea lamprey induced mortality; (3) Monitor lake trout growth, maturity, and reproduction; (4) estimate lake trout abundance and mortalities; (5) Monitor lake trout movement pattern in Lake Huron; (6)monitor lake trout diet and estimate prey consumption of lake trout.
Michigan Department of Natural Resources	Fisheries Division, Marquette Fisheries Research Station	Assessment of Lake Trout Populations in Michigan Waters of Lake Superior	To annually determine; relative abundance, length and age composition, sex and maturity, sea lamprey wounding, growth, and mortality for lean and siscowet lake trout in nearshore waters. To periodically determine relative abundance, diet and above listed biological parameter for offshore populations
Michigan Department of Natural Resources		Assessment of the Fish Community of Lake St. Clair	The objectives of this study are (1) to measure the abundance of yellow perch, juvenile gamefish, and various forage species in Lake St. Clair, (2) to monitor abundance of adult gamefish species, (3) to document the abundance and distribution of aquatic plants in Lake St. Clair with sidescan sonar and hydroacoustic technology, and (4) to monitor trends in sport fish catch rates for the Lake St. Clair fishery.
Michigan Department of Natural Resources	Fisheries Division - Management	Fish Surveys	This program surveys fish populations in lakes and streams in the Lake St. Clair watershed. Surveys evaluate population abundance, species diversity, and fisheries management programs.
Michigan Department of Natural Resources	Fisheries Division	Lake Michigan fish population	Great Lakes/Lake Michigan fish population and fisheries assessments
Michigan Department of Natural Resources		Lake Sturgeon Assessment in Lake St. Clair and St. Clair River	Determine population parameters, spawning locations, movements of lake sturgeon in the St. Clair System.
Michigan Department of Natural Resources	Alpena Fisheries Research Station	Les Cheneaux Islands Fish Community Assessment	To monitor status and trends in the fish community in the Les Cheneaux Islands vicinity of northern Lake Huron with special emphasis on yellow perch.

Organization	Department	Title	Description
Michigan Department of Natural Resources	Wildlife Division	Michigan Frog and Toad Survey	Monitor long-term abundance and distribution of populations.
Michigan Department of Natural Resources	Wildlife Management	Pheasant Monitoring	Monitoring to estimate population trends and fall hunting success
Michigan Department of Natural Resources	Wildlife Management	Quail Monitoring	Monitoring to estimate population trends and fall hunting success
Michigan Department of Natural Resources	Wildlife Management	Ruffed Grouse Monitoring	Monitoring to estimate population trends and fall hunting success
Michigan Department of Natural Resources	Alpena Fisheries Research Station	Saginaw Bay Fish Community Survey	To assess the status and trends of the fish community with special emphasis on yellow perch and walleye. The database maintains a gillnet data series that dates back to 1989 and a trawling data series that dates back to 1972. The study provides critical information and statistics to describe the dynamics of the various fish populations and is also used to monitor the effects of invasive species.
Michigan Department of Natural Resources	Alpena Fisheries Research Station	St. Marys River Fish Community Assessment	To monitor status and trends of the fish populations in the St. Marys River.
Michigan Department of Natural Resources		Status and Trends in Aquatic Resources Michigan	The Status and Trends Program is a statewide inventory effort designed to provide information to address local and regional management issues on inland waters. The program was designed by the Resource Inventory Planning Committee (Hayes et al. 2003) and was implemented in 2002. The major components of the program involve standardization of sampling gear, statistical basis for site selection, and an expansion of traditional game fish surveys to include things such as habitat, water quality, and non-game fish. The lakes portion of the program is coordinated by staff at the Institute for Fisheries Research, and the streams portion is coordinated by staff at the Hunt Creek Fisheries Research Station. Numerous parameters will be collected covering aquatic populations, habitat, and people using the resource.
Michigan Department of Natural Resources	Alpena Fisheries Research Station	Vital Statistics of Walleye in Saginaw Bay	This is a tagging study of walleye in Saginaw Bay that provides improved estimates of total annual mortality and survival, exploitation rate, and information on movement.
Michigan Department of Natural Resources	Wildlife Division	White-tailed Deer Monitoring	Monitoring to assess population trends and yearly recruitment to set harvest limits and predict hunting success
Michigan Department of Natural Resources	Wildlife Management	Wild Turkey Monitoring	Monitoring to estimate population trends and fall hunting success
Michigan Department of Natural Resources		Wildlife Surveys	wildlife surveys or indexes, including migratory waterfowl and others
Michigan Department of Natural Resources			Assessment of Lake Michigan fish populations with an emphasis on trout, salmon, whitefish, and yellow perch. Assessment of angler use and harvest.

Organization	Department	Title	Description
Michigan Natural Features Inventory		Michigan Natural Features Inventory (MNFI)	Michigan Natural Features Inventory (MNFI) maintains a continuously updated information base, the only comprehensive, single source of data on Michigan's endangered, threatened, or special concern plant and animal species, natural communities, and other natural features. MNFI has responsibility for inventorying and tracking the State's rarest species and exceptional examples of natural communities. MNFI also provides information to land managers for many types of permit applications regarding these elements of diversity.
Minnesota Climatology Working Group	Water	Minnesota Climate Monitor	This service offers information resources which allow users to monitor the present status of climate conditions found across Minnesota. Included are current climate data, precipitation, temperature, soil temperature, pan evaporation, ski/snowmobile trail reports, snow depth, heating and cooling degree days.
Minnesota Department of Health	Radiation Control	Environmental Radiation Monitoring	Environmental radiation monitoring is the systematic collection and analysis of certain environmental media, such as air, milk, and water, to determine the level of radioactivity present. Levels of radioactivity are compared to safety standards to ensure a safe environment. The current MDH environmental radiation monitoring program objectives are: to detect any above normal levels of radioactivity in Minnesota; to determine long-term trends so that any changes in the radiological environment are identified and corrective actions, if needed, are taken; to compare against data collected by nuclear utilities; to maintain a knowledge base for responding to nuclear materials accidents. These objectives are met by sampling various environmental pathways for human exposure and directly measuring radiation levels near the plants and at other locations around the state.
Minnesota Department of Health	Division of Environmental Health	Public Water Supply Supervision Program	
Minnesota Department of Health	Division of Environmental Health	Well Management Program	
Minnesota Department of Natural Resources	MIS Bureau	DNR Data Deli	The Minnesota Department of Natural Resources GIS Data Deli is an internet-based spatial data acquisition site that allows users to download raw computer-readable data for use in their Geographic Information System (GIS), image processing system, or traditional database environment. The site includes links to extensive and summary level data descriptions (metadata) to support users.
Minnesota Department of Natural Resources		Ground Water Level Monitoring Program	View hydrographs and acquire data for wells in Minnesota DNR Division of Water Observation Well Program
Minnesota Department of Natural Resources		Ground Water Level Monitoring Program	Collect baseline data on ground water level fluctuations and trends. Data from these wells are used to assess ground water resources, determine long term trends, interpret impacts of pumping and climate, plan for water conservation, evaluate water conflicts, and otherwise manage the water resource. Soil and Water Conservation Districts under contract with DNR Waters measure the wells monthly and report the readings to DNR Waters. Readings are also obtained from volunteers at several locations.

Organization	Department	Title	Description
Minnesota Department of Natural Resources		Lake Level Minnesota	Lake Level Minnesota is a program in which volunteers and cooperative organizations collect and report lake levels throughout the state. Each spring, DNR Waters employees travel throughout the state to reset and survey lake gages. These gages are used to measure the change in water levels throughout the open water season. This lake level information is gathered in DNR Waters' Lakes Database (Lakes DB).
Minnesota Department of Natural Resources		Minnesota County Biological Survey	To identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and native plant communities.
Minnesota Department of Natural Resources		Minnesota Maps	These maps identify recreation areas for hunting, boating and hiking; change in forest cover and inventory natural resources such as forests, natural community and rare species by county, public waters maps (includes wetlands and streams) by county, hydrogeologic assessments.
Minnesota Department of Natural Resources	Ecological Services	Natural Heritage Information System	Provides information on Minnesota's rare plants, animals, native plant communities and other rare features. County-by-county survey of natural communities. Information available upon request.
Minnesota Department of Natural Resources		Regional Assessment Program	Maps and reports created by Groundwater Mapping Program to depict the characteristics and pollution sensitivity of Minnesota's groundwater resources.
Minnesota Pollution Control Agency		Air Quality Index for Minnesota	The Air Quality Index (AQI) was developed by the U.S. Environmental Protection Agency (EPA) to provide a simple, uniform way to report daily air quality conditions. The AQI in Minnesota is determined by measuring four pollutants: ozone, sulfur dioxide (SO2), fine particulate matter (PM2.5), and carbon monoxide. The Minnesota Pollution Control Agency (MPCA) takes hourly measurements of these pollutants at air quality sites located throughout the state. Ozone levels, which are only elevated in warm weather, are measured from April through September in Minnesota.
Minnesota Pollution Control Agency	Water Quality	Ambient Ground Water Quality Monitoring	The ambient monitoring network consists of a network of 100 to 150 shallow monitoring wells coupled with 100 to 150 deeper drinking water wells. The shallow wells provide an early warning network in which we expect to first see changes in water quality. The deeper wells provide information about the quality of water that people are drinking. Each well is sampled biannually for an indefinite period of time. At each well, the MPCA collects samples for chemical parameters that are of concern for the area being sampled. Chemical parameters include nitrate, volatile organic compounds, chloride, and residential (lawn) pesticides in cooperation with the MDA.
Minnesota Pollution Control Agency	Environmental Outcomes Division	Ambient Trace Metal Monitoring	In the larger river basins (including the St. Louis), 5 mainstem sites and 5 tribs. are sampled.
Minnesota Pollution Control Agency		Basin Flow and Chemistry Monitoring	This monitoring is used to determine the flow and amount of pollutants coming from each tributary, and how these amounts vary at different times of the year.
Minnesota Pollution Control Agency	Environmental Outcomes	Biological Monitoring	Assess the condition of wadable streams and wetlands.

Organization	Department	Title	Description
Minnesota Pollution Control Agency		Citizen Lake Monitoring Program	The CLMP is a cooperative program combining the technical resources of the Minnesota Pollution Control Agency (MPCA) and the volunteer efforts of citizens statewide who collect water-quality data on their lakes.
Minnesota Pollution Control Agency	Environmental Outcomes Division, Rivers and Streams Monitoring Unit	Citizen Stream-Monitoring Program	Goals of the CSMP are to: Help determine the condition of Minnesota streams by expanding our water-quality monitoring network; Provide the opportunity for anyone interested to participate in a basic, centrally administered and interpreted stream monitoring program
Minnesota Pollution Control Agency	Regional Environmental Management Division	Clean Water Partnership Program	Lake or stream watershed diagnostic and restoration projects.
Minnesota Pollution Control Agency		Indicies of Biological Integrity Development	Once IBI's are developed the intention is to sample streams on a five year cycle. The results of the sampling will be used to evaluate over-all condition, effectiveness of previous control actions taken, and to gather discharge information on ten basins in Minnesota including the Lake Superior basin.
Minnesota Pollution Control Agency	Environmental Outcomes Division	Integrated Stream Monitoring	Monitor rivers and streams using an integrated approach designed to provide a more holistic picture of river water quality. This approach uses biological, physical, and chemical indicators to assess the conditions of rivers and streams.
Minnesota Pollution Control Agency	Environmental Outcomes Division	Lake Assessment Program (LAP)	The Lake Assessment Program (LAP) is a cooperative study of a lake involving MPCA staff and local citizens, such as a lake association or municipality. The Minnesota Department of Natural Resources and Soil and Water Conservation Districts also cooperate. In addition MPCA samples and assesses several other lakes in a similar fashion each year though reporting is less formal (data is assessed but detailed reports may not be written for all lakes).
Minnesota Pollution Control Agency	Regional Environmental Management	Lake Superior Beach Monitoring and Notification Program	The goal of the program is to assure a safe and healthy aquatic recreational environment by informing the swimming public about risk of contracting waterborne diseases from exposure to contaminated waters. The program collects samples from 36 Lake Superior beaches and analyzes those samples for waterborne diseases and human health risks.
Minnesota Pollution Control Agency		Lakes Regional and Trend Monitoring	MPCA samples 30 lakes once or twice a month from June through September. This results in at least 12 visits to each lake over the course of two to three years. This data is added to the regional database and may be used for assessing trends.
Minnesota Pollution Control Agency	Environmental Outcomes Division	Minnesota Milestone (Routine Stream) Monitoring	To detect water quality changes over time by continuing to record basic chemical measures of stream water quality for locations at which such measures have been collected regularly for a long period of time.
Minnesota Pollution Control Agency		North Shore Streams Monitoring Project	1. assess current water quality conditions 2. provide baseline information for detection of water quality trends 3. assist in the development of stream protection and remediation management options

Organization	Department	Title	Description
Minnesota Pollution Control Agency	Environmental Outcomes Division	Sediment quality studies in the St. Louis River AOC	This is not a designated program at the MPCA. Rather, this is a collection of sediment quality studies that have been conducted by MPCA staff in the former Water Quality Division and current Environmental Outcomes Division. Initiation of these projects has been dependent on securing federal grants from either U.S. EPA Headquarters or the EPA's Great Lakes National Program Office. Remediation staff in the Duluth office of the MPCA are also involved in sediment quality studies at two Superfund sites and a boat slip in the Duluth Harbor; these staff will submit a separate program description to the Great Lakes Commission (i.e. through Doug Beckwith). Much of the MPCA's sediment quality data that has been collected from the St. Louis River AOC since 1990 has been compiled in a Microsoft Access 2000 database. Several watershed GIS projects in ArcView 3.2 were also prepared.
Minnesota Pollution Control Agency		Stream Toxics Monitoring	Monitor Trace metals in streams in the state's major river basins.
Minnesota Pollution Control Agency	Regional Environmental Management Division	Total Maximum Daily Load Studies	Minor or major watershed or regional scale projects to identify sources and set load targets to meet water quality standards and beneficial uses.
National Atmospheric Deposition Program	Illinois State Water Survey	Mercury Deposition Network	The objective of the MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors.
New York Natural Heritage Program		New York Natural Heritage Program	The New York Natural Heritage Program enables and enhances conservation of New York's rare animals, rare plants, and significant ecosystems. We combine thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resources planning, protection, and management.
New York State Department of Environmental Conservation		Finger Lakes Biomonitoring	Water chemistry and zooplankton monitoring
New York State Department of Environmental Conservation	Division of Water	Finger Lakes Sediment Core Investigation	Assess organic and inorganic chemical trends over time, and determine sediment accumulation rates, within each of the Finger Lakes.
New York State Department of Environmental Conservation	Division of Water	Finger Lakes Synoptic Water Quality Investigation	Assess conventional water quality and limnologic trends within the Finger Lakes, and compare/contrast water quality conditions between the lakes.
New York State Department of Environmental Conservation		Fishway	Fish passage, egg collection and lamprey control
New York State Department of Environmental Conservation	Division of Fish, Wildlife & Marine Resources	New York State Amphibian and Reptile Atlas Project	The survey began in 1990 and continued through the end of 1999. The current distribution of herpetofauna was documented within USGS 7.5 minute topographic quadrangles. The herp atlas does not include habitat associations, but participants often include a few notes about habitat on their cards. Species noted in a particular area provide a rough estimate of existing habitat.

Organization	Department	Title	Description
New York State Department of Environmental Conservation	Division of Fish, Wildlife & Marine Resources	New York State Bird Conservation Area Program	Established in 1997 to protect and enhance bird populations and their habitats on State lands and waters. The BCA program is modeled after the National Audubon Society's Important Bird Areas program. There are currently 31 BCAs in New York; three of which contain coastal wetlands along the Great Lakes (Braddock Bay; Buckhorn Island; Eastern Lake Ontario Marshes). Wetlands within these BCAs are monitored for land area, habitat type, invasive species, and non-point source pollution.
New York State Department of Environmental Conservation	Division of Fish, Wildlife & Marine Resources	New York State Breeding Bird Atlas	First edition from 1980-1985. The state is divided into ten regions, within which are individual sampling blocks (3 x 3 miles). There are 5,335 blocks in the entire state. The Atlas is currently being updated for 2000-2005; approximately 88 of those blocks are in the Great Lakes Coastal Area. The survey focuses on breeding bird distribution which is not linked to habitat types. However, species noted in a particular area will provide a rough estimate of existing habitat.
New York State Department of Environmental Conservation		NY sediment sampling	Depositional chronology and surficial sediment contamination
New York State Department of Environmental Conservation	Division of Water	Rotative Intensive Basin Studies	Statewide waters assessment
New York State Department of Environmental Conservation	Division of Water	Water Quality Study of the Finger Lakes	Assess water quality conditions and trends in the Finger Lakes
New York State Department of Environmental Conservation (NYSDEC)	Fish & Wildlife	Binational Prey Fish Hydroacoustic Survey	Six transects across Lake Ontario. Looking at abundance of preyfish, alewife, and smelt. Recently collected mysids.
New York State Department of Environmental Conservation (NYSDEC)	Lake Services Section, Division of Water	Citizens Statewide Lake Assessment Program	The Citizens Statewide Lake Assessment Program (CSLAP), is a cooperative effort between the NYSDEC and the not-for-profit New York State Federation of Lake Associations, Inc. (NYSFOLA) for volunteer lake monitoring. CSLAP is a scientific and educational program in which citizen volunteers from member NYSFOLA lake associations collect water quality information on lakes. The water chemistry samples, watershed data and historical information collected by the CSLAP volunteers are used to build long term data bases, educate lakefront property owners, lake users, and concerned citizens, and to develop management strategies specific to each CSLAP lake.
New York State Department of Environmental Conservation (NYSDEC)	Div. of Fish, Wildlife and Marine Resources, Bureau of Habitat	Evaluation of impacts of toxic substances on nontarget wildlife	Dietary composition of common goldeneye and scaup; assessment of organochlorine levels in resident mallards at sites within the Niagara River drainage.

Organization	Department	Title	Description
New York State Department of Environmental Conservation (NYSDEC)	Fish & Wildlife	Juvenile and adult Lake Trout Assessment; Biomonitoring (lower trophic levels; nutrients); Preyfish Assess.; Eastern Basin Warmwater Fish Com. Assess.	Multiple stations with a number of different types of gear; undertaken at least annually (biomonitoring is undertaken from Apr to Oct, annually). Index abundance and monitor population demographics (fish assessments); measure indexes of productivity
New York State Department of Environmental Conservation (NYSDEC)	Fish & Wildlife	Lake Erie Fisheries Research Unit- Research	Current status of fish stocks- Multiple stations and gear, programs usually conducted annually
New York State Department of Environmental Conservation (NYSDEC)	Water	Macrobenthic community (sub-project of Rotating Intensive Basin studies)	
New York State Department of Environmental Conservation (NYSDEC)		New York State Breeding Bird Atlas	The Breeding Bird Atlas is a comprehensive, statewide survey that will reveal the current distribution of breeding birds in New York.
New York State Department of Environmental Conservation (NYSDEC)	Fish & Wildlife	Sportfish contamination	Contaminant monitoring in Lake Erie and Ontario
New York State Department of Environmental Conservation (NYSDEC)	Fish & Wildlife	Young of year (YOY) fish tissue sampling	Monitoring of contaminants in YOY spottail shiners in Lake Ontario and Lake Erie
New York State Department of Health	Bureau of Public Water Supply Protection	Wellhead Protection Program	The Wellhead Protection Program was created by the 1986 Amendments to the Safe Drinking Water Act. The DEC developed New York's Wellhead Protection Program, which was approved by the U.S. Environmental Protection Agency in 1990. The goal of the Wellhead Protection Program is to protect the ground water sources and wellhead areas that supply public drinking water systems from contamination. New York's approach to wellhead protection recognizes and includes the existing federal, state and county programs that protect groundwater and complements these programs through a combination of activities and efforts using existing public and private agencies and organizations at all levels.

Organization	Department	Title	Description
New York State Dept. of Environmental Conservation	Bureau of Air Quality Surveillance	Ambient Air Quality Monitoring Network	The Bureau of Air Quality Surveillance is responsible for the operation of the various ambient air quality monitoring networks for the State. The information obtained is used by us to determine the attainment status of the criteria pollutants: ozone (O3), sulfur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO), lead, and particulate matter (PM). We provide near real time data on the DEC website for measured gaseous pollutants, as well as fine particulate matter PM2.5. In addition, volatile organic compounds are measured for the State toxics network, the National Air Toxics Trends Stations network, and the two Photochemical Assessment Monitoring Stations (PAMS) sites. We operate a PM2.5 Speciation Trends Network to determine the chemical composition of fine particulate matter in various parts of the State. We also perform air pollution particle identification using microscopic techniques including a scanning electron microscope.
New York State Dept. of Environmental Conservation	Bureau of Air Quality Surveillance	Atmospheric Deposition Monitoring Sites	The New York State Atmospheric Deposition Monitoring Network was designed, in 1985, in response to the mandate of the "State Acid Deposition Control Act" (SADCA). The objectives of the network are as follows: provide a consistent, quality-assured, long-term acid deposition database; measure acid deposition in sensitive receptor areas; measure acid deposition in urban and upwind areas; use these data to perform spatial and temporal analyses of acid deposition; its precursors, and its effects; and track the effectiveness of acid deposition precursor emissions reductions. The state's monitoring network measures acid deposition and related quantities to assess the effectiveness of sulfur control policy and other strategies aimed at reducing the effects of acid rain.
New York State Dept. of Environmental Conservation		Lake Ontario Contaminant Trend Analysis	Assess temporal changes in residue concentrations of major chemical contaminants in salmonids taken from Lake Ontario.
New York State Dept. of Environmental Conservation		Monitoring Persistent Toxic contaminant Trends in Young Fish in New York State Great Lakes Areas of Concern	Assess spatial and temporal changes in contaminants within New York's Great Lakes basin; identify sources of continuing inputs of persistent bioaccumulative compounds
New York State Dept. of Environmental Conservation	Bureau of Air Quality Surveillance	PM 2.5 Monitoring	The PM 2.5 program monitors PM-2.5 FRM throughout the state of New York.
New York State Dept. of Environmental Conservation		Stream Biomonitoring	Since 1972, the Stream Biomonitoring Unit of the New York State Department of Environmental Conservation has used aquatic macroinvertebrates to monitor the water quality of the State's rivers and streams.
Ohio Department of Health		Bathing Beach Monitoring Program	To monitor the waters at selected public bathing beaches along the Ohio/Lake Erie border for E. coli bacteria content, and to alert the public whenever such bacteria content creates a potential threat to health.
Ohio Department of Natural Resources	Division of Wildlife	ANS plant species monitoring and control	Species targeted: purple loosestrife, phragmites, reed canary grass and flowering rush.

Organization	Department	Title	Description
Ohio Department of Natural Resources	Division of Wildlife	Bald Eagle Management Program	Program to monitor and reestablish the bald eagles throughout Ohio
Ohio Department of Natural Resources	Sandusky & Fairport Harbor Fish Research Units	Commercial Fishery Monitoring	We monitor the Ohio commercial fishery which primarily operates out of Lake Erie's western basin and major central basin ports. There are seine and trap netting operations that remove yellow perch, white bass, white perch, whitefish, catfish, and many rough fish species like sheephead, carp, gizzard shad and buffalo. Lake Erie Fisheries Unit personnel contact commercial fishers to obtain up-to-date harvest information, and to get age and growth information from their landed catch. For more info on avoiding commercial nets see our "Lake Erie Fishing Guide."
Ohio Department of Natural Resources	Division of Water	Evaluating Ground Water Pollution Potential in Ohio	A ground water pollution potential mapping program for Ohio was initiated in 1986 under the direction of the Ohio Department of Natural Resources, Division of Water. The DRASTIC mapping system, developed by Aller, et al, 1987, was chosen because it allows the pollution potential of an aquifer to be evaluated systematically using existing information. Vulnerability to contamination is a combination of hydrogeologic factors, anthropogenic influences, and sources of contamination for a given area. The DRASTIC system focuses on the hydrogeologic factors that influence ground water movement.
Ohio Department of Natural Resources	Division of Forestry	Forest Monitoring	In 1996 the Ohio Division of Forestry established a series of randomly located one-sixth acre permanent plots within Ohio's state forests. Each plot consists of four subplots arranged systematically around the plot center. At each plot, information is gathered about trees, saplings, seedlings, and herbaceous plants. Data was collected on all plots during June, July, and August of the establishment year. One-third of the plots will be re-measured each year. The purpose of this project is to monitor the condition of Ohio's state forest system and to track long term state forest health trends.
Ohio Department of Natural Resources	Office of Information Technology	Geographic Information Management Systems (GIMS)	Geographic Information Management Systems (GIMS) is a term used by DNR to describe a collection of related technologies used to manage spatial data. These technologies include geographic information systems (GIS), computer-aided design systems, automated and desktop mapping systems, remote sensing and image analysis systems, and their related database management systems. The goal of the GIMS program is to provide natural resource information to the public in a more efficient and effective manner.
Ohio Department of Natural Resources	Division of Water	Ground Water Level Monitoring in Ohio	The Division of Water, Water Resources Section (WRS) is responsible for collecting, researching, interpreting and disseminating hydrologic and ground water resource information for the State of Ohio. An important component of this program is to characterize Ohio's ground water resources through monitoring and evaluating long-term trends in ground water level fluctuations throughout the state's various aquifer systems.

Organization	Department	Title	Description
Ohio Department of Natural Resources	Division of Water	Ground Water Resources Mapping in Ohio	Early in the 1970's, the Division of Water realized the need to distribute basic ground water availability information to the general public in an easy to use, semi-technical format. To meet this need, the Division began producing a series of maps which describe Ohio's ground water resources on a county by county basis. Generally referred to as "Ground Water Resource Maps", these maps are intended to aid homeowners, industries, municipalities, and regional water systems in developing reliable ground water supplies. Ground water resources maps show the expected yield to a drilled well at any location in a county. All maps use a consistent color coding system to represent well yields. For example, properly constructed wells drilled in areas colored blue on any map can be expected to yield 100 to 500 gallons per minute. Areas colored yellow would yield 25 to 100 gallons per minute . In all, there are six colors used to identify well yield categories ranging from purple (greater than 500 gpm) to orange (less than 3 gpm).
Ohio Department of Natural Resources	Division of Natural Areas and Preserves	Heritage Database	The Natural Heritage Database was started in 1976. It now contains more than 13,000 records which represent known locations for Ohio's rare plants and animals, high quality plant communities and other natural features. Data are obtained from a broad range of sources throughout the state. In addition to the division's needs, data are used in the department's environmental review process and are provided to consulting firms, federal, state and local government agencies, conservation groups and private citizens.
Ohio Department of Natural Resources	Division of Geological Survey	Lake bottom sonar readings	Sonar readings of the bottom of Lake Erie. Analysis includes change detection.
Ohio Department of Natural Resources	Division of Wildlife	Lake Erie ANS trawl surveys	Species targeted: round gobies, zebra mussels, quagga mussels
Ohio Department of Natural Resources	Division of Geological Survey	Lake Erie Coastal Erosion Study	To identify the factors controlling the temporal and spatial variation in erosion rates along the Ohio shoreline to improve the predictive models of future shoreline recession. Improved measurement of historic shoreline recession and detailed observations of the geologic and physical factors controlling shoreline recession have been identified as critical needs. Geophysical investigations in the lake basin address transport pathways and identify potentially valuable sand and gravel resources which may be utilized in future shoreline-protection activities. A comprehensive digital database will aid in coastal-management decision making.
Ohio Department of Natural Resources	Sandusky Fisheries Research Unit	Lake Erie Trawl and Gill Net Surveys	Trawl and gill net survey are conducted in the Ohio waters of Lake Erie to ascertain relative abundance, growth, and maturity rates of the major predator and forage fish species. Total counts by species and age group, were obtained from both trawl and gill net catches.
Ohio Department of Natural Resources	Division of Geological Survey	Nearshore habitat dynamics	Tracking substrate changes

Organization	Department	Title	Description
Ohio Department of Natural Resources	Division of Forestry	North American Maple Project (NAMP)	In 1992 NAMP plots were established in Geauga, Lake, and Trumbull Counties in northeast Ohio. NAMP is a Canadian/U.S. project investigating concerns about sugar maple health. Study plots are located in active sugarbushes.
Ohio Department of Natural Resources	Division of Natural Areas and Preserves	Ohio Stream Quality Monitoring Project (SQM)	Developed in 1983 by the Division of Natural Areas and Preserves, Ohio's Stream Quality Monitoring (SQM) Project uses a variety of biological testing techniques to compile information on the quality of the state's scenic rivers and streams. Volunteers are trained to collect and classify aquatic invertebrates. The Ohio SQM Project maintains data on 20 state scenic river segments.
Ohio Department of Natural Resources	Division of Wildlife	Population Surveys	Population trend tables for species within Ohio's three primary habitat types: forest species, grassland species, and wetland species.
Ohio Department of Natural Resources	Division of Wildlife	Sea Lamprey Survey on Chagrin River	Species targeted: sea lamprey
Ohio Department of Natural Resources	Division of Geological Survey	Sediment cores	Core samples taken from Ohio waters.
Ohio Department of Natural Resources	Division of Geological Survey	Shore Structure Inventory	GIS database of man made shoreline hardening devises developed for erosion protection. Included in the inventory are type of structure, composition, location.
Ohio Department of Natural Resources	Division of Water	Statewide Aquifer Mapping Project (SAMP)	Aquifer delineations were completed at a scale of 1:24,000, using standard USGS 7.5 minute quad maps as a base. As with the bedrock aquifer maps are constructed on a standard 7.5 minute USGS quadrangle base. Data sources include maps, reports, and drilling logs from a variety of public and private organizations.
Ohio Department of Natural Resources	Division of Wildlife	Statewide Asian Carp Surveys	Species targeted: asian carp
Ohio Department of Natural Resources	Division of Wildlife	Statewide Zebra Mussel Surveys	Species targeted: zebra mussels
Ohio Department of Natural Resources	Sandusky Fisheries Research Unit	Walleye Tagging	Walleye have been tagged in the Ohio waters of Lake Erie since 1986. Estimates of survival, exploitation, mortality rates, sex ratios and distribution are estimated through this project.
Ohio Department of Natural Resources	Division of Water	Water Inventory	The Water Inventory Program administers activities designed to characterize the changing water supply conditions across the state and provide the information necessary to build a foundation for planning and developing reliable, long-term water supplies. The program performs the following primary activities.· Collects, compiles, analyzes, and disseminates hydrologic and climatological data and information concerning all aspects of the hydrologic cycle.· Operates and maintains the statewide network of 125 ground water observation wells. · Administers the Division's cooperative agreements with the U. S. Geological Survey for stream and ground water gauging and other water resource projects. · Summary statistics of the data and information compiled are provided in The Monthly Water Inventory Report (50 years of publication), a technical publication that provides a cursory review of current and cumulative hydrologic conditions.

Organization	Department	Title	Description
Ohio Environmental Protection Agency	Division of Surface Water	Ohio sediment inventory	Parameters include nutrients, metals and industrial contaminants (primarily PCBs and PAHs)
Ohio Environmental Protection Agency	Air Quality	Ohio's Air Monitoring Network	The goals of the air monitoring network are to: attain and maintain ambient air quality standards, conform with the requirements of the clean air act and Ohio Law, protect public health.
Ohio Environmental Protection Agency	Division of Surface Water	Ohio's Sport Fish Tissue Monitoring Program	Ohio EPA and ODNR collected fish samples for analyses, Ohio EPA and ODA laboratories analyzed fish tissue samples for contaminants of concern, and ODH evaluated the tissue contaminant data and issued fish consumption advisories where necessary.
Ohio Environmental Protection Agency	Division of Drinking and Ground Waters	Public Water System Supervision Program - Compliance Monitoring Program	U.S. EPA established the Public Water System Supervision Program (PWSS) under the authority of the 1974 Safe Drinking Water Act (SDWA). Under the SDWA and the 1986 and 1996 Amendments, U.S. EPA sets national limits on contaminant levels in drinking water to ensure that the water is safe for human consumption. Ohio EPA has primacy to administer the PWSS program in Ohio. The Ohio EPA's Division of Drinking and Ground Waters is repsonsible for scheduling chemical and bacteriological monitoring for Ohio's 5,425 public water systems, reviewing water quality results, determining compliance and enforcement of non-compliant systems. Public water system operators monitor treated drinking water for approximately 100 contaminants on a monthly, quarterly, annual or triennal basis.
Ohio Environmental Protection Agency	Division of Surface Water	Statewide Biological and Water Quality Monitoring and Assessment	Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 300-400 sampling sites. Biological, chemical, and physical monitoring and assessment techniques are employed in biosurveys in order to meet three major objectives: determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; determine if use designations assigned to a given water body are appropriate and attainable; and determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices.
Ohio Environmental Protection Agency	Division of Surface Water	Wetland Bioassessment Program	

Organization	Department	Title	Description
Ohio EPA	Division of Drinking and Ground Waters	Ohio's Ambient Ground Water Monitoring Program	The Ambient Ground Water Monitoring Program (AGWMP) is maintained by Ohio EPA Division of Drinking and Ground Waters to characterize general water quality conditions in Ohio. The primary objective of the AGWMP is to provide state-wide ground water quality information to enhance water resource planning and protection activities. As the data base expands, these data are particularly valuable for documenting water quality trends at specific sites. The AGWMP places a priority on collecting water quality data representative of aquifers used by public water systems as source water for public water distribution. To achieve the goal of aquifer representativeness, the AGWMP focuses its water quality sampling efforts on raw, untreated ground water. Currently, samples are collected for a suite of 32 inorganic water quality parameters either every six or eighteen months. The active sampling network comprises some 280 wells distributed across about 200 facilities. U.S.EPA, Clean Water Act, Section 106, and state matching General Revenue funds support the sample collection, analysis, and information synthesis.
Ohio Lake Management Society		Citizen Lake Awareness and Monitoring (CLAM)	CLAM is a statewide program to care for Ohio's lakes, reservoirs, and their watersheds. We have established a statewide lake/pond water quality database for lake managers and public agency staff to analyze and compare lake conditions throughout Ohio. We also educate the public about nonpoint source pollution and watershed management.
Pennsylvania Department of Conservation and Natural Resources		Beach Monitoring	The Pennsylvania Department of Conservation and Natural Resources is responsible for monitoring beaches at Presque Isle State Park
Pennsylvania Department of Conservation and Natural Resources		Pennsylvania Natural Heritage Program (PNHP)	The Pennsylvania Natural Heritage Program (PNHP) conducts inventories and collects data regarding the Commonwealth's native biological diversity. Information is stored in an integrated data management system consisting of map, manual, and computer files. The PNDI information system is continually refined and updated to include recently discovered locations and to describe environmental changes affecting known sites. The goal is to build, maintain, and provide accurate and accessible ecological information needed for conservation, development planning, and natural resource management.
Pennsylvania Department of Environmental Protection	Bureau of Air Quality	Ambient Air Monitoring	The goals of the Pennsylvania's ambient air monitoring program are to evaluate compliance with federal and state air quality standards, provide real-time monitoring of air pollution episodes, develop data for trend analysis, support the development and implementation of air quality regulations, and provide information to the public on daily air quality conditions. DEP monitors air quality in areas having high population density, high levels of expected contaminants or a combination of both factors.
Pennsylvania Department of Environmental Protection		Citizens' Volunteer Monitoring Program (CVMP)	This program is a citizen volunteer monitoring network which collects water quality information as well as performed habitat assessment and water quality rating based on benthic macroinvertebrate sampling.

Organization	Department	Title	Description
Pennsylvania Department of Environmental Protection		Drinking Water Reporting System	The Division of Drinking Water Management oversees and implements Pennsylvania's Safe Drinking Water Act, including the development of the restricted account spending plan, regulations policies, guidance and standards, the issuance of permits, monitoring and surveillance activities, compliance, data management activities and public information. The Division conducts filter plant performance evaluations at filtered public drinking water systems with surface water sources and participates in the Partnership for Safe Water at those systems; responds, verifies and recommends corrective measures at all drinking water systems contaminated with Giardia or Cryptosporidium in the finished drinking water.
Pennsylvania Department of Environmental Protection	Bureau of Air Quality	Fish Consumption Advisory	Consumption advisories provide guidance to individuals or segments of the population at greater risk from exposure to contaminants in fish. Advisories are not regulatory standards, but are recommendations intended to provide additional information of particular interest to high-risk groups such as pregnant women and young children. These advisories apply only to recreationally caught sport fish in Pennsylvania, not commercial fish. The federal Food and Drug Administration establishes the legal standards for contaminants in food sold commercially, including fish.
Pennsylvania Department of Environmental Protection	Bureau of Air Quality	Monitoring Toxic Pollutants	Toxic pollutants are a group of 188 pollutants identified by the federal Clean Air Act that have been associated with a wide variety of adverse health effects, including cancer. Toxic pollutants are emitted from various sources, including major stationary, area, as well as mobile sources. DEP monitors toxics at 12 sites throughout the state.
Pennsylvania Department of Environmental Protection	Bureau of Air Quality	Pennsylvania Atmospheric Deposition Monitoring Network	The purpose of this program is to determine how much acid rain is falling in Pennsylvania for environmental assessment purposes.
Pennsylvania Department of Environmental Protection		Pennsylvania Spatial Data Access (PASDA)	The Pennsylvania Spatial Data Access system (PASDA) is Pennsylvania's official geospatial information clearinghouse and the Commonwealth's node on the National Spatial Data Infrastructure (NSDI). The PASDA clearinghouse provides for the widespread sharing of geospatial data, eliminates the creation of redundant data sets, and serves as a resource for locating data throughout the Commonwealth through its data storage, interactive mapping/webgis applications, and metadata/documentation efforts.
Pennsylvania Department of Environmental Protection	Division of Water Quality Assessment & Standards	Pennsylvania Zebra Mussel Monitoring Network	Pennsylvania's Zebra Mussel (ZM) Monitoring Network has monitoring records for about 50 of the state's 67 counties, primarily presence/absence results reported annually. Pennsylvania occurrences of zebra mussels were first noticed in Lake Erie in 1989. Since our program began in 1992, less than 100 stream miles of the Ohio, Allegheny, and Monongahela Rivers have recorded ZM observations. Our intention is to serve as an "early warning" and information referral source for water users.

Organization	Department	Title	Description
Pennsylvania Department of Environmental Protection	Division of Water Quality Assessment & Standards	Pennsylvania's State-Wide Surface Waters Assessment Program	The Pennsylvania Water Quality Network (WQN) is a statewide, fixed station water quality sampling system. This program, (formerly referred to as the Unassessed Waters, or UW Program) was designed to: conduct stream assessments as quickly and effectively as possible; complete a state-wide assessment of all streams within 10 years; document Point Source and NPS impairments state-wide, and identify the causes and sources of these impairments.
STATE OF MINNESOTA	NATURAL RESOURCES	GREAT LAKES FISH MONITORING PROGRAM	Minnesota collects 15 coho salmon in even years and 15 chinook salmon in odd years as its responsibility for the Great Lakes Fish Monitoring Program. Samples are collected by Minnesota Department of Natural Resources, Section of Fisheries personnel at the designated site at French River on Lake Superior. Fish samples are ultimately analyzed for a series of potential contaminants.
STATE OF MINNESOTA	NATURAL RESOURCES	LAKE SUPERIOR FISH CONTAMINANT MONITORING - GENERAL	Approximately every 5 years Minnesota samples and analyzes for contaminants all common fish species found there. These include lake trout, siscowet lake trout, rainbow trout, pink salmon, lake herring, bloater chubs, rainbow smelt, burbot.
State University of New York	College of Environmental Science & Forestry	Nutrient Dynamics in Salmon Creek, NY	To study processes controlling nutrient delivery from the watershed to the stream, under varying flow regimes.
Water Watchers		Water Watchers	Educational, develop data base, publish data, group environmental concern
Wisconsin Department of Agriculture, Trade and Consumer Protection		Groundwater pesticide and nitrate database	
Wisconsin Department of Natural Resources	Drinking Water - Groundwater	2000-04 Town-based Arsenic Sampling	The data consist of well water sampling results for arsenic, done by homeowners in 18 townships located in Outagamie and Winnebago counties. Data summaries are available on the DNR Arsenic web site (see data access methods). Access to the complete data set can be obtained through the contact person. The sampling program is ongoing and data will be added as more towns participate and other counties join in the sampling effort. This data set was collected to further evaluate the extent of naturally occurring arsenic in private wells in Northeastern Wisconsin (Outagamie and Winnebago Counties).
Wisconsin Department of Natural Resources	Air Management	Air Emissions Management System (AEMS)	The Air Emission Management System (AEMS) is a database where the Wisconsin facility air emission inventory data are processed as part of the Air Emissions Inventory Program. This program was a result of the Clean Air Act which requires states to develop an operation permit program and collect fees from air contaminant sources. Any person owning or operating a facility which emits an air contaminant in quantities above the reporting levels listed in Table 1 of NR 438.03, except indirect sources of air pollution, must annually submit an air emissions inventory report. Data from these reports are entered into the AEMS which then calculates air emissions and their associated fees. The AEMS was created in 1995 and contains information on over 3,000 facilities in Wisconsin.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Watershed Management	Aquatic Pesticide Treatment Data	Tracking the treatment size, chemicals used, and target species for aquatic pesticide permits in the Southeast Region. The Department monitors aquatic plant management techniques according to Wisconsin Administrative Code NR 107 and 109. We do this monitoring to ensure that the registered aquatic herbicides are being applied in a manner consistent with the Environmental Protection Agency (EPA) and Department of Agriculture, Trade and Consumer Protection (DATCP) label directions and standards.
Wisconsin Department of Natural Resources	Facilities and Lands	Archeological and Historical Sites of WI	These maps show the locations of historic properties listed in the inventories of the State Historical Society of Wisconsin, but are available for internal WDNR use only. They are not for public dissemination. There are two maps for each county. One shows the locations of historic structures, and the other shows the locations of archaeological sites and burial sites. Shaded areas of 40 acres or greater indicate the presence of historic properties. Diagonal hatching represents DNR lands. The counties are grouped under DNR regions. Each county map is divided into townships, identified by a 5-digit number. The first digit is ""A2"" for townships west of the meridian, or ""A4"" for townships east of the meridian. The next two digits are for the Town, and the last two are for the Range. After locating the township, find the section and the quarter-quarter section within it where your project is located. If the project area is shaded, follow the procedures outlined in the Manual Code. The maps show the locations of historic structures, archaeological sites and burial sites listed in the inventories of the State Historical Society of Wisconsin.
Wisconsin Department of Natural Resources	Integrated Science Services	Big Game Hunting Data	The Big Game Harvest Summary is a summary of the white-tailed deer, black bear, and wild turkey kill. This report is a yearly summary of the hunters and harvest of these 3 species. The white-tailed deer harvest is based on information gathered during the archery and gun deer seasons. The report summarizes kill by bow and gun deer hunters. Data are gathered from hunter's registration of deer and the aging of deer at the time of registration. Permit success and hunter pressure is also summarized in this report. Deer data are summarized by weapon type, deer unit, and county. Black bear harvest is summarized by bear management zone, deer management unit and county. Harvest information is from registration data. Wild turkey kill information is from registration data. These data are collected from both the spring and fall turkey seasons. Kill is summarized by turkey management zone (TMZ). Permit issuance and success is also summarized by TMZ. The Great Lakes Indian Fish and Wildlife Commission provides information on the kill by the Chippewa tribes to the department.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Endangered Resources	Biotics	Biotics is a data tracking system with both tabular and spatial components containing locational and biological data on rare and endangered species and natural communities in WI. The data are collected and submitted by a very wide range of people and/or extracted from museums, herbaria, etc. Therefore the quality (completeness) and quantity can vary significantly from record to record. This database tracks both Aquatic and Terrestrial elements. Not all records contain the same amount of data. Data are collected as part of an international network of Natural Heritage Programs for protection of rare species and native natural communities.
Wisconsin Department of Natural Resources	Integrated Science Services	Brule Research	Fish community estimates, in-stream physical characteristics, and riparian forest attributes of coldwater trout streams in Douglas and Bayfield counties were used to examine the influences of riparian forest management and in-stream large woody debris (LWD) densities and volumes on the fish community. The purpose of the study was to better understand the influences of in-stream woody debris on fish communities in coldwater streams so that predictions could be made about how management efforts to restore historical levels of woody debris to these streams would impact the fish community.
Wisconsin Department of Natural Resources	Forestry	Champion Trees of Wisconsin	"Champion" trees are defined as the largest tree of a particular species or taxa as determined by measurements of the trunk circumference, tree height and tree crown spread. Over 2100 records are kept on 271 tree species, subspecies and cultivars in Wisconsin. The database contains information on a tree's size, location, ownership, nominator and condition. The data is periodically published in hardcopy in Wisconsin's Champion Trees. The most current edition is PUB-FR-115 1998. The DNR keeps big tree records to encourage the appreciation of Wisconsin's forests and trees.
Wisconsin Department of Natural Resources	Integrated Science Services	Checklist of Wisconsin Vertebrates	Working checklists of the vertebrate animals occurring in Wisconsin are provided. Six hundred ninety species are documented from the state, including 159 fishes, 19 amphibians, 35 reptiles, 408 birds and 72 mammals. Six hundred sixty-eight species are believed to be native, while 25 are introduced non-native species (14 fishes, 8 birds, and 3 mammals). Status of state and federal listing is also provided. Wisconsin Statute 23.09(2)(km) directs the Department of Natural Resources to "develop an information system to acquire, integrate and disseminate information concerning inventories and data on aquatic and terrestrial natural resources."

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Citizen Lake Monitoring Network	Self-Help Citizen Lake Monitoring and the Self-Help Volunteer Lake Monitors have been a part of Wisconsin's lakes program since 1986. The network operates on the principle that citizens who live on a lake know the lake better than anyone else. Self-Help Citizen Lake Monitoring includes opportunities for chemistry, dissolved oxygen monitoring, and aquatic plant surveys by citizen volunteers. Since its beginning, over 3200 volunteers have participated in the program. Currently, the program has grown to include over 1200 active volunteers monitoring over 850 lakes. The Department of Natural Resources provides all equipment to the volunteer. Training of the volunteers is provided by either DNR or University of Wisconsin - Extension staff. Volunteers provide their time, expertise, energy and a willingness to share information with their lake association or other lake residents.
Wisconsin Department of Natural Resources		Drinking Water System	Includes treated drinking water quality data for groundwater and surface water systems as well as untreated water quality data from groundwater systems. Includes data from the Public Water Monitoring Program.
Wisconsin Department of Natural Resources	Integrated Science Services	Environmental Site Register	The Environmental Site Register (ESR) is a database that contains core information about facilities, organizations and people regulated by the Department of Natural Resources. The ESR makes it easy to find facilities, companies, contacts and their relationships to each other. It shows what different DNR programs regulate the facility, what they know about it and who the program's contacts are. It provides location, contact, license, permit, activity, emission, and compliance information. The ESR integrates information from the DNR's different environmental programs. It allows programs like Waste Management, Watershed Management and Air Management to know they are talking about the same facility, organization or person. Similarly, it allows others to see all of DNR's involvement with a facility, company or person. The ESR is also the foundation for the Department's Environmental Fee Program. This program serves the DNR's regulated community as well as the environmental programs, finance and management and budget.
Wisconsin Department of Natural Resources	Cooperative Environmental Assistance	Fact System	The Fact System is an Internet search tool allowing users to query an Oracle data warehouse that contains integrated pollution data from numerous DNR databases. The Fact System does not contain any newly collected data. It integrates other DNR data for the purposes of public access and integrated problem solving.
Wisconsin Department of Natural Resources	Endangered Resources	Falconry Permits	This database stores data of people in Wisconsin who can take and hunt with raptors. Permitting is a joint state and federal activity. The birds that are used are banded and records must be kept on file. The database is kept to comply with Federal and State legislation mandating a falconry permit system.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Fish Stocking Database	Provides record of fish stocked in Wisconsin waters. Section 29.35 and NR 19.05 (1), Wis Administrative Code, provide for permits to import all fish brought into the state for stocking including permits for private stocking in state waters. Stocking permits are needed for all fish stocked in the state excluding those stocked in private fish hatcheries. Copies of permit applications are kept with the Bureau of Fisheries and Habitat Management. This database serves as the central repository of all fish stocking data in the state and is designed to accurately and efficiently keep records on this activity.
Wisconsin Department of Natural Resources	Watershed Management	Floodplain Analysis Database (FAD)	A list by county and community of the status and types of floodplain engineering analyses that have been performed. This list is maintained to establish floodplain elevations for regulatory zoning purposes.
Wisconsin Department of Natural Resources	Forestry	Forest Inventory and Analysis (FIA)	The National FIA Database Retrieval System produces tables and maps from the USDA Forest Services Forest Inventory and Analysis Data Base (FIADB). The user inputs the following information: 1) geographic area of interest (state/county retrieval or radius retrieval) 2) attribute of interest (timberland area, number of trees, growing-stock volume, etc.) 3) optional filters (for restricting the query to a specific ownership, species, etc.) 4) classification variables to be used for columns and rows and the web application generates the resulting table. If the user selects County or Congressional District as the row variable, a shaded county map is generated. The purpose of the FIA is to look at current forest conditions and trends over time.
Wisconsin Department of Natural Resources	Forestry	Forestry Compartment Reconnaissance Database	Per Chapter 100 of the Public Forest Lands Handbook (HB24605, 1994) "Reconnaissance (recon) of land is a tool utilized in the assessment of geographical, structural, and compositional attributes of existing resources. This information is collected and computerized in tabular format. The tabular information is linked to spatial information on hand drawn maps or computerized maps found in a GIS. Basic resource information is collected, stored, and updated systematically and continually. The database is used to analyze existing resources, evaluate management alternatives, and assist in the development and implementation of management plans. Recon is one tool used to assess forest resource information at the property level. This information will provide a data layer that should be used for regional analysis. This type of assessment is necessary to implement ecosystem management." The existing Recon Database was created to mimic the paper system of collecting forestry reconnaissance data. In the paper system, paper maps were created from aerial photographs of forest stands.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Waste Management	Groundwater & Environmental Monitoring System (GEMS)	GEMS is the primary vehicle for storage and analysis of environmental monitoring data collected for the Bureau of Waste Management. It also contains monitoring well construction and location information, site contact information and assignment information including WDNR staff assigned to each site and the program responsible for the site - whether the Bureau of Waste Management or Bureau of Remediation and Redevelopment. Data from over 640 sites are stored on the system. GEMS is designed to track regulatory compliance with Ch. NR 500s.
Wisconsin Department of Natural Resources	Drinking Water - Groundwater	Groundwater Retrieval Network (GRN)	This system reports data from the Department's Public Water Supply (public drinking water supply wells), Private Water Supply (private drinking water supply wells, non-point source priority watershed projects, and special groundwater studies), and the Bureau of Waste's Groundwater and Environmental Monitoring System (GEMS) (landfill wells). Data covers the period from the early 1970s to present for the Public Water Supply data, 1988 to present for the Private Water Supply data, and from the mid 1970s to present for the GEMS database. Not all programs which currently generate groundwater related data are linked into the GRN system. Data from the Bureau of Remediation and Redevelopment (LUST, spills, or remediation sites) as well as data from the Bureau of Watershed Management (wastewater treatment facilities and land spreading sites) is not currently retrievable through the GRN system. The purpose of the GRN system is to link groundwater data residing in various program related database systems to a retrieval system for consolidated reporting capabilities.
Wisconsin Department of Natural Resources	Integrated Science Services	Insects of the Prairie Invertebrate Inventory	Specimen information for collected coleopterans, dipterans, hemipterans, hymenopterans, orthopterans, (and spiders) under the Wisconsin Department of Natural Resources study for the Prairie Invertebrate Inventory. The specimens were recorded primarily within Wisconsin, however this data set does contain some records from Illinois, Iowa, and Missouri. Samples were collected from approximately 180 different locational sites in Wisconsin. The study is intended to inventory all insects utilizing grasslands, identify which species are dependent upon remnant native grasslands (prairies), and through a natural experiment process, the effect of remnant size, isolation, and land use/management history upon these remnant-dependent (r-d) species.
Wisconsin Department of Natural Resources		Invasive Species Monitoring	To track the spread of invasive species in Wisconsin waters and to document presence/absence of invasives in waters of the State.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Integrated Science Services	Lab Data Entry System (LDES)	The LDES reports inorganic, microbiological, radiochemistry, and organic sample results from the State Laboratory of Hygiene. It updates a 15-year-old system, making use of new technologies for data reporting and error checking. Data are available for both completed and partial sample results. The databases that can automatically receive data from this database include: Public Water Supply, Private Water Supply, and Fish & Sediment Contaminant databases. This is an updated and streamlined version of an older lab data entry system. It allows easier access of data by Staff, warehouses lab data (1987 to present) stores comments about analyses.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Lake Michigan Charter Boat Data	Summary information is based on raw data from Lake Michigan charter boat reports. Information obtained from Charter Boats includes grid fished, date, number of anglers, number of fish caught by species, number of lines fished and number of lampreys attached to chinook salmon and lake trout. Creel survey information from the charter boat industry is used in conjunction with the WDNR creel and moored boat survey to estimate the number of salmon and trout harvested on a yearly basis. This is used to update our stocking rationale model, simulate effects of bag limit reductions on harvest and for other biological purposes.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Lake Michigan Contest Data	Information from Fishing contests along Lake Michigan or Green Bay. Information that is collected at various fishing contests along Lake Michigan and Green Bay include date, location, species caught, length, weight, finclip and tag information. Data from these fishing contests are used to monitor the condition of salmon and trout. Long-term trends of average, trophy and standard weight are used to assess the condition factor of these fish. Data from contests are used in conjunction with other surveys and information to help manage the fish populations in the lake.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Lake Michigan Creel Data	Raw data from Wisconsin's Lake Michigan creel survey from 1969 to present. Three types of data were collected for each site sampled: angler, boat trailer or car counts for effort, angler or party interviews for harvest rates and biological information on harvested fish. Instantaneous counts were made by creel clerks at all sites in the survey. Since 1969, the WDNR has monitored the Lake Michigan sport fishery with a statewide contact creel survey. This provides the WDNR with a continuous record of harvest, harvest rates and biological data of the harvest. In order to manage the Lake Michigan sport fishery, creel survey assessments must be conducted on both the forage and predator fish stocks.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Lake Michigan Moored Boat Data	Raw data from Wisconsin's Lake Michigan moored boat survey. Anglers who moored their boat on Lake Michigan and Green Bay were surveyed by questionnaire beginning in 1988. The earlier surveys (1982-1985) were based on voluntary information from moored-boat owners who received their survey form from sport fishing clubs. However, starting in 1988, creel clerks were asked to compile a list of boat registration numbers of moored-boats present on Lake Michigan during a day of bad weather. These numbers were used to develop a list of boat owners from the Wisconsin Department of Natural Resources master file of registered boats. Information from the moored boat industry is used in conjunction with the WDNR creel and charter boat survey to estimate the number of salmon and trout harvested on a yearly basis. This is used to update our stocking rationale model, simulate effects of bag limit reductions on harvest and for other biological purposes.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Lake Protection Districts/Associations	A lake district is a special purpose unit of government. The first districts came into existence in 1974 with the passing of Chapter 33 of the Wisconsin State Statutes. Lake districts have the authority to levy taxes, make special assessments, or charge user fees to finance lake management activities on owners of property in the lake district. A lake district can assume responsibilities for ownership, repair, maintenance and operations of a dam. A lake district may also exercise the same powers as a sanitary district if authorized by the town which created the sanitary district. District voting members make major policy decisions at annual meetings. There are approximately 200 lake districts in Wisconsin today. Similar to lake districts, lake associations are organizations with members who own land on or near a lake. They can be involved in various levels of lake management activities and vary from well-run lake management groups to loose-knit social groups. Lake associations raise funds through membership dues but do not levy taxes for their activities.
Wisconsin Department of Natural Resources	Integrated Science Services	Long Term Lake Monitoring Program	Originally part of an EPA Program, LTM now consists of thirteen lakes in Wisconsin and eight in Upper Michigan. These lakes have been monitored three times per year since 1983. The study was designed to determine the chemical responses of lakes to changes in and deposit of acidic rain. The purpose of the monitoring is to determine the chemical responses of lakes to changes in and deposit of acidic rain.
Wisconsin Department of Natural Resources	Integrated Science Services	Mapping Wetlands Dominated by Reed Canary Grass	We've developed and demonstrated the feasibility of mapping wetlands dominated by the invasive plant, reed canary grass (Phalaris arundinacea) in a pilot area, using Landsat TM satellite data. By the end of 2006 we expect to complete mapping the reed canary grass dominated wetlands throughout the entire state using this method. Funding is coming from a State/Tribal Wetland Grant 104(b). Method is documented on our Assessment and Monitoring web page: http://dnr.wi.gov/org/water/fhp/wetlands/assessment.shtml . The report is titled Using Landsat Imagery to Map Invasive Reed Canary Grass (Phalaris arundinacea): A Landscape Level Wetland Monitoring Methodology

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Bureau of Endangered Resources	Natural Heritage Inventory Program	The NHI program is responsible for maintaining data on the locations and status of rare species, natural communities, and natural features in Wisconsin. Wisconsin's Natural Heritage Inventory program's three objectives are to: collect information on occurrences of rare plants and animals, high-quality natural communities, and significant natural features in Wisconsin; standardize this information, enter it into an electronic database, and mark locations on base maps for the state; and use this information to further the protection and management of rare species, natural communities, and natural features.
Wisconsin Department of Natural Resources	Remediation and Redevelopment	Newton Creek System Remediation	The Newton Creek and Hog Island Inlet system are within the St. Louis River Area of Concern on Lake Superior. Historical releases resulted in sediment and a floodplain soil contaminated with petroleum-related compounds and lead in the Creek and Inlet. Newton Creek begins near the Murphy Oil Refinery in Superior, Wisconsin, and flows approximately 1.5 miles to Hog Island Inlet of Superior Bay. The Inlet is a 17-acre shallow, protected embayment with emergent vegetation connected to Superior Bay by a 50-foot-wide channel. An investigation in 1995 by the WDNR concluded that ecological impacts to Newton Creek and Hog Island Inlet were severe. In 1997, Murphy Oil made improvements to their wastewater treatment facility and remediated contaminants in the upstream impoundment area and Segment A of Newton Creek. In 2003, the DNR removed and disposed 4000 yards of contaminated sediment and floodplain soils from Newton Creek and Segments B-K. Once contaminated sediments are remediated, Hog Island Inlet will provide valuable sheltered, productive, shallow-water habitat.
Wisconsin Department of Natural Resources	Integrated Science Services	Northern Goshawk Monitoring Database	The Wisconsin Department of Natural Resources (DNR) has been collecting information on Northern Goshawks for sometime. Many departmental priorities are associated with this species and the habitats it uses. Department staff from the Bureaus of Endangered Resources, Integrated Science Services, Wildlife Management, and Division of Forestry are working together to meet objectives established for Northern Goshawks by the department. Annual monitoring of existing territories is one of these objectives. This database was developed to document productivity results of Northern Goshawk Territories in Wisconsin. This data will be analyzed to help assist in evaluating the statewide population.
Wisconsin Department of Natural Resources	Integrated Science Services	Northern Highland Fishery Research Area	Fish and angler data from 1946 to present, for up to five lakes in the Northern Highland State Forest. Lakes included: Escanaba, Nebish, Pallette, Spruce, and Mystery. The purpose is for long-term fish research, fish population variability, regulation evaluations, etc.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Wildlife Management	Pheasant Crowing Counts	Crowing rooster pheasant surveys are conducted to monitor pheasant population trends throughout Wisconsin's pheasant management counties. This database reports the results of both the spring pheasant crowing count index and the hen index, and provides for analysis of historical population trends. In addition to an estimation of populations, these indices may also provide evaluation of wild pheasant restoration projects such as: Iowa and Jilin F1 release areas, the Dodge County Private Lands Project, the Glacial Habitat Restoration Area and various cooperative habitat projects using Pheasant Stamp, Wings Over Wisconsin, and Pheasants Forever funds. The purpose of the study is for population trend interpretation, annual and long term comparison.
Wisconsin Department of Natural Resources	Integrated Science Services	Red-shouldered Hawk Cooperative Study	In 2002, a research project was initiated to assess the effects of forestry practices on state threatened Red-shouldered Hawks breeding on the Menominee Indian Reservation. The project is a cooperative effort between the Wisconsin Department of Natural Resources, the Menominee Tribes of Wisconsin, and Menominee Tribal Enterprises. Responses from broadcast surveys are followed up by ground searches to locate active nests. Microhabitat data is collected from occupied nests and compared to random plots. Surveillance cameras are placed at active nests to record prey species, and predation occurrence. The purpose of the study is to identify nesting and foraging habitat preferences of Red-shouldered Hawks; to document hawk nesting density and productivity during the study; collect long-term data on the possible impacts of commercial selection harvest logging on nesting Red-shouldered Hawks; and to recommend forestry management guidelines to benefit this species within similar habitats.
Wisconsin Department of Natural Resources	Remediation and Redevelopment	Registry of Closed Remediation Sites	Closed sites with groundwater contamination remaining above Ch. NR 140 enforcement standards are included in this registry. Sites exceeding Ch. NR 720 soil standards have also been added since Aug. 1, 2002. A Closed Remediation Site is parcel of land at which the groundwater has become contaminated and which is affected by a particular type of legal restriction. Specifically, certain steps have been taken to stabilize/remediate the contamination, and the state is satisfied that no further efforts are necessary provided that certain precautions are used for some uses. The owner agrees to a restriction on the legal uses of the property in exchange for not having to take further action for remediation. The restriction may affect well construction or other uses of the land and is binding upon whoever becomes the owner of a property. With the Registry of Closed Remediation Sites, defined by changes in NR 700, users can find properties in which they may be interested using an interactive map of the state, zooming in and out to find a location of interest. Users can also search by county or city, township or village.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Root River Steelhead Facility	Salmon and trout migrate up Wisconsin tributaries in spring and fall each year during their spawning runs. The Root River Steelhead Facility is a weir located on the Root River to capture these fish. Department personnel capture salmon and trout for propagation and fisheries management purposes. All fish returning to the weir are counted with some used for collecting eggs and sperm and others for collecting biological data on including species, length, weight and finclip. The purpose of collecting eggs and sperm are to continue our Lake Michigan stocking program. Wisconsin streams are not conducive to successful salmon and trout spawning so the Department must collect eggs and sperm from wild fish to continue the stocking program. In addition, because we collect information on the number, type, length and weight of returning salmon and trout we can develop trends on health and condition of these fish and assess the return to rivers for each species.
Wisconsin Department of Natural Resources	Integrated Science Services	Sediment Core Data	There are about 72 lakes for which there are sediment core data. Each parameter is on a different spreadsheet. Some do not have zooplankton or algal pigments. This data is used to determine water quality history. The purpose of the data are to determine water quality history.
Wisconsin Department of Natural Resources	Integrated Science Services	State Natural Area Breeding Bird Survey	Breeding bird surveys conducted by volunteers and some DNR employees at a variety of State Natural Areas. Some sites are well represented while others have never been surveyed. The purpose of these surveys is for inventory, monitoring and evaluation of State Natural Areas.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Statewide Fish Contaminants	Data on contaminants in fish collected from Wisconsin waters. Includes physical and chemical data on fish such as collection location, fish species, length, sex, contaminant, concentration of contaminant, quality assurance information, and other sample information. This data collection supports the Fish Advisory and Sediment Management and Remedial Techniques program efforts characterizing contaminated sediment areas. These data are collected to primarily issue fish consumption advice, but also to investigate contaminant sources and contaminated sites; analyze pollution trends, track their extents, and assess damage; monitor pre/post remediation efforts and measure their success; and predict wildlife impacts.
Wisconsin Department of Natural Resources	Integrated Science Services	Stream Habitat Evaluations	1.Priority watershed Program Evaluation. Stream habitat and fish data were collected for evaluating BMPs in improving stream ecosystems. 2. Urban Stream Data. Stream habitat and fish data were collected for evaluating impacts of urban land use on stream systems. The purpose of this research is to evaluate the impacts of urban land use on stream systems.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Wildlife Management	Waterfowl Breeding Population Surveys	The Waterfowl Breeding Population Survey involves randomly selected aerial transects with ground truth counts to generate data for population estimates. In addition to waterfowl, wetland number and type are recorded in the transects. The survey is patterned after the North American Waterfowl Breeding Population Survey developed by the US Fish & Wildlife Service, but modified for local conditions. Population estimates are published for four strata of Wisconsin; Southeast Central Region, Northern Low Density Region, Northern High Density Region, and Southwest Driftless Region. Population estimates for Mallard, Blue-Wing Teal, Other Ducks, and Canada Geese are presented. Annual survey results, including numbers of wetlands and waterfowl population estimates from 1973 to the present, are summarized and presented. Population estimates are used for monitoring spring breeding waterfowl population trends.
Wisconsin Department of Natural Resources	Watershed Management	WI Long Term Trend Monitoring	The Wisconsin Long Term Trends monitoring networks consists of 42 surface water monitoring stations spread throughout the State. Sites are sampled either quarterly or monthly for a variety of parameters including nutrients, suspended solids, dissolved oxygen, and trace metals.
Wisconsin Department of Natural Resources	Wildlife Management	Wildlife Health Contaminant Database	The Wildlife Health (Toxicology) Program focuses on monitoring federally designated Areas of Concern around the state for the effects that environmental contaminants such as PCBs and heavy metals have on wildlife resources. Another aspect is to insure that those harvestable wildlife species are safe for human consumption. The purpose of the project is to monitor contaminants in wildlife.
Wisconsin Department of Natural Resources	Wildlife Management	Wildlife Health Disease Surveillance Database	The Wildlife Health Program is responsible for investigating, monitoring, and managing the impacts of diseases on free-ranging and captive Wisconsin wildlife. The Wildlife Health Disease Surveillance Database contains necropsy and serology information related to the results of disease monitoring efforts and is used to evaluate the health of wildlife populations and individual animals. The program's purpose is disease surveillance in free range and captive wildlife species.
Wisconsin Department of Natural Resources		Wisconsin Beach Monitoring Program	The Wisconsin coastal beach program is a collaboration between state and local environmental and health agencies to monitor recreational waters for health risks to help people make informed choices when they go to the beach.

Organization	Department	Title	Description
Wisconsin Department of Natural Resources	Bureau of Watershed Management	Wisconsin Beach Program	In 2003, the Wisconsin Department of Natural Resources, in cooperation and collaboration with local, state and federal authorities, is beginning implementation of the federal BEACH (Beaches Environmental Assessment and Coastal Health) Act of 2000. The BEACH Act is an amendment to the Clean Water Act requiring all coastal states, including Great Lakes states, to develop programs for effective water quality monitoring and public notification at coastal recreational beaches. The US Environmental Protection Agency has made grants available to participating states to develop and implement a statewide beach program. The Wisconsin Department of Natural Resources (WDNR) is the link between the federal government and local health departments, and helps to set the standards for the beach program and funnel federal funds to the local authorities.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Wisconsin DNR Lake Maps	Detailed scanned images of Wisconsin DNR Lake Maps. Lake Maps were created by the WDNR, Wisconsin Conservation Dept., and the CCC for Wisconsin. The purpose of this site is to make Wisconsin DNR Lake Maps readily available.
Wisconsin Department of Natural Resources	Integrated Science Services	Wisconsin Frog and Toad Survey	
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Wisconsin Lakes - Aquatic Plant Database	File consists of information on aquatic plants collected around the state of Wisconsin. The purpose of the file is for research and historical documentation.
Wisconsin Department of Natural Resources	Fisheries Management - Habitat	Wisconsin Lakes - Sensitive Area Designations	As stated in Ch. NR 107.05, sensitive areas are areas of aquatic vegetation identified by the Department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water. The purpose of this dataset is to identify areas with unique and/or critical ecological habitat; and/or historical, geological, and/or archaeological significance.
Wisconsin Dept. of Natural Resources	Ecological Inventory and Monitoring	Wisconsin Statewide Small Mammal Inventory	Objectives: This project will focus on species with deficiencies in habitat, population and distribution data (excluding Chiroptera - bats). For approximately 40 smaller, primarily nongame mammal species, we are in the process of determining: 1. Local and regional distribution 2. Relative abundance 3. Habitat association 4. Population trend and status 5. Influence of land use and management 6. Ecology of vector-borne diseases

Organization	Department	Title	Description
U.S. Local			
BROWN COUNTY HEALTH DEPT.		Great Lakes Beach Monitoring	THRU OUR D.N.R. THE HEALTH DEPT. CHECKS SOME OF OUR PUBLIC SWIMMING BEACHES TO DETERMINE THE E. COLI COUNT FOR THE TEST DATE
Carlton County Soil and Water Conservation District		County River Monitoring	Monitor rivers throughout Carlton County for various physical parameters.
Cayuga County Health Dept., Environmental Health Division		Public Bathing Beach Surveillance	Compliance with NTS Sanitary Code, Subpart 6-2, Bathing Beaches
Cayuga County Health Dept., Environmental Health Division		Public Water Supply Monitoring	Compliance with Federal Safe Drinking Water Act and NYS Sanitary Code Part 5
Cayuga Lake Watershed Network		Cayuga Lake - Citizens Statewide Lake Assessment Program	To provide data over time from 4 deep water locations
Center Line		Center Line Illicit Discharge Elimination Program	Three county drains have been identified as potential sources for illicit discharges. Two of these three drains have been surveyed for E. coli to determine illicit discharge locations. Sixty-one samples along 19 miles of sewer tributary have been sampled. Each location was sampled twice. Follow up sampling and dye testing will be performed if problems are detected in the initial samples.
Center Line		Center Line Storm Sewer Overflow/Wet Weather Monitoring	The city storm sewer is monitored during wet weather events for high E. coli levels.
Charlevoix County Planning Department		Land Use Inventory	Perform Land Use Cover Inventory periodically to determine change in land use/cover of County
Chicago Park District		Beach Monitoring	The Chicago Park District manages the city's 31 lakefront and one in-land beach for the enjoyment of Chicago families and visitors.
City of Ithaca		Six Mile Creek	Pilot project for flood mitigation assessment in Tompkins County
City of Ithaca Environmental Laboratories		Watershed Assessment Program: Lake Monitoring	Development of Sediment and Phosphorus TMDLs
City of Milwaukee Health Department		Water Quality Monitoring	Surveillance water quality baseline monitoring surface water quality monitoring
Cuyahoga County Board of Health	Environmental Health Services	Bathing Beach Water Quality Program	The purpose of the bathing beach water quality program is to prevent the occurrence of disease that can result through swimming in recreational waters, and to educate beach operators and the public about potential risks that may be associated with swimming in recreational waters. Bathing waters, and other influences on water quality such as storm sewer outfalls, creeks, etc. are monitored Memorial Day through Labor Day to determine E. coli bacterial levels. Water quality data is disseminated to beach operators and the public via telephone, website, and local newspaper. Water quality advisories are issued as needed.

Organization	Department	Title	Description
Cuyahoga County Board of Health		Permanent Sampling Program	The Board of Health established a streammonitoring program in the late 1980's. This program has allowed for the chemical and biological monitoring of water quality in our health jurisdiction. The information collected from this program has documented the need for the Board of Health's Operation and Maintenance Program for Household Sewage Treatment Systems (HSTS). To date, thousands of water quality samples have been collected. Likewise, over 50 permanent water quality monitoring sites have been established within the various watersheds in Cuyahoga County. The sampling data collected is used to obtain general baseline conditions and to identify problem areas potentially being impacted by sources of water pollution. These locations are sampled five times per year, during dry weather conditions. Likewise, chemical sampling occurs throughout streams, storm sewers, and ditches in Cuyahoga County. This information is used to assess and prioritize areas within watersheds that need to be addressed for specific pollutant reductions.
Douglas County Department of Health and Human Services		Inland Beach Monitoring Program	To determine the water quality of our inland lakes that are used by residents and visitors to our area. Also to identify sources of pollution.
Elkhart County Health Department	Environmental Health Services	Seasonal Surface Water Testing	Seasonal surface water testing from May to October. Focus on E. Coli as it relates to full body contact in largest recreational bodies of water. Additional testing on pH, DO, nitrates, phosphates, chlorides, TDS and Temp.
Elkhart Public Works & Utilities		Fish Community Surveys of River & Streams in Elkhart & St. Joseph Counties, IN.	We are using fish communities as water quality indicators to document what impact our urban environments impose on the river & stream resources.
Erie County Department of Health	Environmental Health	Beach Monitoring	The Erie County Department of Health is responsible for overseeing all monitoring programs in the county, issuing beach permits, and enforcing state regulations.
Green Bay Metropolitan Sewerage District		GBMSD Ambient Water Quality Monitoring Program	To collect water and sediment quality data from the Lower Fox River and Green Bay, with the purpose of better understanding the natural resource and to better assess possible impacts of our discharge on that resource.
Interagency Task Force on E. coli Point Source Committee.		Northwest Indiana E. coli monitoring	To identify key areas of the Lake Michigan Watershed which contribute significantly to beach closures in Northwest Indiana.
Lake County Health Department and Community Health Center	Lakes Management Unit	Lake Michigan Beach Monitoring Program – Lake County IL	Our Unit conducts daily E. coli monitoring from the end of May to Labor Day each year at 11 Lake County, IL Lake Michigan beaches and weekly E. coli monitoring at 2 Lake County, IL Lake Michigan Dog Beaches. Additionally, we are building two E. coli predictive models at two beaches starting at the end of May 2004. The purpose of the program is to protect the public's health utilizing E. coli as an indicator organism and to implement USEPA BeachAct goals.
Lake Shore Public Schools	Science Department	Great Lakes Education Program	Annually, sixth grade students test the water at Lake St. Clair. One goal is to meet the state objectives of involving students in testing.
LaPorte County Parks Department	Parks Department	Hoosier Riverwatch	Water and Macroinvertebrate testing and collection of waterways in the Lake Michigan Watershed.

Organization	Department	Title	Description
Macomb County	Public Works	Bear Creek Clean Water Initiative	The goal of the project is to identify and eliminate sources of E. coli contamination in Bear Creek. The first step is to track down the sources of E. coli entering the watercourse through systematic sampling and testing of the Bear Creek and drains tributary to it. Wet weather, dry weather, and sediments were sampled.
Macomb County	Health Department	Lake St. Clair Water Quality Assessment	The objectives of this project include establishment of a surface water and sediment quality database; evaluation of impact of climatological variables and sewer overflows on surface water quality; and collection of sediment chemistry data at previously identified locations of concern. The project includes five complementary monitoring activities: near shore, off shore, watershed, bathing beach, and wet weather.
Macomb County	Health Department	Macomb County Bathing Beach and Surface Water Quality Program	The Macomb County Health Department conducts a water quality monitoring program each year from mid April through late September. Water samples are analyzed for Escherichia coli (E. Coli) bacteria, which, in high numbers, indicate that surface water contamination by sewage or other wastewater has occurred and that harmful bacteria may be present.
Macomb County	Health Department	Macomb County Illicit Discharge Elimination Program	This project focuses on the elimination of improper connections to the storm sewer system, as well as, the elimination of illegal dumping into storm sewers. In addition, the project focuses on minimizing the amount of seepage into the storm water system from the sanitary sewer system and from septic systems.
Macomb County	Public Works	Macomb County Illicit Discharge Elimination Program	This project conducts initial investigations of outfalls for E.coli temperature, surfactants, and ammonia as part of the Phase II permit process.
Macomb County	Department of Planning and Economic Development	Mapping Database of Macomb County Outfall Locations	For each of the 27 communities in Macomb County three preliminary Geographic Information System (GIS) data layers are being created to help communities with Phase II permit requirements. Data layers include US census urban boundaries, MDEQ approved sub-watershed and drain basins, and outfall locations and ownership.
Macomb County	Health Department	Surface Water Sampling Program	This project focuses on monitoring of surface water quality through systematic sampling of county watersheds.
Manitowoc County	Soil and Water Conservation	Lake Michigan Bacteria Source Tracking	Sources of E coli bacteria will be identified through monitoring of bacteria at Manitowoc County Beaches. Identified sources will be corrected to the extent possible
Manitowoc county	HEALTH	LAKE MICHIGAN BEACH WATER QUALITY	MONITORING THE SWIMMING BEACHES OF LAKE MICHIGAN IN MANITOWOC COUNTY. INFORMING THE PUBLIC OF WATER QUALITY ISSUES.
Manitowoc County	Soil and Water Conservation	Manitowoc County Beach, e Coli Source identification	Coordinate monitoring efforts to achieve identification of sources of E. coli Bacteria responsible for Beach Closures
Marinette County Land and Water Conservation Dept.			To locate and measure wildlife damage to crops
Marinette County Land and Water Conservation Dept.			General Information and to modify county shoreline zoning

Organization	Department	Title	Description
Marinette County Land and Water Conservation Dept.			To provide supporting data for a future grant application
Marinette County Land and Water Conservation Dept.			We have been working with the Wisconsin Wetlands Assoc. to determine the presence of purple loosestrife. We will begin an effort to track Eurasian water milfoil in 2004 if grant funds are received. We hope to build on these areas.
Milwaukee Metropolitan Sewerage District		WATERBase - Milwaukee Metropolitan Sewerage District Water Quality Monitoring Data	The Milwaukee Metropolitan Sewerage District (MMSD) maintains an extensive water quality monitoring program to aid in pollution abatement, facilities planning, and flood control. As a result, a large data set of traditional water quality measurements beginning in 1975 became available. Other physical, biological, and chemical measurements as well as more sampling sites have been added each year.
Milwaukee Metropolitan Sewerage District(MMSD)	Water Quality Research Dept.	MMSD Surface Water Quality Monitoring Program	The Surface Water Quality Monitoring program was developed and exists to comply with State Discharge Permit regulations, Clean Water Act, and supplies monitoring data used for operations and facilities planning.
North Shore Sanitary District			Bacteria Counts at Waukegan Beaches
North Shore Sanitary District			Waste Water Flows and Overflows From Storm Water Treatment Facilities
Northeastern Illinois Planning Commission		Lake Michigan Lakewide Management Plan (LaMP): Types and Locations of Pollutant Sources in Northeastern Illinois	description of the locations and types of known potential sources of toxic materials and nutrients that originate within Illinois' portion of the Lake Michigan watershed
Northeastern Illinois Planning Commission	Environment and Natural Resources Group	Lake Water Quality Assessment Program	collect water and sediment quality data on non-routinely monitored, publicly-owned or publicly-accessed lakes within the six-county northeastern Illinois region
Northeastern Illinois Planning Commission	Research and Forecast Group	Land Use Inventory	Inventory land use cover for six counties of northeast Illinois (Cook, DuPage, Kane, Lake, McHenry, and Will counties), based on interpretation of aerial photography. The data product is an Arc/Info coverage, with the 3,750 sq. mi. region delineated into
Northeastern Illinois Planning Commission		Unit Area Pollutant Load Estimates for Lake County, Illinois, Lake Michigan Watersheds	event mean concentrations were used to calculate annual pollutant loadings for each of the ten Lake County Lake Michigan watershed inventory land uses, not including water, and to calculate total loads by watershed
Northeastern Illinois Planning Commission	Environment and Natural Resources Group	Volunteer Lake Monitoring Program	volunteers measure lake water clarity (transparency) using a Secchi disk; subset of volunteers also collect water quality samples
Northeastern Illinois Planning Commission			Area wide Water Quality Management Plan
Northeastern Illinois Planning Commission			An Evaluation of Urban Storm water Pollutant Loads to Lake Michigan form Lake County, IL
Oakland County	Drain Commissioner's Office	Chapter 20 Drains in Oakland County	The purpose of this program is to map the drains in Oakland County defined in Chapter 20 of the Drain Code (Chapter 20 drains are established at the county level to protect public health).

Organization	Department	Title	Description
Oakland County	Health Division	Drinking Water Supply Program, Well Protection and Education Code	The purpose of this program is to allow for the issuance of permits for new well construction and inspection of private wells, as well as educate the citizens of Oakland County who utilize ground water for drinking.
Oakland County	Planning And Economic Development Services	Environmental Stewardship Community Inventory	The purpose of this program is to inventory local community master plans and ordinances relative to standards for water resources and natural areas protection.
Oakland County	Planning and Economic Development Services	Geographic Information System (GIS) Data Inventory	The program monitors a variety of land-based information through Geographic Information Systems (GIS) including land use, impervious surface, community master plans, significant potential natural areas, and wetlands and water features.
Oakland County	Health Division	Oakland County Beach Monitoring Program	Water at each of the beaches in Oakland County is tested on a weekly basis June through August, measuring for an indicator bacteria, Escherichia coli (E. Coli). The water collection and beach surveying are done by environmental health students hired by the county for summer internships.
Oakland County	Drain Commissioner's Office	Oakland County Illicit Discharge Elimination Program	The project focuses on the elimination of improper connections to the storm sewer system, as well as the elimination of illegal dumping into storm sewers. In addition, the project focuses on minimizing the amount of seepage into the storm water system from the sanitary sewer system and from septic systems.
Oakland County	Drain Commissioner	Twelve Town (GWK Basin) Combined Sewer Overflow (CSO) wet weather event monitoring	The George W. Kuhn (GWK) Basin servicing Twelve Municipalities in Southeast Oakland County is monitored for E.Coli and Fecal coliforms during wet weather overflow events to make sure that the system is functioning properly. In addition seven separated storm sewer systems are also monitored for E. Coli and Fecal coliforms including; the GWK North, GWK South, Red Run Warren, Wilson, Walker Relief, Henry Graham, and Dequinder Rd. Drains.
Ozaukee County Planning, Resources & Land Management			Ulao Creek was straightened in the past and the land use in the watershed has changed dramatically. The land use went from farming to urban in most of the watershed. The Ulao Creek Partnership is interested in finding out what the base flow of the creek
Racine County	Land Conservation	Land & Water Resource Management Program	To reduce soil erosion to "T" value on all cropland and prevent any direct discharge of ag. manure from entering surface and groundwater.
Saint Clair County	Health Department	Bathing Beach and monitoring program	Protect citizens of Saint Clair county from exposure to water conditions that may be detrimental to health. This program seeks to provide information on water quality; provide education programs to community on water quality; establish an information database on water quality, and; preserve water quality.
Saint Clair County	Health Department	Saint Clair County Illicit Discharge Elimination Program	This project focuses on the elimination of improper connections to the storm sewer system, as well as, the elimination of illegal dumping into storm sewers in Anchor Bay and Pine River watersheds by testing drainage areas along natural waterways and roadside ditches. It targets testing of failing septic systems.

Organization	Department	Title	Description
Saint Clair County	Drain Office	Saint Clair County Illicit Discharge Elimination Program	This project focuses on the elimination of improper connections to the storm sewer system, as well as, the elimination of illegal dumping into storm sewers in Anchor Bay and Pine River watersheds by testing all county drains. This project will move to other watersheds as funding permits.
Saint Clair County	Health Department	St. Clair County Monitoring Sites Other Than Beaches	Gather data for background information and to help determine possible causes of beach closings.
South Eastern Michigan Council of Governments (SEMCOG)		Aerial photography	Southeastern Michigan Council of Governments' (SEMCOG) 36-year aerial photography collection consists of seven surveys (the first in 1966 and then every five years since 1970) totaling over 16,300 frames. Each survey covers the Southeast Michigan region consisting of Livingston, Macomb, Monroe, Oakland, St. Clair, Wayne and Washtenaw counties.
South Eastern Michigan Council of Governments (SEMCOG)	Information Services	Demographic Data	Southeastern Michigan Council of Governments (SEMCOG) collects and develops a wide range of demographic data across the seven county Southeast Michigan Region. Including: Regional Development Forecast (RDF), Community Profiles, Annual and monthly estimates of population and households, and Residential building permits.
South Eastern Michigan Council of Governments (SEMCOG)		Precipitation Data	For over 30 years, South Eastern Michigan Council of Governments (SEMCOG) in partnership with Wayne County, Macomb County, Livingston County, and the City of Detroit has maintained a Rain Gauge Network covering much of Southeast Michigan. The network covers Wayne, Oakland, Macomb, Livingston, and parts of Washtenaw counties. Data are collected by independent observers from approximately 75 precipitation gauges.
South Eastern Michigan Council of Governments (SEMCOG)		SEMCOG Interactive Maps	SEMCOG's Internet Mapping is a collection of map services published on the Internet that let visitors to our Web site view and interact with many of SEMCOG's GIS datasets. These map services are interactive in nature, in that the user is provided tools to navigate the map and display up to date information about map features. This technology enables SEMCOG to make our spatial data available to the public in a clear and easy to use format.
St. Joseph County Conservation District	Rocky River Watershed Coordinator	Rocky River Water Quality Monitoring	The Rocky River is the focus of a 319 Grant through the United States Environmental Protection Agency and Michigan's Department of Environmental Quality.
Tompkins and Cortland County Soil and Water Conservation Districts		Fall Creek/Virgil Creek Sampling and Monitoring Plan	The objective of the program is to establish current baseline water quality conditions in Virgil Creek and Fall Creek and to identify any current or future use impairments that might exist. Additionally, the data collected will help local, regional, and state watershed managers gain a better understanding of spatial differences in water quality along these two creeks as well as the location and impact of any potential sources of pollution in these creeks. Spatial analysis of this data may be useful in refining this program as well as in targeting future monitoring programs and the implementation of best management practices for areas with documented water quality problems and/or improvement opportunities.

Organization	Department	Title	Description
Town of Caroline		Stream Restoration at the Barille Site	
University Wisconsin Extension		Nutrient Management program	To provide nutrient management properly on farm and home soils
Village of Ephraim	Wastewater Treatment Plant	No Title (we are not that formal)	Monitoring of plant operations and effluent to comply with a Wisconsin NPDES permit
Washington County	Land & Water Conservation Division	Stream Monitoring in Washington County	1)Determine existing water quality conditions and assess watershed protection needs. 2)Promote stewardship by raising public awareness about water quality issues. 3)Evaluate effectiveness of Best Management Practices. (before/after) 4)Evaluate effectiveness of long-term, comprehensive watershed rehabilitation efforts. 5)Reveal and characterize trends in water quality.
Wayne County	Health Department	Wayne County Bathing Beach Water Quality Program	During the summer months the Wayne County Environmental Health Division monitors levels of the bacteria, E. coli, at the of the natural bathing beaches in Wayne County to protect the health of the bathers.
Wayne County Department of Environment		Rouge River Project	Work on monitoring is targeted at developing a long-term monitoring plan for assessing the "health" of the Rouge River. This program will be designed to assess long-term trends, document compliance with the water quality standards, and will be consistent with upcoming policy from United States Environmental Protection Agency regarding wet weather monitoring for watershed planning. In addition, the Project is developing policies that are based upon resource monitoring as a trade off to end-pipe monitoring. The concepts have been accepted by the Urban Wet Weather Federal Advisory Committee and are in the process of being accepted by the local decision makers in the watershed. Areas of monitoring include public health, rainfall, habitat, benthos, fish, combined sewer overflow, water quality, stream level and flow, sediment monitoring, toxics, nonpoint source pollution, aesthetics monitoring, frog and toad survey.
U.S. Non-Governmental			
Audubon New York	c/o Cornell Lab of Ornithology	Important Bird Area (IBA) Program of Audubon New York	The Important Bird Area (IBA) Program of Audubon New York, in cooperation with a host of partners, has identified 127 critical bird breeding, migratory stop-over, feeding, and over-wintering areas in the state. Important Bird Areas have been identified throughout New York in all types of habitats, including forests, shrub/scrub, grasslands, freshwater and saltwater wetlands, and bodies of water. Since 1997 Audubon New York has been engaged in many efforts aimed at achieving conservation successes at IBAs. These efforts include several types of conservation actions, conservation planning, bird monitoring, and education and outreach.
Central Lake Superior Watershed Partnership		Monitoring the waters of Upper Michigan	To establish baseline data for the waters of Upper Michigan

Organization	Department	Title	Description
Chippewa Ottawa Resource Authority		Inter Tribal Fisheries and Assessment Program	To assess the health and structure of the tribal commercial fisheries in the 1836 Treaty ceded waters of the Great Lakes.
Clinton River Watershed Council		Adopt-A-Stream	Adopt-A-Stream is the umbrella program for CRWC's volunteer stewardship activities. Monitoring includes physical (in-stream and riparian habitatconditions) and biological (macroinvertebrates) parameters. Other activities include riparian landowner stewardship such as streambank stabilization, native landscaping, and river clean-ups. Currently only several individuals and groups are involved in the monitoring portion of this program, but CRWC has developed a plan to expand this program in the next two years to include monitoring teams in each of the seven major subwatersheds of the Clinton River.
Clinton River Watershed Council		Stream Leaders	Stream Leaders is CRWC's school-based water quality monitoring program. Currently there are two dozen schools in the program monitoring at approximately 40 sites twice a year (May and October). Data is collected on the following parameters: chemical (pH, phosphates, nitrates, temperature, turbidity, DO, BOD, and fecal coliform), physical (in-stream and riparian habitat conditions), and biological (macroinvertebrates). The data are compiled into a Water Quality Index and CRWC publishes an annual "scorecard" on the overall water quality for each of the seven major subwatersheds of the Clinton River (Upper Clinton, Paint Creek, Stony Creek, Clinton Main, North Branch, Red Run, and Clinton River East).
Clinton River Watershed Council (MDNR and Trout Unlimited)		Clinton River Coldwater Conservation Project	This is a joint effort between CRWC, MDNR, and four chapters of Trout Unlimited to assess fish habitat and identify enhancement opportunities in the Clinton River. The project's first phase is focusing on Galloway Creek in Auburn Hills and the mainstem of the Clinton River from Galloway Creek to the Oakland-Macomb county line. Volunteer teams are collecting data on temperature, flow, in-stream and riparian habitat conditions, and macroinvertebrate communities, using methods approved by MDNR. This will be the most comprehensive inventory of this stretch of the river that has ever been undertaken.
Conservation Resource Alliance		River Care Program	Our River Care program is designed to provide for the short and long-term maintenance of waterways throughout northwestern Michigan. We passively monitor for ANS while completing and monitoring our watershed restoration projects (primarily erosion control and instream habitat improvement projects).

Organization	Department	Title	Description
Crystal Lake Watershed Fund		Environmental Monitoring and Assessment of the Crystal Lake Watershed	Environmental parameters describe the existing and historical conditions within the Watershed. Distinctions can be made between levels of substances that occur naturally or are artificially introduced into the water, land, and air of the Watershed. It is important to follow scientifically acceptable procedures for sample collection and analysis for quality assurance and quality control purposes. Baseline conditions and levels and changes are documented and then assessed to determine effects (positive, negative, or none) that may be produced due to population influx, changing land uses, and other developments. Decisions are then considered in watershed management for purposes of both prevention and remediation. Monitoring programs derive their utility and validity from the length of the data series in time, the consistency and intercomparability of the measurements, and the reliability of their data. Available resources are appropriated wisely to select the most meaningful sites, times, and parameters for monitoring and assessment.
Earth 911		Beach Monitoring Data Repository	This partnership effort between dozens of states and communities and several groups including US EPA, and Earth 911 will provide you with specific information regarding the most recent water quality conditions at your local beaches. It also provides assess to community-specific actions that can be taken to help keep local beaches, coastal waters, and lakes, streams, and rivers clean and safe.
Friends of the Buffalo Niagara Rivers		Assessment of Potential Aquatic Habitat Restoration Sites in the Buffalo River AOC"	The study will document the following biological and physical characteristics of 10 promising potential habitat restoration sites within the AOC:-benthic features-fishery features-vegetation-limnological features-physical characteristicsThis project is part of a unique collaborative effort to plan and fund sediment remediation for the restoration of aquatic habitat. The USACE has completed a Reconnaissance Study of the Buffalo River and will soon begin a Feasibility Study (FS) of clean-up options. This project will help define the FS and provide useful data bases for decisions on remedial options.
Grand Traverse Band of Ottawa and Chippewa Indians		Grand Traverse Band - Biological Services Program	The Grand Traverse Band-Biological Services Program (the Tribe) primarily monitors commercial fish species within Grand Traverse Bay and northeastern Lake Michigan. The Tribe monitors and samples commercially caught fish, as well as those collected through independent assessments. The Biological Services Program utilizes various sized bottom gill nets. Some limited electroshocking is done within the Bay as well.
Grand Traverse Band of Ottawa and Chippewa Indians		Grand Traverse Band Water Quality Program	To monitor waters within the historic reservation for the purpose of a) determining the current water quality conditions and b) detecting long-term trends in water quality

Organization	Department	Title	Description
Great Lakes Commission		Centralized Air Emissions Reporistory Online	The Centralized Air emission Repository On-Line (CAROL) is a web site developed by the Great Lakes Commission that uses maps of the Great Lakes region to illustrate the amount of toxic chemicals being released to the basin. The data is compiled by the eight Great Lakes states and the province of Ontario and presents the best available emission release data for a calendar year.
Great Lakes Research Consortium		Semivolatile Air Monitoring Network	Concentration and loading of organics (including dioxin) in air
Huron River Watershed Council		Adopt-A-Stream	To increase awareness and appreciation of the Huron River watershed by conducting a scientific study of the mainstem and streams by volunteers, and to facilitate individual and community efforts that preserve and improve the conditions necessary for a healthy river system.
Inland Seas Education Association		Invasive Species Monitoring Program; All Other Schoolship Programs	To monitor the introduction or spread of invasive species in our Lake Michigan sampling locations. This is a focus of our program, although it is completed as part of our educational programs aboard our Schoolships. Students of all ages (Grade 4 through adult) learn to identify native and invasive species and analyze collected samples for unusual new invasives.
Leelanau Watershed Council		Leelanau Watershed Council's Monitoring Program	The Leelanau Watershed Council's monitoring program is designed to compile comprehensive data for lakes and streams, develop nutrient budgets for each lake and identify trouble spots, and inform visitors, residents, and local officials of water quality conditions.
Menominee Indian Tribe of Wisconsin		Environmental Services Department - Surface Water Monitoring	Collect water quality data on the Menominee Indian Reservation
Michigan Lake and Stream Associations		Cooperative Lakes Monitoring Program	The Cooperative Lakes Monitoring Program (CLMP) is a partnership between the Land and Water Management Division of the Department of Environmental Quality (DEQ) and the Michigan Lake and Stream Associations, Inc. (ML&SA). The primary purpose of this cooperative program is to help citizen volunteers monitor indicators of water quality in their lake and document changes in lake quality over time.
Michigan Lakes & Streams Association, Inc.		1) Purple Loosestrife Watch; 2) Eurasian Watermilfoil Watch; 3) "Drop-a-Brick" (Zebra Mussel Watch)	The three aforementioned programs are essentially one program with three parts. The purpose(s) being for lake associations, and stream associations to document the introduction of these three ANS, to map the location and rate of spread, and to monitor the success and/or failure of any local control or eradication programs.

Organization	Department	Title	Description
Mill Creek Action Alliance		Mill Creek Volunteering Project	The Mill Creek Volunteer Monitoring Project began in 1999 before a controversial drainage project was undertaken on a section of Mill Creek. Every spring and fall, volunteers collect benthic macro invertebrates and other water quality data from nine sites along Mill Creek. Data are recorded and published. Data are also sent to the Michigan Department of Environmental Quality. The goal of the project is to collect and compare data from dredged and non-dredged sites and to document the impact dredging has had on the water quality of Mill Creek. The project is designed to be a long term monitoring project. It will continue as long as volunteers are available to collect data. Two full color reports have been published, "The Effects of Dredging vs. The Effects of River Restoration On Mill Creek" and "Mill Creek Volunteer Monitoring Project Second Annual Report". Contact the project manager for copies.
Mohawk Valley Water Authority	Water Quality Laboratory	Stream water quality monitoring - Oneida and Herkimer Counties Water Quality Committee	The Water Quality Committees of Herkimer and Oneida Counties have been monitoring stream water quality in the Great Lakes Basin using Finger Lakes- Lake Ontario Watershed Protection Alliance (FL-LOWPA)funding.
National Audubon Society		Christmas Bird Count	To obtain information on the distribution, status, and trends of bird opulations during the early winter season
National Wildlife Federation		Frogwatch USA	Frogwatch USA is a long-term frog and toad monitoring program managed by the National Wildlife Federation in partnership with the United States Geological Survey to: Collect information about frog and toad populations in the U.S.; Promote an appreciation for the diversity of frog and toad species; Foster an understanding of the importance of protecting wetland habitats; and Provide an opportunity to learn about and establish a closer relationship with the natural environment.
NatureServe		NatureServe	NatureServe and its network of member programs are a leading source for reliable scientific information about species and ecosystems of the Western Hemisphere. This site serves as a portal for accessing several types of publicly available biodiversity data.
Oneida Tribe of Indians of Wisconsin	Environmental Quality	Biological Monitoring Program	To collect baseline aquatic invert data, conduct pilot studies, determine reference sites for the development of biocriteria, conduct restoration projects to improve instream and riparian habitat, and continue collecting water quality data.
Oneida Tribe of Indians of Wisconsin	Environmental Quality	Oneida Nation Exotic Species Monitoring Program for the Year 1999	The goal of sampling for the first year was to determine the numbers and species of exotic species present in Reservation waters and to accurately map where those specimens were collected with GPS
Owasco Watershed Lake Association, Inc.		OWLA Water Quality Monitoring	To Keep Owasco Lake and its watershed free from pollution and sedimentation and enhance aesthetic and biological qualities.
Riveredge Nature Center		Testing the Water	The Testing the Waters Project seeks to involve students from schools throughout the Milwaukee River watershed in the monitoring of water quality on the river, the identification of factors affecting water quality of the river and the implementation of ac

Organization	Department	Title	Description
Save the Dunes Conservation Fund		Miller Woods Bird Banding Program	To determine trends and status of bird migrating and breeding populations by banding birds.
Sierra Club	Water Sentinel, Illinois Chapter	Water Sentinels Illinois	All Illinois Water Sentinels monitoring projects conduct the chemical and/or biological water quality monitoring needed to address issues specific to their waterbody. The Valley of the Fox, River Prairie and Heart of Illinois groups have focused their attention on nutrient pollution, due to the recognized nutrient problem in Illinois and the lack of state water-quality standards for nutrients. The Chicago Group is monitoring bacterial levels at Lake Michigan beaches. The McHenry County and Kishwaukee Solduc Group are monitoring some of Illinois' highest quality streams in the Fox and Kishwaukee watersheds, streams which are lying in the path of anticipated urban sprawl. These projects are gathering baseline data for these high quality streams, building a firewall of information against any possible degradation.
Sierra Club	Water Sentinel, Mackinac Chapter	Water Sentinels Michigan	The Mackinac Chapter Water Sentinels has been monitoring water quality in Horse Creek and the Pine River (Gratiot County) since 2001 by assessing benthic macroinvertebrates (aquatic insects) and polluted sediments.
The Nature Conservancy		Interactions between freshwater mussels and zebra mussels in the Upper Clinton River	To determine if chronic low levels of zebra mussel infestation on native mussels has a long-term impact on freshwater mussel populations in a small river habitat that supports two globally rare mussels.
The Nature Conservancy Pennsylvania Chapter	Pennsylvania Science Office	Aquatic Community Classification	Natural Heritage Program biologists are conducting an Aquatic Community Classification of biological communities occurring in Pennsylvania's streams and rivers. This project was initiated in order to define existing aquatic communities so that Pennsylvania's aquatic natural resources can be effectively managed and conserved. There are 5 primary objectives of the project: to centralize and evaluate existing aquatic information for Pennsylvania; to produce a description and map of Pennsylvania's aquatic biological communities; to examine relationships between the defined biological communities and their habitat; to assess the condition of Pennsylvania's aquatic communities; and to assess whether or not communities are rare or threatened in order to implement and prioritize conservation and/or restoration. This study will improve our understanding of Pennsylvania's aquatic natural resources, help prioritize waterway restoration, and assist the conservation and regulatory communities in making planning, restoration, and conservation decisions.
Thornapple River Watershed Con. & Barry Conservation District		Stream Team	We are just getting this set up, will send more info as we develop it.
Timberland Resource Conservation & Development Council		West Michigan Adopt-A-Stream and Regional Adopt-A-Stream	W. MI: To involve communities in stewardship of the land and water and to understand ecological connections. (mostly students); Regional (in development): To enhance the standardization of volunteer monitoring protocols throughout the Muskegon, White, and Grand River watersheds (& others).

Organization	Department	Title	Description
Tip of the Mitt Watershed Council		Comprehensive Water Quality Monitoring	Reliable and accurate water quality data for 54 sample sites on 47 lakes and rivers in Northern Michigan have been collected consistently for the last 17 years to be used by staff to evaluate aquatic ecosystem health, examine trends within or among water bodies, and identify specific problems.
West Michigan Environmental Action Council		Adopt-A-Stream	The Adopt-A-Stream program involves volunteers of all ages, and from all sorts of groups, in cleaning-up, monitoring and restoring streams throughout Kent County and surrounding areas. The goals of this programs are to: to protect and improve Kent County streams through community/citizen involvement in stream monitoring and restoration; to build citizen support for sound, local watershed management; to educate the public about water quality issues and empower citizens to protect and improve their streams by making use of federal, state and local government agencies and ordinances; and to supplement water quality data collected by professional staff in water quality agencies and scientific institutions.
Wildlife Habitat Council		Nest Monitoring Program (NMP)	Employees and community volunteers monitor nest boxes to document the nesting cycle and number of fledglings, in order to measure reproductive success. Each year these results, including numbers of nest boxes, eggs and fledglings, are submitted to Wildlife Habitat Council (WHC) and compiled into an annual report that documents the success of each species and the program as a whole.
Wisconsin's Water Action Volunteers		Citizen Stream Monitoring	The goals of the program are: 1. that Wisconsin citizens will monitor stream and river health. 2. to support data sharing for educational purposes. 3. to provide a network for volunteer groups, individuals, and schools to interact. 4. to provide support for civic conservation and environmental groups. 5. to help increase linkages between volunteer monitoring efforts and public resources protection programs.
U.S. University/Education			
Annis Water Resources Institute (Grand Valley State University)		Muskegon Lake Monitoring Program	Observe short-term and long-term changes in the ecological health of Muskegon Lake. Understand within lake dynamics and role of external driving forces. Integrate lake ecology to the watershed level, and society at large.
Central Wisconsin Groundwater Center		Private Well Water Testing	

Organization	Department	Title	Description
Colorado State University	Cooperative Institute for Research in the Atmosphere	Interagency Monitoring of Protected Visual Environments	The Interagency Monitoring of Protected Visual Environments (IMPROVE) program is a cooperative measurement effort governed by a steering committee composed of representatives from Federal and regional-state organizations. The IMPROVE monitoring program was established in 1985 to aid the creation of Federal and State implementation plans for the protection of visibility in Class I areas (156 national parks and wilderness areas) as stipulated in the 1977 amendments to the Clean Air Act. The objectives of IMPROVE are: (1) to establish current visibility and aerosol conditions in mandatory class I areas; (2) to identify chemical species and emission sources responsible for existing man-made visibility impairment; (3) to document long-term trends for assessing progress towards the national visibility goal; (4) and with the enactment of the Regional Haze Rule, to provided regional haze monitoring representing all visibility-protected federal class I areas where practical.
Cornell Cooperative Extension	Horticulture	Community Water Watch	A volunteer stream monitoring program
Cornell Cooperative Extension of Cayuga County		"P-Project": Education and Monitoring Program to Reduce External Phosphorus Loads to Owasco & Cayuga Lakes	The data will be utilized to prioritize future monitoring programs and phosphorus education programs. For example, if testing from a specific sampling site consistently produces higher than expected levels of total P, future monitoring may focus on that site in regard to more specific forms of phosphorus.
Cornell University	Natural Resources	Assessing the Health Of Great Lakes Coastal Wetlands	To assist in the development of a long-term binational monitoring program for Great Lakes coastal wetlands through the analysis of data collected by six teams in 2002.
Cornell University	Lake Ontario Biomonitoring Program	Biomonitoring program for Lake Ontario	At multiple stations, water samples are collected for nutrients (TP, Chl-a and N), zooplankton, and possibly phytoplankton from May through end of September.
Cornell University	Natural Resources	Hydroecology and conservation mapping	New York tributaries are mapped according to their need for restoration and the capacity of the communities to implement successful restoration projects. An assessment of the deviation of each tributary from its natural flow regime has also been developed.
Cornell University	Natural Resources	Lake Ontario Biocomplexity	The Lake Ontario Biocomplexity Project was designed to answer fundamental questions about ecosystem control including the extent to which ecosystems are self-organized or dominated by outside influences such as average water residence time.
Cornell University		Landscape Impact on Suburban Runoff: Determining Nutrient Loading Rates Based on Land Use	To assess the contribution of suburban landscapes on nutrient loading rates of surface waters.
Cornell University	Civil & Environmental Engineering; Ecology & Evolutionary Biology	Real-time Water Quality Monitoring in the Southern End of Cayuga Lake	Greater scientific understanding of coupled physical, biological, and chemical interactions of the southern basin of Cayuga Lake. Public outreach via website to increase understanding of lake processes and lake condition. Establishment of long-term data set for southern end of Cayuga Lake.

Organization	Department	Title	Description
Cornell University	College of Agriculture and Life Sciences		Characterize sediment, NO3-N, dissolved P, total P, alkalinity, SO4, Cl, pH, both concentration and loading
Cornell University Research Ponds, Depart. of Ecology and Evolutionary Bio		Aquatic Macrophyte Abundance Diversity	To record and evaluate submersed aquatic plant growth within Cayuga Lake and Provide accurate information to the governmental agencies charged with responding to public concerns of excessive "weed growth". Address the concerns of the public about the overall "health" of the Lake. Assess the contribution of aquatic plant communities to the Cayuga Lake ecosystem through scientific inquiry.
Cornell University, Dept. of Natural Resources/Cornell Center for the Env.		Study of sediment sources in streams of the glaciated Allegheny Plateau	Determination of dominance of surface generated or bank erosion in various drainages of southern Cayuga Lake
Dickinson College	The Alliance for Aquatic Resource Monitoring	Alliance for Aquatic Resource Monitoring (ALLARM)	ALLARM has the largest stream alkalinity and pH database in Pennsylvania with over ten years of data. Our one-of-a-kind database was built by a dedicated core of citizen monitors from across the state.
Florence County UW-Extension		Fisher Lake Restoration	Annual semester long program for middle and high school students. Workshops and seminars on shoreline ecology, watersheds, native plants and shore landscaping, water quality and testing. Fisher Lake is in the Upper Green Bay Watershed. In addition to shoreline restoration, students monitor water quality by gathering macroinvertibrates, and testing for bacteria, phosphorus, dissolved oxygen, temperature, clarity and pH. Students also monitored for zebra mussels this year.
Grand Valley State University	Pigeon River Watershed Monitoring Project	Pigeon River Watershed Monitoring Project	Determine current water quality conditions and establish baseline data, assess contributions of point and nonpoint sources, determine effects of hydrological events.
Grand Valley State University-Annis Water Resources Institute		AWRI Outreach and Education Program	Monitoring at Spring Lake, mouth of Grand River, and Lake Michigan at Grand Haven; is performed for educational purposes aboard the D.J. Angus vessel.
Heidelberg College	National Center for Water Quality Research	Coastal wetlands ability to trap non-point source pollutants	Pollutants include sediment, nutrients (P, N, Si, Cl), pesticides (atrazine, alachlor, metribuzin, metalachlor, etc)
Heidelberg College	National Center for Water Quality Research	Cooperative Private Well Testing Program	This program is designed to support local groundwater education and private source water protection by combining locally sponsored private well testing programs with the development of detailed local data bases on rural drinking water quality. It's a voluntary program focusing on analysis of water from private wells, and interpretation of the results in the contexts of shallow groundwater quality and human health risks from contaminants in well water. More than 25,000 wells have been tested from Ohio's 88 counties.
Heidelberg College	National Center for Water Quality Research	Hexagenia populations	Recolonization of Lake Erie by Hexagenia; its increase in abundance; its incorporation into diets of forage fish; interactions of zebra mussels and Hexagenia in western basin
Heidelberg College	National Center for Water Quality Research	Macroinvertebrate populations	Survey of macroinvertebrate communities

Organization	Department	Title	Description
Heidelberg College	National Center for Water Quality Research	Ohio Tributary Monitoring Program	The Ohio Tributary Monitoring Program is an ongoing activity of the Water Quality Laboratory. The program provides highly detailed data on concentrations of a wide range of water quality constituents at stations near the mouths of the major rivers in Ohio and the River Raisin in Michigan.
Heidelberg College	National Center for Water Quality Research	Pesticide Monitoring in Lake Erie and Ohio River Tributaries	Detailed sampling program for current use pesticides in Ohio. Results are in the context of ecological and human health risks.
Heidelberg College	National Center for Water Quality Research	Sediment and Nutrient Concentrations in the River Raisin	The program provides highly detailed data on concentrations of a wide range of water quality constituents at station on the River Raisin.
Indiana University	School of Public and Environmental Affairs	Indiana Volunteer Lake Monitoring Program	The Indiana Volunteer Lake Monitoring Program was established by the Indiana Department of Environmental Management to help protect and manage the state's lakes. Nearly three-quarters of Indiana's 520 lakes of 50 or more acres suffer from deteriorating water quality. We train volunteers statewide to monitor Secchi transparency. Each volunteer measures clarity from a boat at least biweekly from May to September. The goals of the project are to: identify long-term water quality trends in lakes; involve citizens in the active stewardship of their lakes; provide opportunities for citizens to learn more about lakes.
Institute for Fisheries Research		Lake Huron GIS	The LHGIS provides resource managers with a basin-wide, centralized collection of data sets spanning jurisdictions (i.e., state, federal, provincial, tribal, and local agencies) and habitats (i.e., nearshore, tributary, connecting channels, offshore, inland lakes, and terrestrial). The final product enables decision makes to more effectively plan for the basin's future, monitor its status, target protection and restoration efforts, and address key habitat issues, such as fragmentation.
Kellogg Biological Station, MSU		Nutrient Monitoring	Nutrients and major solutes are measured in groundwater springs, lakes, streams, and wetlands to study land/water interactions and the impacts of land use.
Lake Michigan College			Analyze water quality for classroom study project to write scientific paper.
Michigan Sea Grant		Zebra Mussel and Aquatic Nuisance Species Monitoring	Citizens, agency personnel, and Sea Grant staff report zebra mussel and other aquatic nuisance species sightings to the ZM/ANS Office, which compiles the data and forwards it through the zebra mussel network. This network includes ANS contacts from Sea Grant, the Great Lakes Commission, Great Lakes Fishery Commission, Great Lakes Environmental Research Laboratory, Environment Canada, Illinois Natural History Survey, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, Ontario Ministry of Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. National Biological Service, municipal and industrial water users, industry associations, citizen associations, and individuals.

Organization	Department	Title	Description
Michigan State University Extension	St. Clair County	Adopt-A-Stream	This is a grassroots program focused on macro invertebrate and chemical testing in the streams of St. Clair County. Anyone interested in taking action to improve our watershed is eligible and encouraged to take part in activities which include implementation of streambank clean-ups, streambank surveys, monitor stream insects and gauge water quality, execute streambank enhancement projects to help control erosion and stabilize streambanks, and learn more about the St. Clair River Watershed.
MSU Extension		Adopt-A-Stream	Promote awareness & insure future quality of watersheds in the county
New York Sea Grant		Eastern Lake Ontario Dunes Photomonitoring	To monitor the improvement of the E. Lake Ontario dunes.
Oakland University	Chemistry	Interim monitoring program	Educational tool that is also used to support environmental groups or specific targeted issues (e.g., forensic studies)
Ohio State University		Contaminant effects in different species	Measurement of contaminant loads in different species and associated effects; biological expressions of toxicity (from growth/reproductive impairment to toxicity)
Pennsylvania Sea Grant		Fish Tumors in Brown Bullhead Catfish	Monitoring of liver and skin tumor rates in brown bullheads from Presque Isle Bay, Lake Erie
Pennsylvania Sea Grant		Mayfly Recovery in Lake Erie	Monitor mayfly emergence during June and July. Track emergence with doppler radar
State University of New York (SUNY)	College of Environmental Science and Forestry	Monitoring and Event Response for Harmful Algal Blooms	Monitor and respond to harmful algal blooms
State University of New York at Cortland	Department of Biological Sciences	Herpetofaunal and Avian Populations in the Onondaga Lake Ecosystem	In the central aspects of this project we are examining the populations of amphibians and reptiles that inhabit the Onondaga Lake ecosystem. This urban lake ecosystem is characterized by a long history of severe human disturbance and is part of the Lake Ontario draniage basin. Our herpetofaunal monitoring and experimentation have been ongoing since the middle 1990's. Avian monitoring has been ongoing since 2001.
SUNY Oswego		Sterling Meteorological Station	Weather station is being established on the south shores of Lake Ontario. Site-specific data on wind speed, wind direction, humidity, rainfall, solar radiation, and barometric pressure will be collected. Project collaborators, such as the Lake Ontario Air Deposition Study (LOADS), Sterling Nature Center, and SUNY Oswego, will also use the weather station.
University of Michigan	Ocean Engineering Laboratory	Lake St. Clair Weather Buoy	An over-water data buoy was deployed to collect and report data in Lake St. Clair. The buoy supplied wind and water data to aid in the development of a system to predict beach closures and to guide county health officials in water sampling strategies.

Organization	Department	Title	Description
University of Michigan	Museum of Zoology-Insect Division	Michigan Odonata Survey	The purpose of the MOS is to encourage the study of Odonata; document the species that occur in Michigan; obtain better data on the abundance and distribution of federal and sate-listed species; define the flight periods and ranges for the species that are found in the state; record pertinent information on locality, habitat, phenology, and ecology in a database for use in publications devoted to the Odonata fauna of the state of Michigan; and to produce as atlas of Michigan Odonata for use by scientists and amateurs alike.
University of Minnesota	Natural Resources Research Institute	Canada Lynx Project	Monitoring habitat use, survival, and recruitment of the Canada Lynx in Minnesota.
University of Minnesota	Natural Resources Research Institute	Forest Bird Monitoring in the Great Lakes National Forests, Forest Bird Diversity Initiative	Presence and abundance of forest birds collected annually in Minnesota to investigate response of forest birds to regional land use patterns
University of Minnesota	Natural Resources Research Institute	Moose population cycles, ecosystem properties, and landscape patterns on Isle Royale	Annual measurements of browse availability, browse consumption by species, and nitrogen availability on Isle Royale - determining spatial patterns of browse consumption conifer basal area, and nitrogen availability related to moose population cycles and densities
University of Minnesota	Education	Water on the Web: Students Monitoring Minnesota Rivers and Lakes over the Internet	Water on the Web (WOW) is an NSF-funded project that allows college and high school students to monitor Minnesota lakes over the Internet. WOW integrates state-of-the-art environmental monitoring with geographic information systems, data visualization, and in-depth educational materials. The goal of the project is to train students to work with real-world data.
University of Wisconsin - Milwaukee	Great Lakes WATER Institute	WATERBase - Lake Michigan Monitoring Buoy	A pelagic monitoring buoy is moored on a triangular anchor system in 109 m of water. It is equipped for both meteorological measurements and water quality measurements (profiling surface to bottom). Data are logged on the buoy and transmitted via cell phone to the WATER Institute twice per day.
University of Wisconsin - Milwaukee	Great Lakes WATER Institute	WATERBase - Monthly Lake Michigan Monitoring Program	Monitoring sites extend from the Milwaukee Harbor to a pelagic station 16 km offshore, and include a perch spawning reef and an urban water intake area. The suite of measurements includes temperature, water clarity, water chemistry, phytoplankton and zooplankton abundance, and bacterial and plankton productivity. Some of these measurements are made directly from the research vessel Neeskay while others are made in the WATER Institute laboratories.
University of Wisconsin - Milwaukee		WATERBase - UWM Biology Stream Monitoring Data	Data available here consist of 12 hour averages calculated from raw data for the year 2000. Measurements taken every 10 to 15 minutes were averaged into a single daytime value representing data collected from 6 am to 6 pm and a nighttime value for measurements taken from 6 pm the date of the measurement until 6 am the next day.

Organization	Department	Title	Description
University of Wisconsin Green Bay		The Lower Fox River Watershed Monitoring Program	The LFRWMP is a multi-year water monitoring program which will provide independent, high-quality data that can be used to make resource decisions to improve water quality and foster habitat restoration within the Fox River Basin. Funded by a grant from Arjo Wiggins Appleton, the program involves coordination between area high school students and teachers, university students and researchers from the University of Wisconsin-Green Bay (UWGB) and the University of Wisconsin-Milwaukee (UWM), the Cofrin Center for Biodiversity, the Green Bay Metropolitan Sewerage District (GBMSD), and the US Geological Survey (USGS).Physical and chemical water quality parameters are assessed in the fall, spring, and summer monitoring events. Habitat assessment are conducted in the fall and summer sessions. Also, amphibian monitoring is conducted each spring, and macroinvertebrate and bird studies are scheduled for June of each year.
University of Wisconsin-Milwaukee			We are actively involved in the conservation and reestablishment of native fishes in WI. This includes the design and implementation of stream restoration and rehabilitation plans, the ecology of rare and threatened species, and genetic differentiation of exploited fishes.
Upstate Freshwater Institute (UFI) for Cornell University		Cayuga Lake Water Quality Monitoring, related to the Lake Source Cooling (LSC) Facility	Assess potential impacts of Cornell University's "Lake Source Cooling" (LSC) Facility
Wells College and Cornell Center for the Environment		Linking Public and Scientific Input to Water Quality Monitoring	Assess scientific validity and reliability of citizen bioassessment of water quality in streams.
U.S. Private			
Binder Park Zoological Society, Inc.			To monitor Barnum creek for impacts from internal and external sources
Superior Environmental Corp.		54th and Clyde Park site	Monitor for release of diesel fuel from a former UST, however chlorinated solvents were detected and client did not have money to monitor extent of solvent problem.
Superior Environmental Corp.		Roger B. Chaffee Blvd site	To monitor for unleaded gasoline compounds on a quarterly and now semiannual basis in the ground water, and determine if the contaminants have migrated and whether the levels are decreasing or increasing.
Traverse City Light and Power			river observation for dam/river level monitoring
Canada Federal			

Organization	Department	Title	Description
Bird Studies Canada and Environment Canada		Great Lakes Marsh Monitoring Program	Through the efforts of many dedicated and skilled volunteers who survey amphibians, marsh birds, or both, the Marsh Monitoring Program (MMP) contributes to the conservation of wetlands and wetland dependent wildlife in the Great Lakes region. The MMP was established by Bird Studies Canada and Environment Canada in 1994 and is intended to run well beyond the year 2000. The program was designed to provide information on marsh bird and selected amphibian populations, and to contribute to our understanding of their habitat needs. Along with the essential role played by MMP volunteers, the program receives important support from Environment Canada, the U.S. Great Lakes Protection Fund, the U.S. Environmental Protection Agency, and the Great Lakes 2000 Cleanup Fund. Forty-three Areas of Concern (AOCs) around the Great Lakes have been identified as being stressed by pollutants, habitat loss, and habitat degradation and are in urgent need of rehabilitation.
Department of Fisheries & Ocean		Great Lakes Fish Contaminants Surveillance Program	This is a basin wide long-term monitoring program, which provides data on contaminant burdens in Great Lakes fish and the forage base. The data are analysed to provide information on spatial and temporal trends in contaminant burdens but also shifts in contaminant dynamics and pathways for various Great Lakes food webs. There are also concurrent fish community measurements of contaminant stress indicators. The DFO open lake fish contaminants monitoring program has been in place since 1977, annually monitoring the burden of a suite of toxic chemicals in fish and fish communities throughout the Great Lakes. It was developed in direct response to the needs of Annex 11 of the Canada/US Great Lakes Water Quality Agreement (GLWQA) which states the need "To provide information for measuring local and whole lake response(s) to control measures using trend analysis and cause/effect relationships and to provide information which will assist in the development and application of predictive techniques for assessing the impact of new developments and pollution sources."
Department of Fisheries & Oceans	Great Lakes Laboratory for Fisheries & Aquatic Sciences	Hamilton Harbour Contaminant Trend Monitoring Study	The objective of this study is to generate fish community contaminants data which will assist in describing the progress of remediation with the objective of reducing the availability of and exposure to toxic chemicals in the Hamilton Harbour ecosystem. A temporal trend contaminant monitoring program using fish as the indicators of toxic chemical availability and uptake will provide a measure of the effectiveness of one of the key elements of the Hamilton Harbour RAP. This project will measure contaminant levels in selected indicator fish species resident in Hamilton Harbour and the supporting fish and invertebrate forage base. The objective of the study will be to provide an assessment of concentrations of contaminants of concern which are bioavailable to the aquatic community of the AOC. There will be a link developed between the contaminant burdens in measured adult fish and potential consumption restriction guidelines issued for key sports fish species resident in the harbour. The ultimate objective of the study will be to provide a mechanism for assessing the effectiveness of previous remedial activities in reducing the bioavailability of a suite of contaminants designated as chemicals of concern for Hamilton Harbour. The monitoring

Organization	Department	Title	Description
			protocol developed from the data generated by this study will prove a temporal assessment of progress towards reducing contaminant burdens in the fish community and reducing consumption restrictions currently in place for a range of fish species consumed by the angling community (FWNP- HC). It will also assess the trends of contaminants potentially responsible for the incidence of tumours and other deformities which result in an overall degradation of the fish community. The project will also document the decline in contaminant levels which lead to the degradation of benthic invertebrate communities and phytonplankton/zooplankton populations.
Department of Fisheries and Oceans	Great Lakes Laboratory for Fisheries and Aquatic S	Fish Species at Risk (SAR) in the Sydenham River Watershed	Objectives: assess the current status of fish species at risk (SAR); identify limiting factors of fish SAR; develop a standardized protocol for sampling fish SAR; establish index monitoring stations. Preliminary Results: 50 sites sampled using multiple gears, and Ontario Stream Assessment Protocol; Fish SAR collected: bigmouth buffalo, black buffalo? (new record), spotted sucker, blackstripe topminnow, eastern sand darter, and greenside darter; Fish SAR not collected: spotted gar, pugnose minnow, lake chubsucker, and northern madtom.
Environment Canada	National Water Research Institute	Agricultural non-point sources of pollution	Parameters include N, P, suspended solids
Environment Canada	National Water Research Institute	Benthic invertebrate populations	Benthic community structure
ENVIRONMENT CANADA		Canada-Ontario Hydrometric Program	Water Survey of Canada, Ontario Region has been keeping track of surface water by measuring the volume of flow in rivers and recording the water levels of lakes and rivers since 1908. The Ontario region division operates a network of 457 stations throughout Ontario under a Federal Provincial Cost share agreement. Major rivers and lakes throughout the Province, including the north have monitoring stations established which produce daily flow and water level data. This data base is published annually in CD Rom format and has existed at some stations since the early 1900's.
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Organization	Department	Title	Description
Environment Canada		Canadian Air and Precipitation Monitoring Network (CAPMON)	The Canadian Air and Precipitation Monitoring Network is a non-urban air quality monitoring network. The objectives of the network are to determine the spatial patterns and establish the temporal trends of atmospheric pollutants related to acid rain and smog; provide data for long-range transport model evaluations and effects research (aquatic and terrestrial); ensure the compatibility of Federal, Provincial and U.S. measurements; and study atmospheric processes. Measurements include precipitation chemistry, particles and related trace gases, tropospheric ozone measurements, nitrogen measurements, and size selection particulate matter.
Environment Canada	Canadian Wildlife Service	Canadian Great Lakes Colonial Waterbird Inventory	All potential colonial waterbird nesting sites in the Canadian Great Lakes are visited at least once every 10 years to census nest numbers. Three decadal surveys have been completed starting in 1976/77. The next survey is planned to begin in 2007. A similar U.S. program is conducted in conjunction with the Canadian program allowing for a complete census of all Great Lakes sites. All potential nesting sites of at least 16 species of pelicans, cormorants, herons, gulls and terns on the Canadian Great Lakes have been censused at least once every 10 years since 1976/77. Surveys are conducted during the incubation period of the birds, May-June. The next survey is planned to begin in 2007. There is a similar U.S. program which allows for the complete coverage of all Great Lakes sites. The survey shows where the major colonies of each species are located and it tracks changes in the number of breeding pairs of each species over time. Most major species have increased noticeable since the first survey; only the numbers of Common Terns have declined.
Environment Canada		Corridor Water Quality Monitoring	
Environment Canada	Environmental Conservation Branch	Detroit River upstream/downstream monitoring	Monthly sampling for nutrients, trace metals, trace organics for loadings
ENVIRONMENT CANADA		Durham Region Coastal Wetland Monitoring	The primary goal of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) is to implement a long-term monitoring program that enables reporting on the condition of coastal wetlands in the Region.
Environment Canada	Canadian Wildlife Service	Effects of agricultural chemicals on wildlife	To assess the fate and effects of organophosphates and carbamates on passerines and make recommendations for their protection
Environment Canada	National Water Research Institute	Effects of zebra mussels (sub-project to open lake nutrient assessment)	Impacts of zebra mussels on water quality, and on mass balances for P and N; effects of improved light transparency on benthos production

Organization	Department	Title	Description
Environment Canada	Canadian Wildlife Service	Great Lakes Herring Gull Egg Monitoring Program	Herring Gull eggs have been collected and analyzed annually since 1974 at the same 10-15 Great Lakes sites. PCBs, PCDD/Fs, OC pesticides and Hg are usually measured. Extra egg material is archived in a CWS tissue bank. Data are analyzed for temporal and spatial trends. Some collections of other tissues and other colonial waterbirds also are part of this program. Herring Gull eggs have been collected and analyzed from the same two sites in each of the 5 Great Lakes since 1974. Single additional sites in Lakes Huron and Ontario and the Detroit, Niagara and St. Lawrence Rivers were added later. Over 100 compounds, including PCB, PCDD/F, and PBDE congeners, OC pesticides and Hg, are analyzed. Temporal trend analysis has shown that all compounds except PBDEs have declined dramatically since they were first measured; PBDEs have increased. Spatial analysis has identified individual "hot spot" locations in Lakes Huron, Ontario and Michigan. Egg material from at least 7 other species of Great Lakes colonial waterbirds (cormorants, terns, night-herons) are also included with this database.
ENVIRONMENT CANADA		Great Lakes Herring Gull Egg Monitoring program	Herring Gull eggs have been collected and analyzed annually since 1974 at the same 10-15 Great Lakes sites. PCBs, PCDD/Fs, OC pesticides and Hg are usually measured. Extra egg material is archived in a CWS tissue bank. Data are analyzed for temporal and spatial trends. Some collections of other tissues and other colonial waterbirds also are part of this program. Herring Gull eggs have been collected and analyzed from the same two sites in each of the 5 Great Lakes since 1974. Single additional sites in Lakes Huron and Ontario and the Detroit, Niagara and St. Lawrence Rivers were added later. Over 100 compounds, including PCB, PCDD/F, and PBDE congeners, OC pesticides and Hg, are analyzed. Temporal trend analysis has shown that all compounds except PBDEs have declined dramatically since they were first measured; PBDEs have increased. Spatial analysis has identified individual "hot spot" locations in Lakes Huron, Ontario and Michigan. Egg material from at least 7 other species of Great Lakes colonial waterbirds (cormorants, terns, night-herons) are also included with this database.
ENVIRONMENT CANADA		Great Lakes Precipitation Network	In 1979, Ecosystem Health Division began operating a network of precipitation samplers to measure concentrations of trace metals, nutrients and major ions in precipitation. A trace organic precipitation network was initiated in 1985. In 1994, the stations were amalgamated to form a 9-station network which is part of the Binational Integrated Atmospheric Deposition Network (IADN).Precipitation Chemistry Network:Monthly composite precipitation samples are collected with automated wet-only precipitation collectors at nine sites located along the Canadian Shores of the Great Lakes basin. Samples are analyzed for nutrients, major ions and metals.Organic Precipitation Network:Biweekly composite precipitation samples are collected with wet-only collectors at 9 stations (including two Canadian Master Stations of the IADN), located along the Canadian shores of the Great Lakes Basin, to determine spatial and temporal trends in atmospheric deposition of organic contaminants (organochlorines, chlorobenzenes, PAH's, total PCB's) to the Great Lakes. Some stations date back as far as 1984.

Organization	Department	Title	Description
ENVIRONMENT CANADA		Great Lakes Sediment Assessment Program	Annual Great Lakes sediment surveys conducted on a rotational basis. The Great Lakes Sediment Assessment Program is currently assessing sediment quality in the Great Lakes. Results of sediment surveys are compared with data from earlier Departmental surveys conducted in the late 1960s and early 1970s. This information is important to the understanding of the anthropogenic activities on open lake environments, and allows assessment of changes in contaminant concentrations since the advent of measures to reduce sources and loadings. The results of these surveys also allow assessment of sediment quality in the context of sediment quality guidelines for the protection of aquatic biota. This body of work represents a collation of surficial sediment data from the major agencies mandated with monitoring temporal and spatial distributions of contaminants across the Great Lakes Basin. These data sets are unparalleled in their resolution and scope, and convey a reasonable understanding of the general prevailing spatial and temporal trends in persistent toxics in the Great Lakes.
ENVIRONMENT CANADA	Environmental Conservation, Ecosystem Health	Great Lakes Surveillance Program	Water quality is monitored in the Great Lakes on an ongoing basis in keeping with the Canadian commitments under the Canada/US Great Lakes Water Quality Agreement.Environment Canada conducts open lake cruises on the Great Lakes to assess transboundary pollution, and to fulfill Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement. Between 1968 and 1974, data collection was of a research nature and the study objectives therefore changed with each year. Since then, the surveillance program has been standardized, and monitoring is conducted in each of the Great Lakes (except for Lake Michigan, which is located entirely within the United States) once every two years. Monitoring of water quality is conducted for nutrients, major ions and organic contaminants, as well as selected biological (chlorophyll a) and physical (e.g., temperature, specific conductance) parameters. The main objectives of the program are to ensure compliance with water quality objectives, evaluate water quality trends and identify emerging issues.
Environment Canada	Environmental Conservation Branch	Lake Erie exit loadings of chemical parameters	Annual exit loading estimates for nutrients (TP, N), C, Cl, Si, Na, K, Ca, SO4, organic contaminants (OCs, CBs, PCBs, PAHs), in-use pesticides, trace metals in dissolved phase and suspended sediment
Environment Canada		Lake St. Clair Bottom Sediment Contaminant Characterization	
Environment Canada		Lake St. Clair/St. Clair Delta Native Freshwater Mussel Study	
Environment Canada		Marine Buoys	These data are used in the production of marine forecasts, as input into numerical weather prediction models for marine forecast guidance and to provide data in a data sparse area. The buoys also provide data for climatological records which are used in many research projects and applications.

Organization	Department	Title	Description
Environment Canada		National Air Pollution Surveillance (NAPS)	The National Air Pollution Surveillance (NAPS) Network was established in 1969 as a joint program of the federal and provincial governments to monitor and assess the quality of the ambient air in Canadian urban centres. Air quality data for sulphur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3) and total suspended particulates (TSP) are measured at over 152 stations in 55 cities in the ten provinces and two territories. Various statistics derived from the measurements and comparisons with the National Air Quality Objectives prescribed under the Canadian Environmental Protection Act are published in annual data reports. For Canada's national Smog Management Program, data for nitric oxide, nitrogen oxides and volatile organic compounds (VOCs) are being collected.
Environment Canada		National Pollutant Release Inventory (NPRI)	
ENVIRONMENT CANADA		Niagara River Upstream/Downstream Monitoring Program	Environment Canada conducts water quality monitoring on the Interconnecting Channels of the Great Lakes (i.e. St. Lawrence, Niagara, St. Clair and Detroit Rivers) to assess upstream/downstream loadings of pollution in fulfillment of Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement. As part of Canada's commitments under the Great Lakes Water Quality Agreement, a long-term water quality monitoring program was initiated at Niagara-on-the-Lake in the Niagara River in 1975. In 1983, an upstream site was added at Fort Erie. Weekly samples have been collected for nutrients, major ions, and trace metals at both sites. In 1986, with the signing of the Niagara River Toxics Management Plan and the Declaration of Intent by Environment Canada, US EPA, New York DEC, and the Ontario Ministry of Environment, the program was expanded to include weekly collection of water and suspended sediment samples to determine concentrations and loadings of trace organics (pesticides, chlorobenzenes, PCBs, PAHs).
ENVIRONMENT CANADA		Ontario Region Suspended Sediment Program	In conjunction with the Water Survey Hydrometric program, Water Survey Division, Ontario Region operates a network of 90 miscellaneous suspended sediment station around the Great Lakes to allow computation of annual sediment loads to the Great Lakes. The suspended sediment network is co-located with 90 hydrometric monitoring sites and produces annual suspended sediment loads for most major tributaries around the Great Lakes.
Environment Canada	National Water Research Institute	Open lake trace metal cycling	ltra-trace levels of Cd, Cr, Pb, Mn, Fe, Ni in water

Organization	Department	Title	Description
ENVIRONMENT CANADA		Pesticides In Aquatic Ecosystems	Surface water monitoring for in-use pesticides is conducted throughout the Great Lakes and in selected watersheds and embayments. Screening level risk assessments on pesticides used in muck crop, tobacco, fruit and row crop agro-ecosystems as well as urban environments have been conducted. Small, medium and large scale surface water environments as well as precipitation have been scanned for pesticides commonly used in Ontario. Recent risk assesments have focused on the potential for in-use pesticides to affect wildlife populations by disrupting endocrine systems.
ENVIRONMENT CANADA		Sediment Quality in Canadian Great Lakes Tributaries - A Screening Level Survey	The Ecosystem Health Division of Environment Canada, Ontario Region, is conducting screening-level surveys of sediment quality in tributaries to the lower Great Lakes. Since 2001, Ontario tributaries to the St. Clair River, Lake St. Clair, the Detroit River, Lake Erie, the Niagara River, Lake Ontario and the St. Lawrence River have been sampled. In future years, tributaries to the other Great Lakes and connecting channels are planned to be sampled. The sediment samples are analyzed for organochlorine compounds, polycyclic aromatic hydrocarbons, metals, total organic carbon and particle size distribution. Selected samples will be analyzed for additional parameters such as dioxins and furans, in-use pesticides and other parameters of emerging concern, as resources permit. The results of these surveys provide information about recently deposited sediment quality, and can be used to help identify if Canadian watersheds are sources of pollutants to the Great Lakes. The information from this program provides an overview of the contaminant status of Canadian tributaries to the Great Lakes and their connecting channels.
ENVIRONMENT CANADA		Southern & Eastern Ontario Snapping Turtle Monitoring	Contaminant levels have been measured in the eggs of snapping turtles collected at various sites in the basins of Lakes Erie and Ontario, as well as the St. Lawrence River since 1983. Health effects of these contaminants have been assessed in some years relative to mercury, PCBs and organochlorine pesticides. Contaminant levels, and occasionally associated health effects, have been monitored in Snapping turtle eggs collected from the lower Great Lakes basin by the Canadian Wildlife Service since 1983. The work has been completed on a "as needed basis" at various sites, with particular attention paid to the Hamilton Harbour AOC, the St. Lawrence-Cornwall AOC, and Algonquin Park as a reference site; other sites along Lake Erie and Lake Ontario have also been examined in the past 20 years. Since 2001, a systematic assessment has been conducted in each of the Canadian lower Great Lakes AOCs to determine contaminant levels and has identified associated health effects for juvenile and adult Snapping turtles.

Organization	Department	Title	Description
ENVIRONMENT CANADA		Southern Ontario Bald Eagle Monitoring	Population size and productivity of bald eagles nesting on the shores of Lakes Erie and Ontario have been monitored annually since 1983. Blood and feather samples have been collected periodically for analysis of mercury, PCBs and organochlorine pesticides. The recovering population of bald eagles in the lower Great Lakes basin has been monitored by Ontario Ministry of Natural Resources and Canadian Wildlife Service and Bird Studies Canada since 1984. Total number of active nests and productivity (number of young per nest) has been determined annually, often through the use of volunteers. Between 1988-1999, blood and feather samples were taken from eaglets to monitor levels of PCBs, organochlorine pesticides and heavy metal contaminants. Since 2000, a low-intensity monitoring protocol based on annual ground and aerial observations of nesting eagles was implemented, to assess productivity. Contaminant monitoring will be conducted at 5 year intervals. The objective of the project is to locate and monitor all territories (new and historic) in southern Ontario through a network of volunteer nest monitors.
Environment Canada	Canadian Wildlife Service	Southern Ontario Bald Eagle Monitoring Program	
ENVIRONMENT CANADA		St. Clair & Detroit River Water Quality Monitoring Program	A whole-water monitoring program for the St. Clair and Detroit Rivers was initiated in 2001 to assess a wide range of organic and inorganic contaminants. This monitoring effort is a component of Environment Canada's Great Lakes Surveillance and Connecting Channels programs and supports Remedial Action Plans (RAPs) for the restoration of beneficial uses of the St. Clair and Detroit Rivers and Lakewide Management Plans (LAMPs) for Lake Erie. The intent is to identify contaminants of concern and to characterize their concentrations with a primary focus on upstream-downstream differences in concentration, compliance with relevant water quality guidelines, values, criteria, and/or objectives, and, where applicable, to provide supporting data to assess the effectiveness of remedial actions and to determine whether improvements in water quality are being achieved.
Environment Canada		St. Clair River Head and Mouth Water Quality Monitoring Program	

Organization	Department	Title	Description
Environment Canada		St. Clair River, Lake St. Clair & Detroit River Suspended Sediment Characterization	
ENVIRONMENT CANADA		St. Clair Water Quality Monitoring Program	Environment Canada conducts water quality monitoring on the Interconnecting Channels of the Great Lakes (i.e. St. Lawrence, Niagara, St. Clair and Detroit Rivers) to assess upstream-downstream loadings of pollution in fulfillment of Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement. In 1986, EHD established an upstream/downstream monitoring program at the head (Point Edward) and mouth (Port Lambton) of the St. Clair River to track improvements in point and non-point source loadings to the river. The information is regularly provided to the St. Clair River RAP Team.
Environment Canada	Canadian Wildlife Service	Wildlife habitat monitoring	Information on deer, vegetation responses and breeding birds; also, waterfowl/wetland data
ENVIRONMENT CANADA		Wolfe Island Monitoring Program	Environment Canada conducts water quality monitoring on the Interconnecting Channels of the Great Lakes (i.e. St. Lawrence, Niagara, St. Clair and Detroit Rivers) to assess upstream/downstream loadings of pollution in fulfillment of Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement. A water quality monitoring program involving the collection of water and suspended sediment samples at a station located at Banford Point on Wolfe Island has been undertaken by Environment Canada since 1976. This program contributes to meeting Canada's commitments under the Great Lakes Water Quality Agreement.Monthly concentrations of trace organics (pesticides, chlorobenzenes, PCBs, PAHs), trace metals, nutrients and major ions are measured. The organics are measured using liquid-liquid extraction with subsequent analysis by gas chromatography coupled with electron capture or mass selective detection (GC-ECD or MSD). The trace metals are determined by inductively coupled plasma and mass spectrometry (ICP-SFMS).The data from this station are used to determine exit loads from Lake Ontario, and to provide information on upstream water quality conditions for the St. Lawrence River basin.
Environment Canada - Ontario Region		Seasonal Water Monitoring and Reporting System (SWMRS)	The Seasonal water Monitoring and Reporting System (SWMRS) is a website developed to be a one window portal for the Health Units to input and manage the water qulaity results from the sampling programs they operate during the summer. The system collects data from E.Coli results and promts the user if the threshold required for posting is reached. During the summer months, local Health Units are required to test the water quality of public swimming beaches within their jurisdiction. When a certain threshold of bacterial (E. coli) count is reached, the beach is posted as unsafe for swimming. While various agencies have collected this data in the past, the data now resides solely with the Health Units.
Environment Canada & U.S. Environmental Protection Agency		Integrated Atmospheric Deposition Network (IADN)	Binational network measuring atmospheric deposition of toxic substances to the Great Lakes at various master and satellite stations around the basin.

Organization	Department	Title	Description
Fisheries and Oceans Canada		Municipal Drain Classification Project	
Great Lakes Fishery Commission (field work by the US FWS and DFO Canada)		Sea Lamprey Management Program	Field work is conducted for the Commission by the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada. The goal is to provide an integrated sea lamprey management program that supports the Fish Community Objectives for each of the Great Lakes and that is ecologically and economically sound and socially acceptable. 1) Assess populations of larval sea lampreys in Great Lakes streams; 2) Control population; 3) Detect new infestations
Parks Canada	Bruce Peninsula National Park	Landscape Characterisitcs	na
Parks Canada		PARKS - Eastern Fox Snake	
Parks Canada		PARKS - Eastern Mole	
Parks Canada		PARKS - Five-lined Skink	
Parks Canada		PARKS - Forest Bird Diversity	
Parks Canada		PARKS - Forest Bird Monitoring	
Parks Canada		PARKS - Forest Monitoring	
Parks Canada		PARKS - Forest Succession	
Parks Canada		PARKS - Frog Chorus Call	
Parks Canada		PARKS - Great Horn Owl Monitoring	
Parks Canada		PARKS - Marsh Bird Diversity	
Parks Canada		PARKS - Rare Plant Monitoring	
Parks Canada		PARKS - Southern Flying Squirrel	
Transport Canada		Federal Contaminated Sites Inventory	Transport Canada - Ports Program has responsibility for certain Harbours and ports on the Canadian side of the Great Lakes. Some contain contaminated sediments.
Canada Provincial			

Organization	Department	Title	Description
Ministry of the Environment	Air Monitoring Section - Environmental & Monitoring	Ambient Air Monitoring	The Environmental Monitoring and Reporting Branch of the Ministry of the Environment has been operating an extensive ambient air monitoring network throughout Ontario for the past 35 years. There are currently 37 state-of-the-art air monitoring stations located in the province, covering areas from Windsor to Toronto to as far north as Thunder Bay and Sudbury, and as far east as Ottawa. The network is designed to measure continuous air quality at 37 ambient monitoring sites across the province and undergoes regular maintenance to ensure a high standard of quality. These ambient sites continuously measure up to six criteria pollutants - ozone, fine particulate matter, nitrogen dioxide, carbon monoxide, sulphur dioxide and total reduced sulphur compounds.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	A Preliminary Investigation Of Walleye	The Black Sturgeon River is the largest tributary entering Black Bay.The objective of this investigation was to begin to assess the status of the walleye stock utilising the Black Sturgeon River. Fundamental questions include: 1) Are there genetically distinct walleye stocks within Black Bay i.e., shoal spawners vs. river spawners? Do Black Bay walleye use the Black Sturgeon River for spawning? 2) Are any of the stocking efforts contributing to the current Black Bay or Black Sturgeon River walleye populations? 3) Are walleye in the Black Sturgeon River a resident population? 4) Are walleye from the Black Sturgeon River dispersing from the river, if so where and how far? 5) Is there any evidence of excessive exploitation in the river? A variety of methods and techniques were chosen to investigate these questions.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Aerial Thermography Of Groundwater Upwelling Sites	This project uses aerial imaging to locate and map the presence of thermal gradients that indicate the location of groundwater upwellings. A byproduct of this project may include identification of point and non-point pollution sources in the Lake Superior basin. Once upwelling areas are identified then they can be further assessed to determine their potential as brook trout stocking sites for reintroduction efforts. A record of groundwater upwelling sites along the Lake Superior shoreline would ultimately be available for use in future waterfront development planning and help to prioritize areas of critical importance to brook trout. Thermal gradients indicating groundwater intrusion areas will be identified using aerial thermal imaging techniques. This method has been used successfully to identify groundwater upwelling areas along the shoreline of Lake Superior in Wisconsin and Minnesota, and in select tributary streams. We are using a different service provider but the basic principles are the same.
Ontario Ministry of Natural Resources		Angler Creel Surveys	
Ontario Ministry of Natural Resources		Bald eagle eggs and blood (sub-project of Bald eagle populations)	OCs, PCBs, Hg in eggs and blood, population status, deformities

Organization	Department	Title	Description
Ontario Ministry of Natural Resources	Ontario Parks	Beach Monitoring	Ontario Parks, under the Ontario Ministry of Natural Resources, collects beach samples from 161 beaches at 27 parks on the Great Lakes through out all of Ontario. There are approximately 3700 samples taken during the bathing season. Ontario Parks has an agreement with the Ministry of Health and Long Term Care to follow the Provincial Beach Management Protocol. Most beaches are sampled weekly.
Ontario Ministry of Natural Resources	Natural Heritage Information Center	Characterizing Habitat for Rare Aquatic Species and Communities	The Nature Conservancy of Canada (NCC) and the Ontario Ministry of Natural Resources (MNR) have developed the Great Lakes Aquatic Biodiversity Conservation Blueprint to identify priority sites for conservation and protection in the Great Lakes watershed. As part of this exercise, the Natural Heritage Information Centre (NHIC) and the Aquatic Research and Development Section (ARDS) developed ALIS (Aquatic Landscape Inventory System) and the AEU (Aquatic Ecological Units) layer. ALIS delineates aquatic habitat into segments (sampling units) based on criteria such as geology, stream size, ecosystem component (lake, wetland, and stream), and presence of barriers to water flow. Various spatial physical attributes such as drainage area, gradient, climate, and land cover are estimated for each segment. These data are summarized at various spatial scales ranging from the entire Ontario portion of the Great Lakes watershed, individual Great Lakes and their watersheds to small aggregations of individual segments. Some components of ALIS were then used to generate a set of ecological units (the AEUs).
Ontario Ministry of Natural Resources		Characterizing Habitat for Rare Aquatic Species and Communities	Correlate "Aquatic Ecological Units" (AEU) and species occurrence data in order to characterize the distribution of rare aquatic species within the Great Lakes Basin. Depending on the outcome of the correlation analysis, the AEU may then be incorporated into the development of a predictive model to identify areas with a high probability of rare aquatic species. The predictive model will be field tested with refinement of the model's parameters as needed.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Coaster Brook Trout PIT Tagging Study	This project uses radio frequency identification (RFID) technology to monitor brook trout populations. The main component of this technology is the passive transponder, which consists of an integrated circuit chip, capacitor, and antenna coil encapsulated in a glass cylinder (i.e., the PIT tag), and requires an external energy source for operation. The transponder is powered or charged by an electromagnetic signal that is transmitted from a reader. The reader broadcasts the signal through an antenna. The signal received charges an internal capacitor on the transponder with enough energy to send back an identifying response. Upon receiving a response from the transponder the reader sends the information to a computer system for logging and processing. We will insert PIT tags (N=500) into the body cavity of brook trout captured in the Cypress River. Two antennas will be set up close to the river mouth to record movement of tagged fish in both up and downstream directions.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit, Lake Huron	Commercial Catch Sampling Program	Assessment of the commercial fishery harvest on Lake Huron. Conducted throughout Lake Huron on fisheries which target lake whitefish, walleye, yellow perch, deepwater chub, and lake trout. Biological characteristics of the commercial harvest.

Organization	Department	Title	Description
Ontario Ministry of Natural Resources	Natural Heritage Information Center	Great Lakes Basin Rare Species Biodiversity Information for Ontario	Enhance and vaildate the aquatic rare species occurrence data in the NHIC databases from a watershed and AOC-based perspective. Provide the resulting information to NHIC partners and stakeholders such as LaMP and AOC teams. Make recommendations on rare species bio-indicators of water quality, especially with respect to macroinvertebrates such as odonata. For each of the 64 tertiary watersheds within the Great Lakes watershed, NHIC will evaluate relevant databases with respect to element occurrence (EO) diversity (number of rare species occurrences per watershed and Area of Concern, AOC). Based on the database evaluation, a priority list will be established in the first year of the project to update and verify database records by location and species. In years 2 and 3, new field collections and entry of existing data will focus on priority species and locations identified in the above evaluation. We expect the work will focus on riverine areas, with some emphasis on Great Lakes coastal wetlands.
Ontario Ministry of Natural Resources		Great Lakes Basin Rare Species Biodiversity Information for Ontario	Enhance and vaildate the aquatic rare species occurrence data in the NHIC databases from a watershed and AOC-based perspective. Provide the resulting information to NHIC partners and stakeholders such as LaMP and AOC teams. Make recommendations on rare species bio-indicators of water quality, especially with respect to macroinvertebrates such as odonata. In the past the NHIC databases have been updated primarily with data collected in a relatively ad-hoc way, from within MNR and other agencies (universities, museums and naturalist groups). The project described here represents a systematic approach to updating the NHIC databases from an aquatic, watershed-based perspective. This model could become the basis for a regular database inventory, maintenance, and update process. For each of the 64 tertiary watersheds within the Great Lakes watershed, NHIC will evaluate relevant databases with respect to element occurrence (EO) diversity (number of rare species occurrences per watershed and Area of Concern, AOC).
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Lake Superior Commercial Fish Program	Primary commercial fish species monitored in Lake Superior are lake whitefish, lake herring, lake trout, chubs and yellow perch. Projects supporting this program include; Commerical Daily Catch Record analysis; Commerical catch sampling; Independent index netting surveys; Partnership index netting surveys; Forage fish trawl surveys; Hydroacoustic surveys; Lake trout stocking; Sea Lamprey monitoring.

Organization	Department	Title	Description
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Lake Superior Recreational Fish Program	Lake Superior anglers fish in all months of the year with significant effort directed toward local winter fisheries (lake trout, lake whitefish and yellow perch), spring and fall tributary fisheries(rainbow trout and salmon), and spring and summer fisheries (lake trout, brook trout, walleye, bass, northern pike and yellow perch). Projects supporting the Recreational Fish Program in Lake Superior include: Summer and winter creel surveys; Co-operative angler creel surveys; Native species rehabilitation projects (walleye, lake sturgeon, brook trout and lake trout); Habitat mapping and restoration; Index netting surveys; Electrofishing surveys; Rainbow trout population assessment (fish counter); Telemetry surveys; Genetic analysis; Larval lake sturgeon drift net surveys; Fish stocking.
Ontario Ministry of Natural Resources	Lake Erie Management Unit	Monitoring and assessment of fish populations	Relative abundance and recruitment status
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit, Lake Huron	Nearshore Fish Community Assessment Program	Independent assessment of nearshore fish communities throughout Lake Huron. Intended to assess warm and coolwater species in the nearshore habitats of Lake Huron. Focuses on walleye, yellow perch, bass sp., and escocids.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit, Lake Huron	Offshore Fish Community Index Program	Independent gill netting program in several locations throughout Lake Huron, aimed at assessing fish communities and populations. Focuses on species such as lake trout, lake whitefish, deepwater chub, walleye, and yellow perch. Relative abundance, recruitment indices, and general biological parameters collected.
Ontario Ministry of Natural Resources		Ontario Parks - Protected Areas Monitoring	Ontario Parks has developed a comprehensive, ecosystem-based framework of criteria and indicators to support a monitoring program for Provincial Parks and Conservation Reserves in Ontario. Monitoring of ecological, social and economic attributes in protected areas will allow Ontario Parks to assess the ecological sustainability of the protected area system. The monitoring framework developed by Ontario Parks is based on a hierarchical criteria and indicators approach. At the most detailed level, this framework includes 133 measures that will be used to assess the health of the protected area system. Indicators and measures included in the framework are grouped under three principles - ecological integrity, social wellbeing and economic health - which represent the principal components of ecosystem sustainability. The framework includes measures of the function, structure and composition of ecosystems (e.g. water quality, land cover, disturbances, species composition and abundance) and the social and economic dimensions of protected area values and use.

Organization	Department	Title	Description
Ontario Ministry of Natural Resources	Inventory, Monitoring and Assessment Section	Ontario Provincial Forest Growth and Yield Program	The Ontario Forest Growth and Yield Program has established and maintains a monitoring network of permanent sample plots (PSPs) in managed and natural forests across Ontario. These plots provide a broad terrestrial ecosystem focus, and serve as a benchmark network for provincial level information needs on forest growth and yield. As of 2004, over 1,100 plots have been established in a standardized fashion, and are remeasured on a 5-10 year cycle. A broad range of data is collected from each plot including site descriptors (UTM, slope, aspect, landform), site history (disturbance information), tree data (species, diameter, height, age), soils data (texture, depth, moisture regime)and information on snags and coarse woody debris. Plots are circular in shape, and consists of the following: a 6400 m2 mortality (snag) plot, three 400 m2 growth plots nested within the mortality plot and nine 25 m2 shrub/regeneration plots (3 per growth plot). Plots were selected to provide good spatial coverage of representative forest conditions, and to provide long-term monitoring for trend and modelling purposes.
Ontario Ministry of Natural Resources	Biodiversity Section, Fish & Wildlife Branch	Ontario Wetland Evaluation System (OWES)	The Ontario Wetland Evaluation System (OWES) is a science-based ranking system that was developed primarily to meet the policy needs of Ontario's Planning Act. The OMNR is responsible for determining which wetlands and wetland complexes (groups of individual wetland units which are functionally related in some important manner) are provincially significant, whether OMNR or other qualified individuals conducts the evaluations. The wetland evaluation system does not produce a detailed biophysical inventory of each wetland. Rather, it assists trained evaluators in ranking the relative importance of different wetlands based on a numerical ranking of wetland values or functions which are grouped into four main components: Biological, Social, Hydrological and Special Features. Data are collected on each wetland relative to these four components. Outer wetland boundaries and internal vegetation community boundaries are also mapped during this exercise.
Ontario Ministry of Natural Resources	Biodiversity Section, Fish & Wildlife Branch	Ontario Wetland Evaluation System (OWES)	The Ontario Wetland Evaluation System (OWES) is a science-based ranking system that was developed primarily to meet the policy needs of Ontario's Planning Act. The OMNR is responsible for determining which wetlands and wetland complexes (groups of individual wetland units which are functionally related in some important manner) are provincially significant, whether OMNR or other qualified individuals conducts the evaluations. The wetland evaluation system does not produce a detailed biophysical inventory of each wetland. Rather, it assists trained evaluators in ranking the relative importance of different wetlands based on a numerical ranking of wetland values or functions which are grouped into four main components: Biological, Social, Hydrological and Special Features. Data are collected on each wetland relative to these four components. Outer wetland boundaries and internal vegetation community boundaries are also mapped during this exercise.

Organization	Department	Title	Description
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Rainbow Trout Population Assessment Using Fish Counter Technology	A daily catch and possession limit of one fish (conservation limit of zero) with a minimum total length of 69 cm (27 in) was put into place. To quantify the effect of this regulation change on rainbow trout numbers a fish counter (Aquantic 2100C) was installed at the upper end of the McIntyre River fishway at Lakehead University in the spring of 1999 and 2000. The resistivity counter detects the passage of fish across an array of three electrodes. The counter continually monitors the resistance of the water above the counting array and calibrates for changes in this resistance every 30 minutes. When a fish passes over the three electrodes, a change in resistance occurs, which is recorded and analyzed by the counter using a firmware algorithm to determine if it fits a typical fish pattern. Should the counter assess that a fish has passed over the array (based on this comparison), the time, direction of travel, and peak signal strength (change of resistance measurement) of the fish event is recorded and stored for later downloading and analysis.
Ontario Ministry of Natural Resources	Upper Great Lakes Management Unit - Lake Superior	Watercourse Stewardship Project	The goal of this project is to establish Regional Reference Values for benthic macroinvertebrate communities of local, 'healthy' streams that can be used to determine the biological health of selected sites in areas that are believed to be impaired. Determining the reference values will begin in the Thunder Bay area and then will be tested in several areas along the north shore to determine if they are applicable throughout the Lake Superior region. Biotic indices will also be selected to allow for the interpretation of subsequent invertebrate collections. The stewardship aspect of the project involves a public education component and the creation of a user-friendly stream monitoring program that will enable the general public to sample stream communities to determine local water quality conditions. Demonstration sites (i.e., impacted areas with possibility for restoration) will be selected to determine the effectiveness of watercourse rehabilitation efforts as reflected by changes in invertebrate communities.
Ontario Ministry of Natural Resources	Ontario Terrestrial Assessment Program	Wildlife Assessment	The Ontario Terrestrial Assessment Program maintains a wildlife assessment function that involves the use of permanent sample plots to collect longterm population information about forest song birds, small mammals, and salamanders. This information is supplemented by information collected on migratory birds, red-shouldered hawk, woodpeckers, and owls through a partnership with Bird Studies Canada. The Ontario Ministry of Natural Resources leads the design, operation, maintenance, and data management related to a permanent sample plot network. Some of the plots in this network are located in the Great Lakes basin. Standardized methods are used to collect breeding bird data, live-traps are used to collect small mammal data, and modified cover-boards are used to collect salamander data. Presence-absence, as well as relative abundance, assessments for some species are possible using the data. Data are available for sharing.
Ontario Ministry of Natural Resources - Lake Erie		Lake St. Clair Status of Fish Stocks	

Organization	Department	Title	Description
Ontario Ministry of the Environment		Clean Water Regulation (MISA) Monitoring Data Ontario Point Sources	The MISA program, by focusing on nine industrial sectors, covered the major toxic polluters. The nine sectors are petroleum, pulp and paper, metal mining, industrial minerals, metal casting, organic chemical manufacturing, inorganic chemical, iron and steel, and electric power generation. The industrial sectoral regulations were promulgated between 1993 and 1995. Like many industrialized areas, Ontario is faced with the challenge of effectively managing the presence of toxic contaminants. Industrial direct discharges represent a significant contributor to water quality impairment and a prominent source of toxics. With the signing of the 1987, 1994 and 2002 Canada/Ontario Agreement Respecting the Great Lakes Basin Ecosystem, Ontario committed to the management of persistent toxic substances. The Municipal Industrial Strategy for Abatement (MISA) program was the provincial response for addressing levels of persistent toxic substances in industrial direct discharges entering Ontario's waterways.
Ontario Ministry of the Environment	Water Monitoring Section	Drinking Water Surveillance Program (DWSP)	Drinking Water Surveillance Program (DWSP) is a monitoring program developed to provide reliable and current information on municipal drinking water. Collected data are used to: support drinking water standards setting; monitor levels of chemicals and establish trends; define and track the occurrence of new chemicals; and assess treatment plant operations. Water supply systems are included in the program based on population served, geographical location and risk of contamination. DWSP is not a compliance monitoring program. Participation of water supply systems in DWSP is voluntary and DWSP data are routinely sent to them once the laboratory has completed the analyses.
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Forage Fish Monitoring Program	Forage fish samples are collected around the Great Lakes and selected inland lakes and rivers where a source of contamination is identified. They are analyzed for a suite of contaminants (e.g. PCBs, mercury, mirex, DDT, dioxins/furans). The contaminant levels are compared to wildlife protection guidelines to assess the extent of pollution, to identify sources of contamination and to assess the effectiveness of pollution control. The forage fish monitoring program is set up to routinely monitor persistent toxic contaminants in juvenile fish in the Great Lakes and selected inland lakes and rivers. Forage fish samples are collected and analyzed to assess temporal trends in contaminant levels in nearshore waters, determine the spatial extent of pollution throughout the Great Lakes, identify sources of contamination and assess the effectiveness of pollution control. Due to their limited home range, forage fish are particularly useful for site specific assessment of contaminant bioavailability and can be used to identify specific point sources.

Organization	Department	Title	Description
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Great Lakes Index Station Network Monitoring	An "index" station approach is used to accommodate the widely varying levels of stress across the large geographic scale of the Great Lakes basin. "Index stations" are located in areas representative of background conditions and in areas where there is a natural integration of the stressors from a larger area. A total of 66 core sites have been established throughout the basin and a minimum of seven sites are visited within a lake basin each year according to the lake-by-lake cycle listed below. This network of stations is designed to provide information on where and how water quality conditions are changing over time by periodically monitoring a suite of environmental indicators. Sampling is undertaken for summer concentrations of priority toxic contaminants in sediment and suspended particulate material as an indicator of the level of priority contaminants present in the aquatic environment. Summer species composition and abundance of benthic invertebrates are monitored as a biological indicator of overall ecosystem health and as a general stress response indicator.
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Great Lakes Water Intake Monitoring	The general purpose of this activity is to provide information on where and how water quality and biological conditions are changing over time. The primary objective of the water intake biomonitoring is to identify trends in nutrient status using nutrient concentrations and phytoplankton biomass as indicators. Water intake biomonitoring is a continuation of the Great Lakes Intakes project that has been ongoing for more than 20 years. The basis of this activity is the year round collection of phytoplankton and nutrient samples from raw intake water at 17 water treatment plants that draw water from the Great Lakes. The tremendous short-term and annual variability in these indicators necessitates a high frequency of sampling (weekly-monthly) to provide adequate data to justify integration of results over meaningful periods (i.e. seasons and years). Only with stable time-integrated information is it possible to assess those long term trends that are the most meaningful with respect to nutrient management programs in the Great Lakes. A secondary benefit of the phytoplankton monitoring is that it may provide an indication of effects from a variety of stressors not actively monitored in the aquatic environment (e.g. effects of UV radiation and climate change) since shifts in algal composition beyond the normal range of previous patterns of variability provide a general indicator of environmental change.
Ontario Ministry of the Environment		Nearshore monitoring and assessment	sample water, sediment and biota in nearshore zone

Organization	Department	Title	Description
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Ontario Benthos Biomonitoring Network	OBBN records contain benthic macroinvertebrate composition and habitat information from stream, lake, and wetland samples in Ontario. Records are marked as relating either to a minimally impacted (i.e. reference) or test site. The Ontario Benthos Biomonitoring Network (OBBN) was co-founded by the Ontario Ministry of the Environment's Environmental Monitoring and Reporting Branch and Environment Canada's Ecological Monitoring and Assessment Network Coordinating Office. The OBBN allows partners to evaluate aquatic ecosystem condition using the reference-condition approach and shallow-water benthos as indicators of environmental quality. The program has four components: 1. A protocol that is based on the principles of rapid bioassessment, and balances standardization with flexibility 2. Training in sampling and sample processing procedures 3. A shared database of reference and test site information 4. Automated analytical software 5. Applied research,
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	Ontario Groundwater Monitoring Network	The objectives of the Provincial Groundwater Monitoring Network (PGMN) are: to provide an accurate assessment on ambient groundwater conditions, to provide an early warning system for changes in water quantity (caused by climatic conditions, land use changes or water taking permits) and water quality due to natural or anthropogenic (man-made) causes and it provides identification of emerging issues of both a water quantity and quality nature. It also provides supportive information for land use planning decisions, and for making sound groundwater resource management and policy decisions on a watershed or aquifer basis. This program also supports the development and refinement of water budgets in sensitive areas such as the Oak Ridges Moraine, drought response decision/action plans, Nutrient Management Plans, ministry operational and corporate business (i.e. Permits to Take Water, Certificates of Approval, interference complaints) and the development and implementation of future source protection plans.
Ontario Ministry of the Environment		Ontario Young-of-the-year Monitoring Program	
Ontario Ministry of the Environment	Environmental Monitoring and Reporting Branch	PCB Trackdown Tier 1 & 2	The primary objective of the study is to identify locally controllable PCB sources, if they exist. Additional objectives include an assessment of the effectiveness of the various investigative tools for trackdown studies, the development of appropriate project design and methodologies, and the provision of guidance for the conduct of future source trackdown projects. Where applicable, the identification of locally controllable sources will allow for abatement and/or remediation initiatives to decrease PCB contamination sources to the Great Lakes.

Organization	Department	Title	Description
Ontario Ministry of the Environment		Provincial (Stream) Water Quality Monitoring Network (PWQMN)	The Provincial (Stream) Water Quality Monitoring Network (PWQMN) collects surface water quality information from rivers and streams at over 350 strategic locations throughout Ontario. Monthly samples are analyzed for a suite of parameters including nutrients, metals, chloride and turbidity. In selected watersheds monitoring is enhanced through higher sampling frequencies and analysis for additional variables such as pesticides. The Ontario Ministry of the Environment (OMOE) leads the design and operation of the PWQMN in close cooperation with its partners (Conservation Authorities, Municipalities). Partners collect water samples and OMOE provides the laboratory analysis and data management. The PWQMN is designed to provide good spatial coverage of representative contributing areas and to provide long-term monitoring for trend purposes. Data are available on request.
Ontario Ministry of the Environment		Sample Results Data (SRDS) - Ontario	Industrial self-monitoring
Ontario Ministry of the Environment		Tributary mouth biomonitoring	use juvenile young-of-the-year fish to determine Canadian tributaries contributing significant loadings of BHC, chlordane, dieldrin, dioxin, HCB, mirex, OCS, PCBs, DDT, Pb, Hg
Ontario Ministry of the Environment		Tributary priority pollutants monitoring	Parameters include chlordane, benzo(a)pyrene, dieldrin, mirex, DDT, HCB, OCS, PCBs, Hg as well as major ions, nutrients (P, N, C) and other trace metals
Ontario Ministry of the Environment		Utility Monitoring Information System (UMIS) - Ontario	Sewage Treatment Plant - self-monitoring
Ontario Ministry of the Environment/Ontario Ministry of Natural Resources		Ontario Sport Fish Contaminant Monitoring Program	Fish samples (dorsal fillets) collected around Ontario are analyzed for a suite of contaminants (e.g. PCBs, mercury, mirex, DDT, dioxins/furans). These contaminant levels are used to produce fish consumption restrictions (advisories) in the Guide to Eating Ontario Sport Fish. The Sport Fish Contaminant Monitoring Program monitors persistent toxic contaminants in sport fish in the Great Lakes and selected inland lakes and rivers. The contaminant levels are analyzed and used to develop sport fish consumption advisories (recommended meals per month) based on health protection guidelines from Health Canada. The Program advises the public on safe levels of sport fish consumption through the biennial production of the Guide to Eating Ontario Sport Fish.
Quebec Ministry of Natural Resources and Wildlife	Wildlife Research Branch	St. Lawrence River Fish Monitoring Network	-Assess the state of the St. Lawrence River using fish communities and an Index of Biotic Integrity as an indicator of ecosystem health. -Assess the state of 9 sport fish species and evaluate fisheries management plans
Canada Local			
Essex Region Conservation Authority		Essex Region Watershed	

Organization	Department	Title	Description
Essex Region Conservation Authority		Ontario Provincial Water Quality (Surface) Monitoring Network (PWQMN)	
Lower Thames Valley Conservation Authority		Flood Forecasting	Forecast flooding in the area.
Lower Thames Valley Conservation Authority		Ontario Provincial Water Quality (Surface) Monitoring Network (PWQMN)	
St Clair Region Conservation Authority	Planning and Research	Habitat Stewardship Program	Water Chemistry Sampling at 12 Sites.
St Clair Region Conservation Authority	Planning/Research	Provincial Water Quality Monitoring Network Program	Water Chemistry Sampling.
St. Clair Conservation Authority	Planning/Research	Habitat Stewardship Program	Annual benthic macroinvertebrate sampling for watershed water quality monitoring.
Toronto and Region Conservation Authority	Environmental Services	Regional Watershed Monitoring Program	Long-term, itegrated monitoring of a variety of indicators in order to assess watershed health. Monitoring is partnership based, and is conducted within the watersheds managed by the Toronto and Region Conservation Authority (TRCA)which include the Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek, Petticoat Creek, Rouge River, Duffins Creek and Carruthers Creek.
Toronto and Region Conservation Authority		Terrestrial Natural Heritage Program	Terretrial biologists conduct surveys throughout the TRCA jurisdiction during the appropriate times of year to gather vegetation community and flora /fauna species information. This detailed information provides us with the information that is needed in order to make sound management decisions.
Toronto and Region Conservation Authority	Environmental Services	Toronto Waterfront Monitoring Program	Environmental Monitoring along the Toronto Waterfront is an important aspect of the TRCA Shoreline Management Program. Understanding environmental conditions of the shoreline provides significant information and input into the preplanning, design and approval of projects. This valuable insight into environmental conditions has also been beneficial to the City's Waterfront Revitalization Plans, official Waterfront Plan development, and City Park planning. Monitoring projects focus on documenting local and regional conditions and bio-physical attributes of the shoreline including: fish and wildlife community surveys, wetland monitoring, bio-monitoring, sediment surveys, and physical habitat surveys.
Toronto Ministry of Health		Beach Monitoring	Samples collected by the Toronto Works and Emergency Services Department are analyzed for E.coli content by the laboratories of the provincial Ministry of Health.

Organization	Department	Title	Description
Toronto Public Health		Beach Monitoring	Toronto Public Health interprets the results from beach monitoring conducted by Works and Emergency Services Department and Ministry of Health and decides if a beach is safe or unsafe for swimming.
Toronto Works and Emergency Services Department		Beach Monitoring	The Works and Emergency Services Department collects daily water samples. Ten beaches are monitored in Toronto including Marie Curtis Park East, Sunnyside, Hanlan's Point, Centre Island, Ward's Island, Cherry/Clarke, Woodbine, Kew Balmy, Bluffer's Park, and Rouge beaches.
Upper Thames River Conservation Authority		Benthic Sampling Program - Thames River	Benthic macroinvertebrate community and habitat data is collected for sites on the Thames River and its tributaries. Most work to date has been completed in the upper Thames catchment (the area in the vicinity of, and upstream of London, Ontario)with approximately 1000 samples conducted at 300 sites from 1997 - 2004. 35 samples at 30 sites have been taken in the lower Thames in recent years. Invertebrates are identified to the Family taxonomic level and resulting data is stored in an MSAccess database at the UTRCA Administrative office and is available on request. Benthic communities are monitored to provide information on aquatic habitat and water quality throughout the Thames watershed. Approximately 100 samples are conducted at about 80 sites to monitor long term trends and short term responses to management and development activities.
Upper Thames River Conservation Authority		Ontario Provincial Water Quality (Surface) Monitoring Network (PWQMN)	
Windor-Essex County Health Unit		Recreational water quality	beach sampling as per MOH protocols
Canada University/Education			
Concordia University, Canada	Civil & Environment	Fate and Transport of Chromiunm in the Environment	Using the chromium data develop model of fugacity,Freundlich Isitherm,Langmuir Isotherm
Great Lakes Institute for Environmental Research		Contaminant effects and species interaction (sub-project of Western Basin contaminants)	Competition between zebra/quagga mussels; transport/fate modeling; effects (biomarkers, genotoxicity, cytotoxicity, etc).
University of Windsor		Benthic changes, especially Hexagenia	Also monitor composition and contaminant burdens of midsummer emergence of adult aquatic insects on Middle and East Sister islands
University of Windsor	Great Lakes Institute for Environmental Research	Western Basin contaminants	Contaminants (OCs. PCBs, recently PAHs) levels in water, sediment, birds, fish, benthos, plankton; also, estimates of primary productivity
Canada Private			

Organization	Department	Title	Description
Sarnia-Lambton Environmental Association		Assessing impacts on local environment	The goals of this project are to ensure that local industries understand impact of stressors on local environment; track long term change in local environmental quality, and; provide information to assist regulators with development of appropriate regulations provide information on local environmental quality to local community.