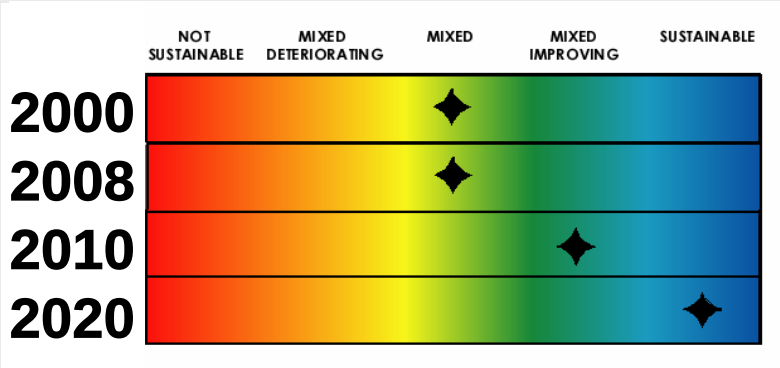
Subgoal 11

Do we have enough information, data, understanding, and indicators to inform the decision-making process?

What is our target for sustainability?

A five year cycle of monitoring and reporting is routinely published on line, in the LaMP, utilized by the Lake Michigan Monitoring Coordinating Council (LMMCC) and the subject of conferences.

Lake Michigan Target Dates for Sustainability



Why is this important?

Accurate information is critical for making informed decisions about Lake Michigan ecosystem management. Legacy or existing systems for monitoring are planned and funded separately and are not formally tied to research. Further, data are often incompatible across agencies and organizations, making it difficult to identify trends.

What is the current status?

- Positive movement was achieved by not only the collaborative FY 2005 intensive monitoring, but also the attention to the issue as one of the Great Lakes Regional Collaboration issues.

What are the major challenges?

- Data remains incompatible across organizations, reducing the value of this asset
- Time lag from sample collecting through analysis to interpretation
- Compare the data gathered from the 1995 Lake Michigan Mass Balance samplings with the 2005 year of intensive monitoring data to determine if trends exist
- More monitoring and research needs on cladophora, botulism, and nearshore issues
- There is inadequate information for some of the SOLEC indicators

What are the next steps?

- Report on Lake Michigan nearshore and food web issues for Great Lakes Regional Research Information Network
- Review monitoring and research to identify LaMP pollutants and trends to determine if LaMP pollutants list needs to be changed
- Complete, analyze, and publish coordinated monitoring results for the lake intensive monitoring year 2005
- Ensure Lake Michigan models will be documented further, and additional scenarios simulated with results shared through the LaMP and in other ways
- Assist coordination for the intensive year and the national coastal assessment year monitoring programs for 2010
- Use 2008 Lake Michigan Pilot funding, for sampling and analysis, to refine monitoring plans
- Utilize FY05 and other monitoring data to aid in adaptive management review of LaMP Pollutant List (See page 11-2 and Appendix A for more information)

What are some tools for addressing the challenges?

- Lake Michigan Online GIS
- Communicating Ecological Indicators
- Permit Data on the Web

What are the State of the Lakes Ecosystem (SOLEC) indicators used to help assess the status of the subgoal?

- Access to Information about the Great Lakes
- Research/Educational Opportunities

For more information on status of indicators, see http://www.epa.gov/solec/sogl2007/

What are the next steps for adaptive management review of the LaMP pollutant list?

- Conforming to or deciding not to conform to the NMN definitions of "shallow nearshore" (0 to 30 meters depth), "medium nearshore" (30 to 80 meters depth), and "off shore" (greater than 80 meters depth) for pollutant categorization. Conforming to the NMN would eliminate the first scenario which relied on the Great Lakes Water Quality Guidance definition of "open waters" in 40 CFR 132.2 to categorize pollutants.
- Using the spreadsheet, created from state water quality and federal monitoring programs for the Lake Michigan Pilot to summarize existing monitoring, to identify what is monitored where in the Lake Michigan Basin.
- Updating Table A-5 in the 2004 Appendix A to show where potential watch list pollutants have been detected. With the summary of monitoring programs, we will be better able to determine whether these substances are monitored in Lake Michigan.
- Comparing detected chemicals to state water quality standards and water quality criteria (i.e., do they exist?) and toxicological information. As an example of the latter, there was a talk at the Surface Water Monitoring and Standards 2008 conference regarding use of TSCA and FIFRA data by States when IRIS doesn't include data for a particular chemical.
- Decide whether the criteria to identify a "watch list" pollutant should include "potential to impact the Lake Michigan ecosystem" or "potential to impact Lake Michigan.

Background

LaMP collaborators identified the need for coordinated collaboration in 1998 and sponsored a lake basin monitoring inventory and the formation of the Lake Michigan Monitoring Coordinating Council (LMMCC). The LMMCC enabled the 2005 Intensive Year of Monitoring as follow up to the 1995 Lake Michigan Mass Balance Monitoring. In 2005, the LaMP Technical Committees also conducted a review of the State of the Lakes Ecosystem Conference indicators to determine the appropriateness for Lake Michigan and to identify any gaps. Work on these issues are in alignment with reviews at the national level conducted by the President's U.S. Commission on Ocean Policy and the Great Lakes Regional Collaboration (GLRC) Strategy Report on indicators and monitoring (www.glrc.us). Highlights and excerpts follow.

The U.S. Commission on Ocean Policy (www.oceancommission.gov) highlighted the need for "unbiased, credible and up to-date scientific information" to properly manage the human activities that effect the nation's oceans coasts and Great Lakes. The Commission, which presented its findings in 2004, found that new scientific findings demonstrate the complexity and interconnectedness of natural systems and that management approaches have not been updated to reflect this complexity with responsibilities remaining dispersed among a confusing array of agencies at the federal, state, and local levels. Managers, decision makers, and the public require timely access to reliable data and solid scientific information that have been translated into meaningful products. The Commission urged Congress to double the federal research budget over the next five years and to fund and adopt an integrated observing system on a regional basis.

The GLRC found that the volume of data collected for the Great Lakes and their tributary watersheds has expanded considerably in recent years, coinciding with an increase in the complexity of issues that need to be addressed. The current lack of accessible, integrated information management systems limits decision-making abilities and application of adaptive management principles for the protection and restoration of ecological resources. Adaptive management requires one to identify priority issues, gather information, establish metrics, evaluate options, implement actions, track progress, reevaluate actions based on observed responses, communicate results and adjust both management approaches and monitoring activities. Although such capabilities are advancing within the Great Lakes basin, they exist only in piecemeal fashion and have not been fully integrated for the comprehensive management of the Lakes. To further complicate matters, decisions made on one issue often affect other issues. Observing systems, monitoring programs, indicators, research, modeling and analysis, information management and communication must therefore be integrated into a holistic decision-making process.

- **Observing systems**, including sensors, stations, networks and field data collection are the primary means for gathering information on the chemical, biological and physical characteristics of the Great Lakes ecosystem.
- **Monitoring Programs** use these observations to take the pulse of the Great Lakes, assess natural variability, drive ecosystem forecasting models, and assess the progress of restorations efforts. Current monitoring challenges include: incomplete inventories of federal, state/provincial and municipal observation and monitoring

Lake Michigan Groundwater Pilot Study

The U.S. Geological Survey is conducting a pilot study in the Great Lakes Basin for a national initiative to assess water availability and use. In this study, key indicators for assessing water availability are being identified and refined. The pilot study also aims to provide scientific information desired by the Great Lakes States in development and refinement of water policies. Ground-water availability in the Great Lakes Basin is being quantified through regional assessments of recharge and storage, estimates of baseflow, and assessments of ground-water data collection. A ground-water-flow model is being developed for the contributing area to Lake Michigan to demonstrate the use of a large regional model to address water-availability questions. In the Great Lakes Basin; however, many water-availability issues are local, and the regional model may not be able to address these issues directly. Modeling techniques to address ground-water/surface-water interaction and local water availability issues will be refined and tested in this project. The ground-water model is an important component of the study because it provides a framework for the system, allows for estimation of indicators that include ground-water flux, and links flow processes to field data.

More information is available at http://acwi.gov/monitoring/network/

The Lake Michigan Toolbox
Lake Michigan Online GIS

Lake Michigan Online Atlas

The Lake Michigan Online Atlas provides Internet access to a number of information resources related to the Lake Michigan basin. Reference maps offer an overview of the region. Computer-compatible data layers can be downloaded for use in a geographic information system (GIS). Hyperlinks and contact information improve access to regional resources. And an online mapping tool allows internet users to explore data and create custom maps using a web browser.

More information is available at http://mapserver.glc.org/website/atlas/viewer.htm.

Great Lakes Fishery Commission GIS

The Great Lakes Fishery Commission is developing an aquatic atlas in GIS format that pulls together data from the Lake Michigan Mass Balance studies, historical sediment surveys, coastal wetland data as well as dam databases to facilitate a holistic approach to managing the Great Lakes basin. These layers of aquatic habitat information will complement the current on-line atlas work of the Great Lakes Commission.

More information is available at www.glfc.org/glgis.

Openlands and Center for Neighborhood Technology

Openlands and the Center for Neighborhood (CNT) technology are updating a website that details the green infrastructure for the greater Chicago region. In the first phase of the project, Openlands and CNT collected 170 layers of valuable data on wetlands, floodplains, rivers, protected open space, threatened and endangered species, greenways, trails and soils. The website has been utilized as a planning tool for creating linkages between existing protected lands and for identifying opportunities for natural resource protection and restoration. Phase II will improve the existing website with new and updated information and expand the project's geographic reach by adding data layers for 5 new counties. Upon completion of Phase II, the website will be interactive and allow users to create customized maps of specific geographic areas with the data layers which are most significant to them.

More information is available at: www.greenmapping.org.

activities; insufficient spatial density of basic observations across the system; incomplete coverage over varying time scales (real-time to historic).

- **Goals or end point examples** were developed by the Great Lakes governors and adopted by the GLRC. The LaMP goals were set through a stakeholder process in 1998 and adopted by the LaMP management committee (See page i-2 for LaMP goals).
- **Indicators** provide information on the state of the Great Lakes and progress toward achieving goals. Continued efforts are needed to ensure the viability of an informative and scientifically-based set of indicators (e.g., the State of the Lakes Ecosystem Conference (SOLEC) indicator suite) that are useful for management decisions and to inform the public. The SOLEC indicator suite has been refined over the last decade to be comprehensive yet practical and actionable. In addition, indicators should be used in relation to realistic "end points" or desired results that are accepted by most stakeholders. When identifying end points, stakeholders must recognize that variability is the norm in natural systems, therefore, many targets and goals should not be expressed as discrete numbers but rather as ranges of desired, natural levels (See LaMP 2000, Chapter 3).

- **Research** and observations have traditionally been focused on single issues. This focus must transition to an ecosystem approach with greater emphasis on predictive forecasting and adaptive management. Research should be directed towards improving the understanding of natural fluctuations and interactions of ecosystem

components. Improvements in predictive capabilities are needed, particularly regarding the impacts of chemical, biological and physical changes on ecosystem structure and function. Development of such capabilities requires a comprehensive research coordination strategy across partnering institutions.

- **Information produced by research and observations** must be made readily available to managers, decision-makers and the public. This will require information integration, management and communication. The LaMP sponsors the Lake Michigan Forum's State of the Lake Michigan Conference every two years, the LMMCC work and the LaMP document itself to inform managers and the public of current status and trends.

  Various methods are used to communicate information to those that require it, but coordination needs strengthening for the sheer breadth of information collected over the region. The lack of a coordinated message can make it difficult for audience groups to interpret and understand information. The audiences that require information are also diverse, requiring that complex information needs to be sufficiently repackaged to meet their needs. Some information, such as lake conditions and beach closings, requires rapid delivery. In addition, two-way communication needs to be promoted so that user needs are conveyed back to those producing the information. A comprehensive, two-way communication strategy has not been developed to address these needs.

Lake Michigan Serves as National Monitoring Pilot

Lake Michigan was selected as one of three pilot studies across the nation to test and improve upon the design of the National Monitoring Network (NMN) for U.S. Coastal Waters and Their Tributaries. The other two pilot studies were the Delaware River and San Francisco Bay. The pilot report provides background information, discusses management issues, an inventory of monitoring under resource components of the NMN, a gap analysis and projected costs to implement the NMN for Lake Michigan.

The Great Lakes and Lake Michigan in particular, are in a period of changing conditions due to a wide spectrum of watershed stressors from toxic pollutants, nonpoint source pollution and water level fluctuations to invasive species disrupting the food web and ecosystem and rampant developmental pressures throughout the region. Thus, unique needs exist in the region; however, consistent monitoring and assessment approaches with other regions of the nation may be necessary to address these issues under a common framework.

With these issues at the forefront, partners working on or around Lake Michigan - including federal and state agencies and academic institutions - have established a robust framework of research and collaborative monitoring efforts. The Lake Michigan Pilot Study will enable partners in the basin to better address these stressors and management issues. It also helped to point out the level to which Lake Michigan Lakewide Management Plan (LaMP)-expressed needs are being met. Results of the Study will serve as a catalyst for assessing and improving upon observing, monitoring and reporting needs for the above-mentioned and other rapidly emerging ecological problems both in the Lake Michigan basin and in the Great Lakes region. Moreover, the explicit linkage between upland, coastal and offshore waters necessitates a more coordinated monitoring network.

The Lake Michigan Pilot Study is also as an excellent surrogate for most coastal marine environments, with its focus on integrating observations of complex physical, chemical and biological processes and development of enhanced monitoring strategies. The Lake Michigan Pilot Study will ultimately generate a monitoring design that could be applied to the other four Great Lakes to better assess the ecological status of the entire Great Lakes basin, while complementary with monitoring parameters in other coastal regions of the United States through its cooperation in the National Monitoring Network for U.S. Coastal Waters and Their Tributaries.

Summary and Major Conclusions from Pilot Study

In spite of their large size, the Great Lakes are sensitive to the effects of a wide range of pollutants from permitted discharge, urban and agricultural run-off, leachate and ground water. The large surface area of the lakes also makes them vulnerable to direct atmospheric pollutants, transported by weather that falls with rain snow or dust from extreme distances.

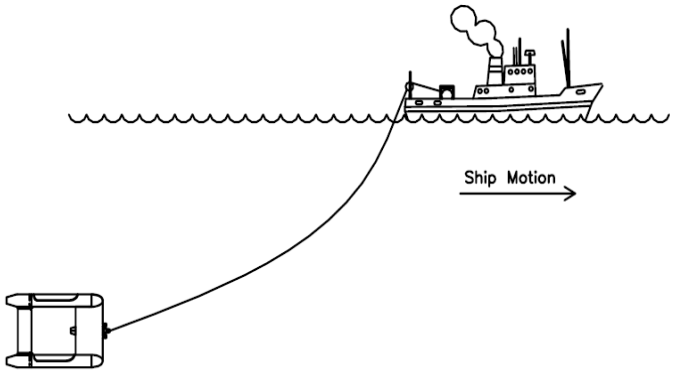
New Nearshore Monitoring Tool

In 2008, the EPA Great Lakes National Program Office will begin additional monitoring nearshore and offshore waters using a sensor package towed behind the R/V Lake Guardian. The main work to be accomplished in the first year is learning the capabilities of the sensor package and beginning the development of a monitoring program that will address the lack of long-term data on the nearshore areas of the Great Lakes. The towed sensor package, the Triaxus, will include: a CTD which will measure temperature, depth, conductivity and dissolved oxygen; a laser optical plankton counter which counts and sizes particles in the Mysis through zooplankton ranges; two fluorometers which will provide information on the main algae groups and on the "health" of the algae; a nitrate analyzer, which can be configured for other chemicals also, will measure this nutrient and identify river plumes and other nutrient sources; finally, sidescan sonar will be used to identify and map underwater habitat and other underwater structures and/or find objects on the lake bottom.

Nearshore efforts will begin by towing a Triaxus at the 20 or 30 meter depth contours around the lakes, beginning with Lake Michigan in 2008. The sensors will help to provide a synoptic characterization of basic biological, physical and chemical aspects of the nearshore area of each lake.

In addition to the nearshore program, the Triaxus will be used to enhance existing offshore monitoring program by providing data as the R/V Lake Guardian travels from one sampling site to another. This information will help us to expand understanding of the variability in plankton, algae and chemistry throughout the lakes. The towed sensors are similar to sensors used on anchored buoys around the Great Lakes. The information from tows near the buoys could be used to determine what water mass is represented by the buoy sensors. Finally, the towed sensor information will be used to provide "ground truth" data for satellite image analyses for chlorophyll and other measurements.

Triaxus being lowered into the water



Triaxus in use
Source: USEPA

Outflows from the Great Lakes are relatively small (less than 1 per cent per year) in. comparison with the total volume of water. Pollutants that enter the lakes are retained and recycled in the system and can become more concentrated with time.

Although part of a single system, each lake is different. Because of the large size of the watershed, physical characteristics such as climate, soils and topography vary across the basin. To the north, the climate is cold and the terrain is dominated by granite bedrock called the Canadian or Laurentian shield consisting of Pre-Cambrian rocks under a generally thin layer of acidic soils. Conifers dominate the northern forest. In the southern areas, the climate is warmer with deeper soils developed on a variety of sediments deposited by glaciers and as lakes, beaches, outwash plains, wetlands and streams. In addition, there are over 30,000 islands and very large bays (Green Bay, Grand Traverse Bay, Saginaw Bay, Georgian Bay) that are also unique in how pollutants arc processed in the sub-bay system thus requiring special or additional sampling.

As receiving bodies of tributaries which are, in turn, receiving bodies for industrial and agricultural discharges, the lakes also serve as drinking water for 40 million people. As the only fresh coast of the United States, the lakes provide recreation through fishing, boating, and the world's largest collection of freshwater sand dunes. Biological monitoring is important not only from an ecosystem perspective but also for public health. Monitoring and research for the last six years has begun to show a great contrast between the near shore and the open lake. This also varies by lake but we see almost two

The Lake Michigan Toolbox
Communicating Ecological Indicators

Ecological indicators need to be made more understandable to the public (including decision makers). Methods for articulating environmental values to make the connection between indicators and what the public (individuals) value about the environment should be considered.

Translating the indicators of regional ecological condition used by USEPA into common language for communication with public and decision-making audiences is critical.

A study by researchers from Clark University, Pacific Southwest Research Station of the USDA Forest Service, University of Tennessee-Knoxville, Oak Ridge National Laboratory, USEPA, and Vanderbilt University revealed that people did not want to know what these indicators measured, or how measurements were performed. Rather, respondents wanted to know what such measurements can tell them about environmental conditions. Most positively received were descriptions of the kinds of information that various *combinations* of indicators provide about broad ecological conditions. Descriptions that respondents found most appealing contained general reference to both the set of indicators from which the information was drawn and aspects of the environment valued by society to which the information could be applied. These findings can assist with future efforts to communicate scientific information to nontechnical audiences, and to represent societal values in ecological programs by improving scientist-public communication.

More information about this issue can be found in a paper titled "Communicating Ecological Indicators to Decision Makers and the Public" at: http://www.ecologyandsociety.org/vol5/iss1/art19/.

separate systems within each lake basin providing another monitoring complexity.

Monitoring currently being conducted does not fully meet the Network design in any of the resource component groups. In some components (e.g., Rivers, Atmospheric Deposition) the current monitoring locations are similar to the proposed design. In other resource components (e.g., Beaches) the constituents proposed for the Network design are currently being sampled. In other resource component groups (e.g., Groundwater, Atmospheric Deposition, Rivers) the temporal approach proposed in the design is for the most part being met Monitoring protocols being used across the resource components are comparable across the various monitoring entities in some cases but not in all cases; and these protocols do not in all cases meet the Network design requirements. QA/QC activities across most of the resource component groups meet the NMN design requirements; however, this is not true for all of them. Data management approaches are not fully integrated for any of the resource components; however, for some components (i.e. Beaches, Atmospheric Deposition, Off Shore) coordinating data management will be easier than for others (i.e. Near Shore, Wetlands). The cost of filling the monitoring gaps varies considerably across the various resource components, from several hundred thousand dollars to close to ten million dollars. The total monitoring gap for the Lake Michigan Pilot Study is in the neighborhood of $25 million.

Finally, even if the NMN is implemented as designed, we still would need to compare the data to benchmarks before we could identify the condition of the resource and know whether additional protective measures are needed.

Federal and state agencies monitor contaminants in Lake Michigan's offshore and shallow near shore waters. No monitoring programs were identified in the medium near shore as defined by the NMN for Lake Michigan. States monitor Lake Michigan watershed water quality in rivers and specific contaminants such as those bioaccumulated in predator fish in order to prepare fish consumption and advice and to prepare Clean Water Act Consolidated Section 303(d)/305(b) reports. The Green Bay and Milwaukee wastewater utilities monitor nutrients and/or pathogens.

Beaches. Strategic monitoring that involves spatial, temporal, and source-tracking methods is needed. Strategic monitoring in conjunction with a thorough knowledge of the beach and its watershed can lead to improvements in beach quality. However, to

develop more progressive monitoring strategies, limited funding for routine monitoring programs may need to be redirected towards start-up costs associated with improved technology.

Wetlands. Prior to the establishment of the GLRC and the release of the U.S. EPA's guidelines for development of a wetland monitoring program in 2006, few coordinated monitoring efforts had been initiated for coastal wetlands. Historically, each agency and organization has had disparate goals and monitoring techniques, and no organization has overarching responsibility for data management. This has lead to significant fragmentation of biological, chemical, physical and landscape information across federal, state, provincial, tribal and local agencies. It is clear that glaring gaps exist in wetland monitoring. With the establishment of new guidelines and reiteration of the importance of wetland monitoring, several new efforts have begun to allow better monitoring of wetland resources.

The MDEQ and WDNR are completing Rapid Assessment Methods (RAMs) for their states, and both Indiana and Illinois are considering utilizing the well established Ohio RAM, since their states are in similar ecoregions. These programs correspond to the Level II analysis recommended by the U.S. EPA, RAMs, however, are likely to classify any coastal wetland resource as a very high quality wetland, thus, these protocols are best utilized at inland wetlands. A more thorough analysis may be conducted in coastal wetlands using a Tier III analysis. In addition, the Great Lakes Coastal Wetlands Consortium (GLCWC) released a complete wetland assessment protocols corresponding to the Tier I. It recommended monitoring parameters. The protocols cover assessment of wetland chemistry and landscape features, as well as biological indicators for fish, macroinvertebrates, vegetation, birds, and amphibians. With the establishment of these protocols, it is hoped that coastal wetland monitoring data will be less fragmented across the basin and more easily shared among agencies and organizations.

Currently, the largest Lake Michigan monitoring effort is organized through Bird Studies Canada's Marsh Monitoring Program. This program sends volunteers in to the field to collect data on wetland bird and amphibian species. Data from the monitoring is compiled into reports every five years. A second major monitoring effort includes the ongoing National Wetlands Inventory (NWI) program conducted by the U.S. Fish and Wildlife Service (USFWS). This program maps wetlands using remote sensing and follows the status and trends of wetland loss and gain throughout the nation. Minor monitoring efforts include the Natural Resources Conservation Service's (NRCS) National Resource Inventory, fish collection by the State of Michigan's Department of Natural Resources (MDNR), Fisheries Division, wetland status and trends analysis and wetland inventory mapping by the Wisconsin Department of Natural Resources (WDNR) and a number of smaller volunteer or local efforts. More information is available at www.glc.org.

Embayments. The NMN design recommends sampling using a probability based design (illustrated in Figure 3-6 on page 49 of the Network design report). The NMN protocol defined 87 embayments within the Great Lakes basin. Fifteen of these are along the Lake Michigan shoreline. The Network design report lists organic and inorganic contaminants, biological, sediments, and physical setting measurement for this resource component, for which the recommended monitoring frequency is once per year. At this point, there is no

The Lake Michigan Toolbox
Permit Data on the Web

Envirofacts (http://www.epa.gov/enviro/) is a single point of access to select U.S. EPA environmental data. This website provides access to several EPA databases to provide you with information about environmental activities that may affect air, water, and land anywhere in the United States. With Envirofacts, you can learn more about these environmental activities in your area or you can generate maps of environmental information.

The Permit Compliance System (PCS) (http://www.epa.gov/enviro/html/pcs/) provides information on companies which have been issued permits to discharge waste water. You can review information on when a permit was issued and expires, how much the company is permitted to discharge, and the actual monitoring data showing what the company has discharged.

STORET (short for STOrage and RETrieval) (http://www.epa.gov/storet/) is a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others.

comprehensive monitoring program focused specifically on embayments in the basin. Seven of 15 Lake Michigan embayments are not currently a part of any monitoring program. State fish chemical and sediment monitoring is incomplete. However, various elements are sampled within a number of embayments as part of some other monitoring program, as fallows:

- Indiana Harbor: Mussel Watch, IDEM water sampling, AOC sampling
- Calumet Harbor: Mussel Watch, TEPA south shore lake survey, AOC sampling
- Milwaukee Harbor Mussel Watch, MMSD, WDNR sampling, AOC sampling
- Grand Traverse embayment at Leelanau State Park: Mussel Watch
- Little Traverse Bay; Tip of the Mitt Watershed Council's water quality studies (ongoing monitoring?)
- Little Bay de Noc: MDNR fishery
- Big Bay de Noc: MDNR fishery

Off Shore. Currently, U.S. EPA, Great Lakes National Program Office and NOAA Great Lakes Environmental Research Laboratory are the entities with long-term monitoring programs on Lake Michigan. U.S. EPA visits eleven or more offshore sites twice per year collecting water chemistry and biological data as part of its mandate based on the Great Lakes Water Quality Agreement and the Clean Water Act. NOAA visits one site on a more frequent basis throughout each year. These monitoring programs complement each other, giving both wide spatial coverage and frequent temporal coverage.

Elsewhere, the NMN design for monitoring is based on a randomized grid. An exception is made for this subcomponent. Targeted sampling of the Great Lakes will use fixed sites and continue historical monitoring efforts in the offshore waters conducted under the Great Lakes Water Quality Agreement and the International Joint Commission. Sampling locations for existing monitoring networks on the Great Lakes, dating from the early 1980's are based on alternative criteria. In the offshore area, water mass movement appears to be sufficient to "randomize" the sampling resource being sampled. As part of the original Great Lakes Environmental Monitoring and Assessment Program (EMAP) in the late 1980's and early 1990's, a comparison study of the existing deterministic sample sites and a randomized grid was performed. The results of that comparison were that very little difference existed between the water chemistry values obtained from either design, with the exception that some randomized grid sites were placed at locations not representative of the offshore area.

Recommendation: Maintain the current offshore programs for both agencies, and supplement the temporally more intense NOAA program with at least one more station in the offshore area located near Milwaukee, WI.

Rivers and AOCs. All 20 of the river sites being proposed for the Lake Michigan portion of the national monitoring network currently have streamflow gauging stations on them. Fifteen sites have some ongoing water quality monitoring. None of the sites has the complete proposed constituent monitoring data set or is monitored at the proposed frequency. All stream gauging is being done according to proposed protocols. All water quality monitoring is being done according to protocols approved by either USGS or U.S. EPA for the constituent of interest. Three additional rivers (Grand Calumet, Sheboygan, and Manitowoc) are also proposed for addition to the NMN design. Each of these rivers has ongoing streamflow and water quality monitoring. These 20 proposed network sites will only provide coverage for about 71% of the river inflow to Lake Michigan. While we do not feel this is adequate coverage, in and of itself, we believe that when coordinated with monitoring at other river sites in the basin it is possible to determine if short-term added monitoring is needed to supplement the network.

Additionally, regarding Great Lakes AOCs, a complete and thorough set of monitoring protocols to measure the restoration of their beneficial use impairments is currently lacking. Since most have a contaminated sediment component, the monitoring of the AOCs cannot be met by near shore or tributary river monitoring. GLNPO is working with the states to develop delisting targets for each of the AOC Beneficial Use Impairments by January 2009. These targets will inform the AOC monitoring plan.

Data Management Issues. Access to accurate and timely data by members of the scientific, management, and policy community is critical to decision making that affects Great Lakes water resources. To support this need, significant time and money has been spent collecting monitoring data

GLNPO Water Quality Surveys

The USEPA Great Lakes National Program Office's water quality surveys generally focus on the offshore waters of the lakes (water greater than 30 meters in depth, or greater than 3 miles from shore). To ensure that sampling activities are representative of lake conditions, samples are collected from multiple sites within each lake basin. The number and locations of the sites needed to obtain a representative sampling of each basin was statistically determined using historical data collected during intensive surveys of each lake. Each basin consists of several routine monitoring stations and a "master station". The master stations generally represent the deepest area of the basin and are often used to collect supplementary data for other (non-survey) purposes. The spring surveys are designed to collect water quality information during unstratified (isothermal) conditions of the lake, and the summer surveys are designed to monitor the Lakes during stratified conditions. As a result, the number of depths sampled during the summer is greater than the number of depths sampled during the spring surveys.

The surveys provide data to detect and evaluate trends and annual changes in chloride, nitrate nitrogen, particulate nitrogen, silica, total phosphorus, total dissolved phosphorus, particulate phosphorus, chloride, and reactive silica.

The biology program monitors phytoplankton, zooplankton, benthic invertebrates, and chlorophyll a in the water column. Zooplankton and phytoplankton samples are collected twice per year, in spring and summer. The majority of benthos samples are collected in summer, although a small number of stations are visited in spring. Some benthos-only stations are located closer to shore.

The Peter L. Wise Lake Guardian

Maps of sampling stations can be found at: www.epa.gov/glnpo/monitoring/guard/sampling_stations.html. Chemical monitoring data are found on GLENDA at: http://www.epa.gov/greatlakes/monitoring/data_proj/glenda/index.html. Some graphs of information on water chemistry through 2006 are at: http://www.epa.gov/glnpo/monitoring/limnology/index.htm.

including physical, chemical, biological, and cultural data for the domain, These data have been, and are being collected by a variety of agencies, organizations, and institutions over space and time, and represent a significant asset in better understanding and managing the Great Lakes.

Unfortunately, much of these geographic data remain inconsistent and/or incompatible across organizations and boundaries, and subsequently are not readily available for downstream analysis. This general unavailability of data in the region can be attributed to many things including institutional barriers, security concerns, differing languages (computer and otherwise), and financial constraints, among others.

One such limiting factor is legacy systems, or "stovepipes," used to collect, store, and transfer data throughout the region. Owing to antiquated software, hardware, and/or engineering methodologies, stovepipes present a significant obstacle to sharing data by making it too expensive (In terms of time and money) to access the data. Another issue affecting the usability of monitoring data throughout the region relates to the general "discoverability" of the data. Despite the trove of data being collected, much of it remains hidden

behind firewalls or scattered across different web pages. For decision makers and resource managers who depend on timely access to information, it is critically important to make data more readily available.

Efforts toward making monitoring data more available are those concerned with the integration and normalization of data across the region. The Great Lakes Observing System (GLOS) is a forerunner in this regard, providing real-time access to Great Lakes observing and monitoring data. GLOS provides access to data on climate, meteorology, chemistry, geology, biology and human activities that affect the Great Lakes, their interconnecting waterways and the St. Lawrence River, GLOS draws data about the Great Lakes system from numerous sources, consolidates it, and makes it available via the Internet. This resource helps to meet the needs of resource managers, researchers, educators, commercial shippers, recreational boaters, beach users and homeland security personnel.

The Middleton Data Center (MDC) is another example of a multi-jurisdictional data aggregation and integration effort. MDC, co-located with the USGS Wisconsin Water Science Center, is involved in several projects to develop better coordinated dam management systems. One of these projects is a cooperative effort with Milwaukee Metropolitan Sewerage District (MMSD) to aggregate disparate data from universities and local, state, and federal agencies affecting areas within the MMSD's purview. The MDC is also involved with the development of water quality and quantity databases, leveraging XML-based mechanisms (i.e. Web Services) for sharing data across the region. These MDC projects provide positive potential and a baseline for further collaborative data management activities throughout the Lake Michigan watershed.

Another important development in the arena of sharing monitoring data through the region is the advent of metadata-driven, web-based data clearinghouse nodes. These clearinghouses make disparate data infinitely more discoverable through keyword, thematic, and spatially-based queries that allow users to readily find and acquire data.

At the national level, several such portals have sprung up over the past several years. In the U.S. these include Geospatial One Stop (GOS: http://geodata.gov), USGS' National Map (http://nationalmap.gov) and NASA's Global Change Master Directory (GCMD: http://gcmd.nasa.gov). On the Canadian side, there are the GeoConnections (GeoConnections: (http://www.geoconnections.org) and GeoGratis (GeoGratis: http://geogratis.cgdi.gc.ca) clearinghouses. Regionally, the Great Lakes Information Network (GLIN) is providing similar functionality through its GLIN GIS (http://gis.glin.net). The GLIN GIS provides user and organizations the ability to publish their Great Lakes-specific datasets, and makes these data available in a variety of formats and Web Services.

Lake Michigan Monitoring Coordinating Council

The Lake Michigan Monitoring Coordinating Council was established to enhance coordination, communication, and data management among agencies and other organizations that conduct or benefit from monitoring efforts in the Lake Michigan basin in the interest of supporting the Lake Michigan LaMP.

The Council has members representing federal, state, tribal, and local governments, nonprofit watershed groups, and other environmental organizations, educational entities, and the regulated community. The Council meets twice each year in locations throughout the watershed. Council meetings, biennial conferences, and feedback from constituents shape the Council's work plan and activities.

The Council framework has been developed to increase coordination between appropriate monitoring entities, allow the development of a strategic plan for monitoring, and add value to the individual efforts of the Council's member organizations. The framework takes advantage of the logical interactions between the various resource-based monitoring entities and other affected stakeholder groups.

The working groups formed under this framework will build on the efforts to coordinate monitoring within individual resources by groups such as the Lakewide Management Plan Committees, the Wisconsin Groundwater Coordinating Council, and the Great Lakes Fishery Commission. Each of these resource-based working groups will coordinate existing monitoring networks around several common considerations: monitoring objectives; spatial, temporal and parameter network design; methods

comparability; quality assurance and control planning; database sharing; and data analysis approaches. More information is available at http://wi.water.usgs.gov/lmmcc/.

Great Lakes National Parks Monitoring

Two national parks in the Lake Michigan basin are participating in a Great Lakes Network made up of 9 national park units from four states in the Great Lakes region. At the southern end of the Lake, work is progressing on assessing the extent of invasive plant species in interdunal wetlands of the Indiana Dunes National Lakeshore and State Parks. These special wetlands are highly vulnerable to invasives such as purple loosestrife and Phragmites. Park staffs are working with The Nature Conservancy, Save the Dunes Council, and Shirley Heinze Trust Fund to formulate a control program that will eliminate invasives and protect the native plant species.

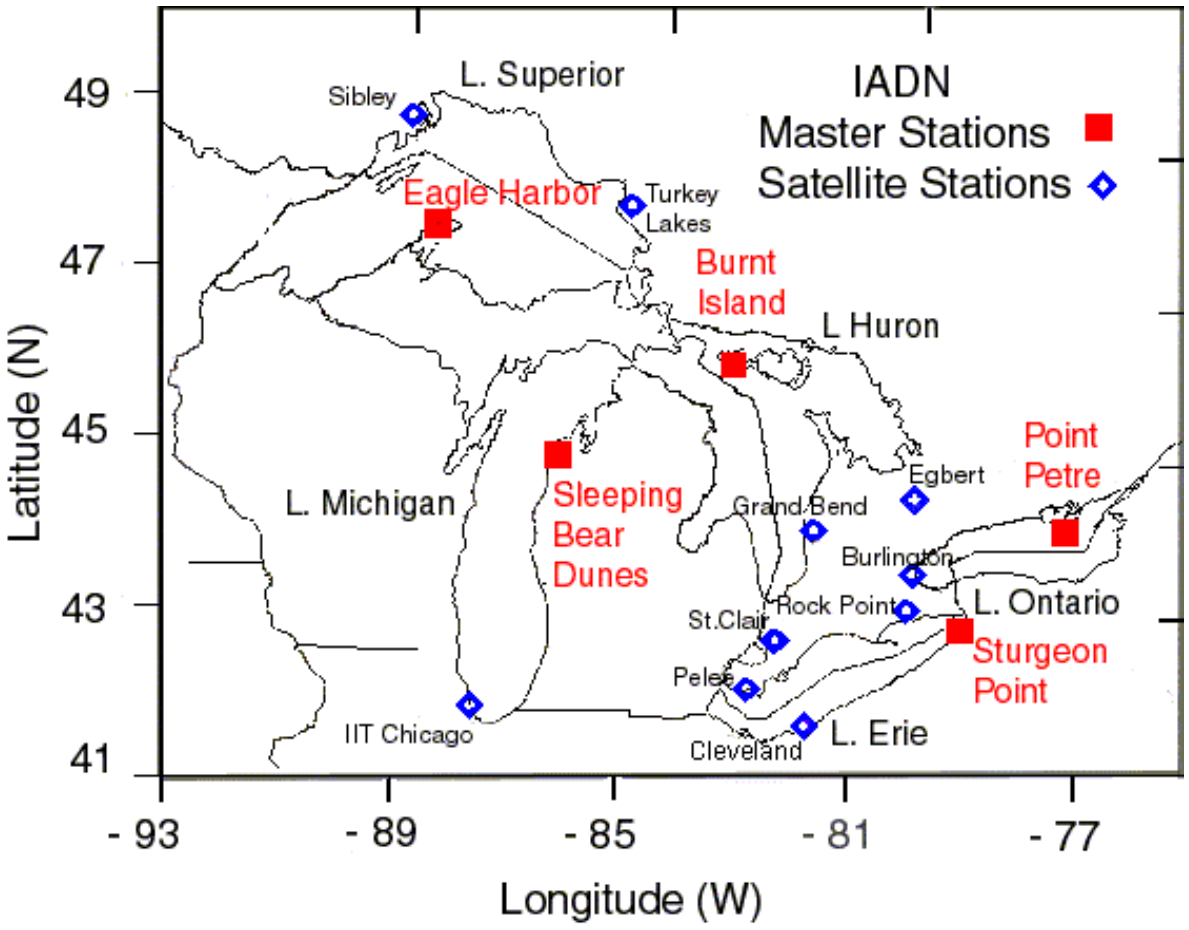
The Sleeping Bear Dunes and the Indiana Dunes National Lakeshore are working as a unit for monitoring, fostering the exchange of information and resources between parks with similar issues, reducing per park costs through multi-park studies and providing network-based expertise that would not be affordable to the parks individually. The overall purpose is to develop broadly-based scientific data on current status and long-term trends in composition, structure, and function of the parks' ecosystems.

State of the Lakes Ecosystem Conference

Additional work has been completed on the Great Lakes indicators over the past 2 years through the State of the Lakes Ecosystem Conference (SOLEC) process. The SOLEC is hosted every two years by USEPA GLNPO and Environment Canada. The next conference will be held in Niagara, Ontario in October 2008. The conferences are intended to provide a forum for exchange of information on the ecological condition of the Great Lakes and surrounding lands. A major goal is to bring together a large audience of government (at all levels), tribal, corporate, and not-for-profit managers to discuss problems that affect the lakes. The conferences have led to information gathering by a variety of agencies and organizations. In the year following each conference, a State of the Great Lakes Report is prepared by the governments based on the conference and public comments following the conference (www.binational.net).

Integrated Atmospheric Deposition Network

The Integrated Atmospheric Deposition Network (IADN) was created under Annex 15 of the Great Lakes Water Quality Agreement in 1990 to determine the magnitude and trends of atmospheric loadings of toxic substances to the Great Lakes. IADN is operated jointly by the USEPA-GLNPO and Environment Canada. Five master stations (1 per Lake) are located in rural areas within one kilometer of the shore to represent background conditions. There are also 10 satellite stations that provide additional detail on levels of toxics in the air around the Lakes. USEPA operates 5 stations: the master stations on Lakes Superior, Michigan, and Erie, as well as two satellite stations in Cleveland and Chicago,



IADN Master and Satellite Stations
Source: USEPA

People on beach at Warren Dunes, Indiana
US Environmental Protection Agency, Karen Holland