1. Introduction and Background

Lake Michigan Background

Lake Michigan is the second largest Great Lake, by volume. The lake is 307 miles long and 118 miles wide, with an average depth of 279 feet and a maximum depth of 925 feet. The Lake Michigan drainage basin covers more than 45,000 square miles. The shoreline of the lake stretches 1,660 miles.

Lake Michigan flows into Lake Huron through the Straits of Mackinac. The flow rate into Lake Huron allows Lake Michigan to be recharged once every 100 years, which is considered a relatively slow recharge rate. The lake supports a unique ecology, with colder forested regions dominating the northern half of the basin, and more temperate, fertile regions in the southern section.

Lake Michigan is located entirely in the United States, which made it uniquely situated for this project. Four states border the lake – predominately Michigan to the east and north, and Wisconsin on the western shore. Indiana and Illinois make up the southern shore of the lake, and while a small proportion of the basin area exists in these states, these areas contain significant natural areas, and high population and pollution sources.

The Lake Michigan basin consists of a variety of land uses. About 44 percent of the land in the basin is taken up in agricultural production. Roughly 41 percent exists as managed or unmanaged forest land. Nine percent of the remaining land is divided up into residential units, with a variety of uses making up the remaining 6 percent of the basin.

Monitoring Relevance to the Lake Michigan LaMP

Pursuant to the 1987 protocol to the Great Lakes Water Quality Agreement (GLWQA), Lakewide Management Plans (LaMP) have been developed for four of the five Great Lakes. The Lake Michigan LaMP effort was led by the U.S. Environmental Protection Agency (U.S. EPA), Region 5, in cooperation with its partners in the states of Michigan, Indiana, Illinois and Wisconsin, the public and other federal and tribal agencies. Additionally, Remedial Action Plans (RAPs) are being prepared and updated for ten Lake Michigan tributaries designated as Areas of Concern by the parties to the GLWQA.

According to the 1987 protocol, "LaMPs shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in ... open lake waters." The LaMP process involves setting goals to reduce toxics, improve habitat, and restore beneficial uses to the environment in the Lake Michigan basin. The RAPs follow a similar approach in specific geographic areas where significant pollution problems have impaired beneficial uses of the water body.

An additional feature of the LaMPs and RAPs is a strong emphasis on public consultation and local involvement. For the Lake Michigan LaMP, this is achieved through the Lake Michigan Forum, a broad-based stakeholder group with members from tribes, industry, environmental groups, local government agencies, community organizations, academia, recreational organizations, and the ten Lake Michigan AOCs. Public advisory councils (PACs) are the primary vehicle for facilitating public involvement in the AOCs. The PACs include broad representation from the AOC community and guide the RAP process at the local level.

While the original draft Lake Michigan LaMP focused strongly on toxic pollutants, the participating agencies and stakeholders recognized that other stressors contribute to impairments of the lake and the tributaries that feed into it. In response, the latest version of the LaMP expanded its scope to address a broader array of management issues, including loss of habitat and biodiversity and introduction of damaging exotic species. The year 2000 draft of the LaMP includes the results of a number of studies and monitoring efforts to determine the fate of pollutants entering the Lake, and how they move through air or water or sediments into the food chain.

A critical component of this broader approach will be a monitoring regime that is coordinated from one jurisdiction to another and sufficiently comprehensive to support the ecosystem indicators which inform management decisions. The Lake Michigan Mass Balance Study will provide important data on the amount of several critical pollutants entering the lake, their movement and how they are made available to fish and plant life. An outstanding need remains, however, to assess the status and scope of monitoring being conducted at the state and local levels on major tributaries to Lake Michigan; to develop a plan for coordinating and enhancing these efforts; and to address gaps and unmet needs in the collective monitoring and reporting regime that hamper decision making at all levels.

Project Goals

Through a cooperative agreement, the Great Lakes Commission worked with U.S. EPA Region 5, and its partners in the Lake Michigan LaMP process, to assess existing monitoring efforts in Lake Michigan basin and subwatersheds, including the ten AOCs and four other tributary watersheds. This report is one of the outcomes of the project. The report includes a comprehensive review of monitoring programs at the federal, state and local levels for the targeted watersheds; an analysis of gaps, inconsistencies and unmet needs; an assessment of the adequacy of existing efforts to support critical ecosystem indicators; and a plan for addressing major monitoring needs, particularly those considered most important for lakewide management decision making. The report has also been used in training members of the Lake Michigan Forum, PACs, and other stakeholders on determining current, local monitoring efforts and establishing community-based monitoring programs.

The project and report are consistent with the ecosystem approach of the LaMPs and RAPs as well as their emphasis on community involvement and participation. Monitoring has been viewed in the broadest sense, including not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. It is intended that the report and future project outcomes will provide the PACs and other stakeholders with important tools for developing their RAPs and will enable them to engage their community in a valuable dialogue regarding the status of knowledge on their local watershed.

Scope of the Assessment Effort

This report assesses monitoring efforts in the broadest sense, including not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. Project participants were responsible for conducting this assessment at the local level in their watersheds. There were fourteen major Lake Michigan tributaries selected for local analysis. The watersheds impacting these tributaries were selected as the base unit of analysis. These watersheds are illustrated in Figure 1. The Great Lakes Commission, in collaboration U.S. EPA and other agencies, assessed monitoring being conducted by state and federal agencies. Please see the methodology chapter for a background on project participants, as well as methods used to gain information to build the inventory.

Figure 1. Watersheds included in the Lake Michigan Monitoring Inventory.

Report Framework

This report is structured along the lines of a typical research report. This introduction is followed by a discussion of the methodologies used to collect the information in the inventory and this subsequent report. The methodology is followed by a series of chapters that present the project findings and inventory content. Summaries of inventory results from each of the fourteen tributaries included in this project are presented in the following categories:

- *LaMP pollutants:* This category includes substances classified as water quality pollutants at three levels. Critical pollutants are those that have been found to impair beneficial uses of the lake and its tributaries. Included in this category are polychlorinated biphenyls (PCB), dieldrin, chlordane, dichlorodiphenyltrichloroethane (DDT) and metabolites, mercury, and dioxins and furans. Pollutants of Concern are those toxic substances that are associated with local or regional use impairments. These include arsenic, cadmium, chromium, copper, cyanide, lead, zinc, hexachlorobenzene (HCB), toxaphene, and polynuclear aromatic hydrocarbons (PAH). Finally, Emerging Pollutants include those toxic

substances that have characteristics that indicate a potential to affect the physical or biological integrity of Lake Michigan. These include atrazine, selenium, and PCB substitute compounds.[1]

- *Nutrients and bacteria:* Nutrients, when present in high levels, can impair water bodies by encouraging the overproduction of algae and other plant life, leading to low oxygen levels and ultimately eutrophication. Several organisms which proliferate in high nutrient conditions include *E. coli* and coliform forms of bacteria. These bacteria can locally impair beneficial uses of water bodies.
- *Meteorological and flow monitoring:* Meteorological and flow monitoring represent two types of physical parameters that can be measured for water bodies. Meteorology (mostly relating to precipitation) and flow data help researchers develop water quality models, which have many uses, including source determination, Total Maximum Daily Load (TMDL) development, and other types of predictive modeling, to name just a few.
- *Sediments:* Contamination of bottom sediments is a common source of water quality impairment in AOCs in the Lake Michigan basin. Monitoring these sediments is important for determining the overall quality of a waterbody and its adjoining ecosystems.
- *Fish contaminants, fish health, and aquatic nuisance species:* Many species of fish in the basin take up chemical pollutants through the food web. Often, the effect is a bioaccumulation or concentration of pollutants within the fish tissue. This presents a significant health hazard to humans who consume this fish. Also, the health of fish populations in the lake and tributaries serves to indicate the health of the ecosystem to some degree. Nonindigenous Aquatic nuisance species can affect native aquatic species in a variety of ways. Monitoring of all these aspects of fish populations is important for tracking the health of life in the lake.
- *Benthos monitoring:* Similar to fish, there are a wide number of other organisms that exist deep within lakes and streams within the Lake Michigan basin. Many of these organisms are very sensitive to pollution and other aspects of a healthy aquatic system. Monitoring for the health and diversity of these species helps to determine the overall health of the aquatic ecosystem.
- *Air monitoring:* While monitoring the content of the air is an important task to determine intrinsic air quality, it is also important for tracking potential sources of water quality impairment. Much research is ongoing in the basin to determine how pollutants can be passed through the air to water bodies through air deposition.
- *Wildlife monitoring:* Any effort to track the health and quality of ecosystems must include some measure of the diversity and health of wildlife populations. Several types of public and private organizations are monitoring a variety of wildlife populations.
- *Land use:* One of the measures of human impact on the natural world is tracking the development of land. Changing the use of land from a naturally-controlled environment to agricultural production or urban or suburban habitation can have a wide range of impacts on the surrounding ecosystems. It is important to track these changes, along with measures of ecosystem health, to help determine the overall impacts from changes in land use.

In addition, each chapter begins with background about the watershed or region of focus, and ends with a local assessment of monitoring efforts. Both of these sections were written directly by the local project participants. Actual survey results will be made available for public use via a geographically-searchable Internet database, which is currently under development.

The tributary chapters are followed by a chapter assessing the monitoring coverage of the open lake and a discussion of state and federal monitoring programs which have a multiple watershed focus. This chapter is followed by a general discussion of the monitoring coverage in the Lake Michigan basin, focusing on gaps

[1]Definitions for LaMP pollutants were excerpted from the *Lake Michigan Lakewide Management Plan (LaMP 2000)*; U.S. EPA, 2000.

and unmet needs. The final chapter contains recommendations from the project participants, in consultation with numerous monitoring stakeholders, such as members of the Lake Michigan Monitoring Coordination Council.