

**Lake Michigan** is the sixth largest lake in the world and the only Great Lake entirely within the U.S. Projections are that by 2030 development in the watershed around surrounding southern Lake Michigan will grow by nearly 40 percent and the population will increase by 2 million, subjecting the area with water-supply and water-quality challenges.

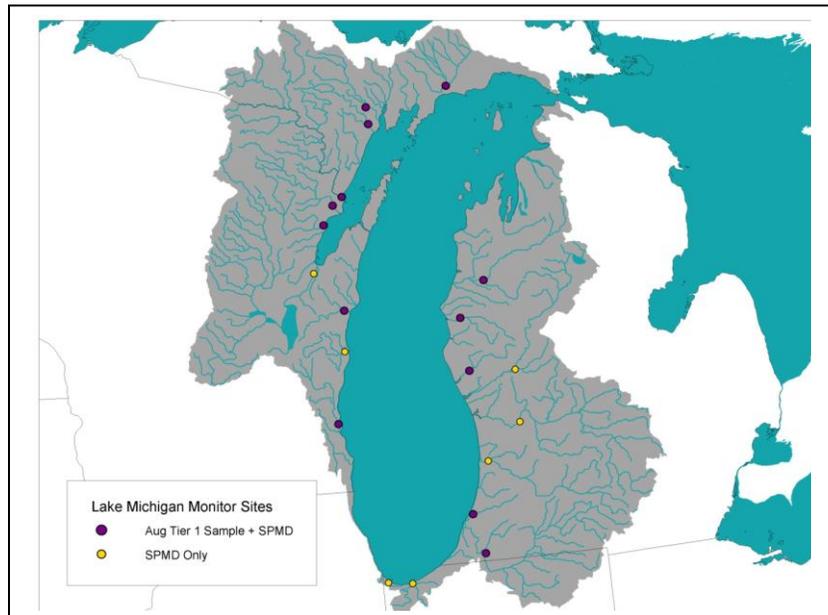
Major management issues in Lake Michigan and the surrounding watersheds relate to sustaining beneficial uses through continued remediation in ten "Areas of Concern" that are experiencing degradation of benthos, impaired food webs because of invasive species, restricted water supplies, loss of habitat (especially coastal wetlands), elevated nutrient loadings and undesirable algae, and beach closings because of potential pathogenic organisms. Lake Michigan has relatively long water retention that makes it particularly susceptible to pollutant buildup. This has led to several fish consumption advisories because of mercury and legacy toxic chemicals, such as polychlorinated biphenyls (PCBs), polychlorinated aromatic hydrocarbons (PAHs), flame retardants, DDT and other organochlorine pesticides.



**Hydrologists prepare to measure streamflow at the mouth of the Milwaukee River before it enters Lake Michigan.**

Elevated nutrient loadings from point and nonpoint sources of pollution from agricultural and urban land and the atmosphere are resulting in excessive growth of algae and other nuisance plants (eutrophication). Phosphorus has been identified as the primary nutrient of concern and hence "targets" for phosphorus loads were established in the 1970s and 1980s through Great Lake Water Quality Agreements. Subsequent actions resulted in decreased phosphorus loadings that have reduced eutrophication in the open lake. Since 1980, phosphorus loadings to Lake Michigan have remained below the targeted loads. Eutrophication issues, however, such as related to nuisance growth of cladophora, now occur in some nearshore areas and embayments. Continued monitoring and tracking of nutrient sources and loads from the upstream watersheds and water quality in the nearshore are therefore critical.

Network activities have been ongoing in Lake Michigan since 2007, funded by USGS in support of the Ocean Research Priorities Plan, as well as through partnerships with local, state, regional, and federal organizations. A major activity involves monitoring of flow and concentrations of nutrients and other constituents at 20 sites. Such monitoring enables direct assessment of about 70 percent of total inflow to Lake Michigan; provides information for key geographic and potential pollution-source areas that have not been previously monitored; and, helps to more comprehensively track loadings from the watersheds to the near-shore environments and Lake Michigan. In addition, Semi-Permeable Membrane Devices (SPMDs) have been deployed at the 20 sites to assess potential toxicity from hydrophobic organic contaminants, such as PAHs and DDT.



**Monitoring at 20 sites helps to track nutrient loadings and other constituents from watersheds to Lake Michigan. Semi-Permeable Membrane Devices (SPMDs) have been deployed to assess potential toxicity from hydrophobic organic contaminants, such as DDT and other organochlorine pesticides and polychlorinated biphenyls (PCBs).**



***Semi-Permeable Membrane Devices (SPMDs) are passive samplers for assessing trace levels of hydrophobic organic contaminants and are designed to mimic biological membranes, such as the gills of fish.***

Beginning in 2010, Network monies also support implementation of automated underwater vehicles (AUVs) in tributary mouths in the Milwaukee harbor environments and the bay of Green Bay. This innovative, real-time technology produces continuous high-resolution data for chlorophyll *a*, temperature, conductivity, dissolved oxygen, pH, turbidity, and blue-green algae; provides side scan sonar images of the lake or river bottom; and profiles water velocity. The continuous data are integrated with field chemistry samples to develop baseline water-quality monitoring surveys, and mapping of bathymetry, point and non-point sources, and substrate. The AUV technology also will be tested as a possible mechanism to track plumes from tributary mouths through embayments and into the nearshore.



***Automated underwater vehicles (AUVs) are used in the bay of Green Bay and the Milwaukee harbor environments, and produce a continuous stream of high-resolution data for chlorophyll *a*, temperature, conductivity, dissolved oxygen, pH, turbidity, and blue-green algae. (Note: AUVs, such as the YSI Ecomapper shown above, are available from a variety of manufacturers.)***

Network data are integrated in a data-management and web services system that is coordinated through the Great Lakes Restoration Initiative. In addition, Network-supported efforts and information contribute to the Near Shore Monitoring Plan of the Lake Michigan Monitoring Coordination Council (LMCC). This Plan describes coordinated monitoring and assessments for tributaries, embayments, and near-shore environments, which will help to track nonpoint sources of nutrients, pesticides, and heavy metals to near-shore environments. In addition, this information will enable evaluation of the health of coastal ecosystems and changes over time, all of which will provide information necessary for managers to make informed decisions, adapt their actions as needed, and assure effective stewardship of Lake Michigan.

**Web Access:**

Lake Michigan Monitoring Coordination Council:

<http://wi.water.usgs.gov/lmmcc/>

Great Lakes Restoration Initiative: <http://www.epa.gov/glnpo/glri/>

**Major partners:**

- Great Lakes Commission
- Great lakes Restoration Initiative
- Lake Michigan Monitoring Coordination Council
- Green Bay Metropolitan Sewerage District
- Milwaukee Metropolitan Sewerage District
- Wisconsin Department of Natural Resources
- University of Wisconsin Water Institute
- Great Lakes Regional Research and Information Network
- Great Lakes Environmental Research Laboratory (NOAA)
- Great Lakes Observing System (GLOS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Geological Survey (USGS)

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