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# Tracking Progress and Working with Partners Projects for the Great Lakes Restoration Initiative

The Great Lakes Restoration Initiative (GLRI) is an interagency program that addresses the most significant environmental problems in the Great Lakes ecosystem. Results from U.S. Geological Survey (USGS) scientific studies and monitoring are helping guide the restoration effort. The GLRI is made up of five focus areas that address these issues:

- Cleaning up toxic substances and areas of concern
- Combating invasive species
- Promoting nearshore health by protecting watersheds from polluted runoff
- Restoring and protecting habitats and wildlife
- Tracking progress and working strategically with partners

USGS project results are presented here for the tracking progress and working strategically with partners focus area. More information is available on the USGS GLRI Web page (*http://cida.usgs.gov/glri/*).

## Potential *Phragmites* Coastal Invasion Corridors Forecast

Current climate-change models predict significantly lower water levels in the Great Lakes that would expose large areas of fertile bottomlands to invasion by non-native species such as the common reed (*Phragmites*). By altering ecological processes, changes in climate, hydrologic, and nutrient-loading patterns could increase the spread of non-native *Phragmites* into existing Great Lakes coastal and diked wetlands. USGS scientists are using remote-sensing data to establish a baseline understanding of current distributions of invasive wetland plants and then forecast potential invasion corridors. A thorough assessment of the species' distribution throughout the U.S. Great Lakes shoreline, as well as the prediction of pathways of spread during climate change, would enable managers to target and prioritize control efforts.

Results include the following:

- A basinwide map showing the distribution of *Phragmites* along the U.S. Great Lakes coastal zone was created by using remote sensing. Radar and LiDAR (Light Detection And Ranging) information was used to create the initial map.
- A decision-support mapping tool is in development that shows the distribution and locations of *Phragmites* and identifies vulnerable areas given different water-level scenarios, nutrient loading, and land-use influences. The Web-based map is interactive and allows the user to zoom in and move throughout the Great Lakes Basin. The mapping tool is being developed from the *Phragmites* distribution map, land-use/land-cover data, soil permeability data, and tributary nutrient data from a model. Users will be able to visualize the water-level declines predicted by climate-change models and assess proximity to biodiversity protection areas or other areas of interest.

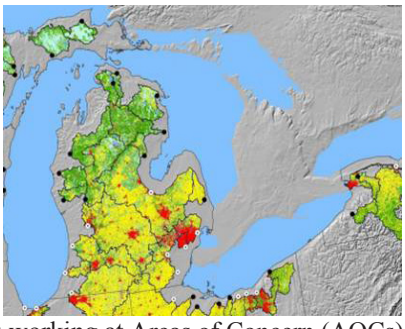
## Great Lakes Basin Responses to Future Change—Lake Michigan

There is an increasing need to forecast environmental responses to future climate and land-use changes to understand how to protect the integrity of current restoration efforts while adjusting to increased demands on the resources. The USGS is developing science-based forecasting tools that capture changes to water flows and discharges of nutrients and sediments to the Great Lakes. The work done by this project provides managers with forecasting tools for predicting the combined effects of climate and land-use changes that will help them identify and prioritize the sites best suited for restoration efforts.

Results include the following:

- A Precipitation-Runoff Modeling System (PRMS) model of the Lake Michigan Watershed is being built and calibrated to a coarse scale by using data from least-impacted USGS streamgages as calibration targets.
- Model calibration methods are being specifically designed to address the ecological and restoration focus of the models.
- The impacts of climate change on streams in the Lake Michigan Watershed are being simulated by using downscaled climate-change predictions from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment report.
- Historical wildlife disease data will be related to hydrological indices simulated by the watershed models. Relationships will then be used to forecast changes in disease occurrence and distribution that may result from hydrologic changes caused by climate and land-use change.

## Great Lakes Observing System Implementation



USGS scientists are supporting the Great Lakes Observing System (GLOS) by deploying equipment for collecting nutrient and sediment data in tributaries, embayments, and nearshore to determine and guide restoration activities. A model is also being developed that will provide measures of restoration progress and comparisons of progress over time and space. This information will allow scientists and managers working at Areas of Concern (AOCs) to access real-time data from multiple agencies.

Results include the following:

- A multi-agency Enterprise Architecture design has been completed, and work continues to integrate USGS sensor networks with GLOS through the use of international standards. Participation in the Great Lakes Testbed of Global Earth Observation System of Systems (GEOSS) provides linkages to similar data from Canadian agencies.
- Thirty monitoring sites were instrumented and are collecting near-real-time data as well as discrete samples for laboratory analyses.
- A Decision Support System (DSS) is in development that focuses on nutrient fluxes to key tributaries to the Great Lakes. The DSS will aid in delisting AOCs by providing access to monitoring data necessary to understanding whether nutrient and toxic-contaminant reduction goals are being met.

## Characterization of Rivermouth Ecosystems

USGS scientists are intensively sampling representative Great Lakes rivermouths to improve guidance for restoration of Great Lakes rivermouth-estuary processes, habitats, and services, and for planning of ecologically sustainable development in these already highly developed zones. Rivermouths often function as an integrator of both lake- and land-derived materials, resulting in ecosystems of high biodiversity and productivity, important to Great Lakes fisheries in both nearshore and deepwater zones. USGS is developing biological indicators to evaluate the influences of tributaries on nearshore and deepwater systems within the Great Lakes.

Results include the following:

- Rivermouth Characterization and Classification—An extensive database of rivermouths and watersheds across the entire Great Lakes Basin was created. Substantial progress has been made in developing a classification system for rivermouths based on biophysical characteristics such as stream discharge, water temperature, and watershed properties.
- Rivermouth Collaboration—An interdisciplinary and cross-organization collaboration of scientists, resource managers, and other stakeholders from across the Great Lakes has prepared a review and synthesis of existing information on rivermouth ecosystems.
- Influence of Watershed Attributes on Rivermouth Food Webs—Disturbances within the watershed (both agriculture and urban development) appear to strongly influence rivermouth food webs. In both minimally and highly disturbed rivermouths, food webs seem to be largely supported by low-quantity, but apparently high-quality, inputs from the associated Great Lake. These lake-delivered inputs may contribute key nutrients to rivermouth communities that allow for the establishment of important biological assemblages.

## USGS Data Compilation for the Great Lakes Basin

USGS maintains data in different formats depending on data type—biological, water resources, geological, and geospatial. Although this information is publicly available, it is not available as a set of data for the Great Lakes. In support of the Great Lakes Restoration Initiative (GLRI), the USGS is working with the Great Lakes Observing System and other data-exchange efforts to make water-resources and biological information more readily accessible as a Great Lakes Basin dataset. This information includes streamflow, groundwater, and water-quality data, as well as online access to USGS reports written for part or all of the Great Lakes Basin. The database model has been developed and is being populated with USGS GLRI data, focusing on priority watersheds and Areas of Concern.

## USGS Support to Lakewide Management Plans

USGS is providing expertise to Lakewide Management Plan (LaMP) processes, programs, conferences, workshops and projects, including the development of LaMP documents and updates. Specifically, USGS scientists are participating in and serve on workgroup and technical committees, management-level meetings, and interagency actions that implement LaMP programs and priorities and would help incorporate LaMP goals in USGS planning efforts. Working with local tribal and natural resources departments, the U.S. Environmental Protection Agency (USEPA), state agencies, and LaMPs, the USGS compiled existing data to recognize areas where data were missing or sparse and areas where ecosystems were vulnerable. The process began by compiling and collecting data focusing on Areas of Concern (AOC) and nutrients.

Results include the following:

- The USGS Great Lakes Science Center coordinated activities with partners in each of the Great Lakes and on supporting nearshore sampling and monitoring activities.
- For Lake Michigan, the efforts included compilation of historical data and information needed to write a paper about monitoring and data available in nearshore ecosystems.
- For Lakes Erie and Huron, emphasis was placed on coordinating activities with partners. In Lake Huron, emphasis focused on issues affecting fisheries and nutrient inputs.
- For Lake Superior, emphasis was placed on support of data activities in areas with potential for mining development.
- Lake Ontario efforts focused around attending LaMP meetings and providing science expertise for collecting data on benthos (bottom-dwelling organisms) to provide information to help USEPA Region 2 make decisions on delisting the St. Lawrence-Massena AOC.

## Geospatial Information for Decision Support in Areas of Concern and Ecosystems

Elevation data and aerial photography have been expanded in the Great Lakes Basin. LiDAR (Light Detection And Ranging) is an optical remote sensing technology that measures the distance to or other properties of an area by illuminating it with light from a laser. LIDAR is a valuable tool for resource managers because it provides high-resolution imagery for monitoring invasive species, inventorying wetlands, and restoring habitat in the Great Lakes Basin. This project has operated in close coordination with USGS American Recovery and Reinvestment Act (ARRA) funded grants to local governments in southeast Michigan and has been completed.

Results include the following:

- LiDAR for six counties in southern Michigan and northeast Indiana was completed. The mapping includes 4,600 square miles of high-resolution elevation data and completes coverage for the Lake Erie Watershed.
- Additional grants for LiDAR mapping were awarded to Allen County, Indiana (including Fort Wayne), and Calhoun County, Michigan (including Battle Creek), to make some improvements to their existing data and provide the product in the public domain. Adams County, Indiana, is in the process of obtaining high-resolution elevation data.

## Watershed Modeling for Stream Ecosystem Management

USGS scientists are providing forecasting tools for managers to determine how water withdrawals or other hydrologic or land-use changes in watersheds may affect Great Lakes ecosystems. The tools will help assess the health of aquatic ecosystems and identify areas in need of protection, conservation, enhancement, and restoration. The information will help guide stream-ecosystem restoration efforts to achieve maximum effectiveness and success.

Results include the following:

- Geographic information system data from the Great Lakes Aquatic GAP (Gap Analysis Program) project was joined with the National Hydrography Dataset Plus (NHDPlus) for the Great Lakes Basin.
- The USGS and U.S. Environmental Protection Agency (USEPA) NHDPlus team edited and checked version 2 of NHDPlus, which was then released as a preliminary product and available for USGS project scientists to use for more accurate modeling.
- Two ungaged streamflow-estimation techniques—
  - A new method to estimate unit discharge values at ungaged stream sites was developed and can be used to produce estimates of daily streamflow at ungaged sites.
  - Analysis software (AFINCH, Analysis of Flows in Networks of CHannels) was used to develop water-use data files for major regulated gages in subbasins that had previously been identified in the 1960 to 2010 USGS annual water-data reports.

Great Lakes RESTORATION

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