**EPA**

United States
Environmental Protection
Agency

New Index of Environmental Condition for Coastal Watersheds in the Great Lakes Basin

INTRODUCTION

The Great Lakes is the largest system of surface freshwater on the earth. It contains about 20% of the earth's fresh water and about 90% of the freshwater in the United States. The wealth of natural resources has made this area a center of economic activity for the United States. From mining, forestry, and agriculture to recreation and shipping, human activities have taken a toll on the natural environment. In response to the continued degradation of the Great Lakes, the United States and Canada signed the Great Lakes Water Quality Agreement in 1972. The goal of this agreement was "restoring the chemical, physical and biological integrity of the waters of the Great Lakes Basin ecosystem" to achieve healthy populations of plants, fish, and wildlife and to protect human health. To monitor progress towards this goal, measurements of human-caused stress must be made over a period of time to evaluate changes in environmental condition.

U.S. Great Lakes Basin
environmental condition by watershed

Best
Worst
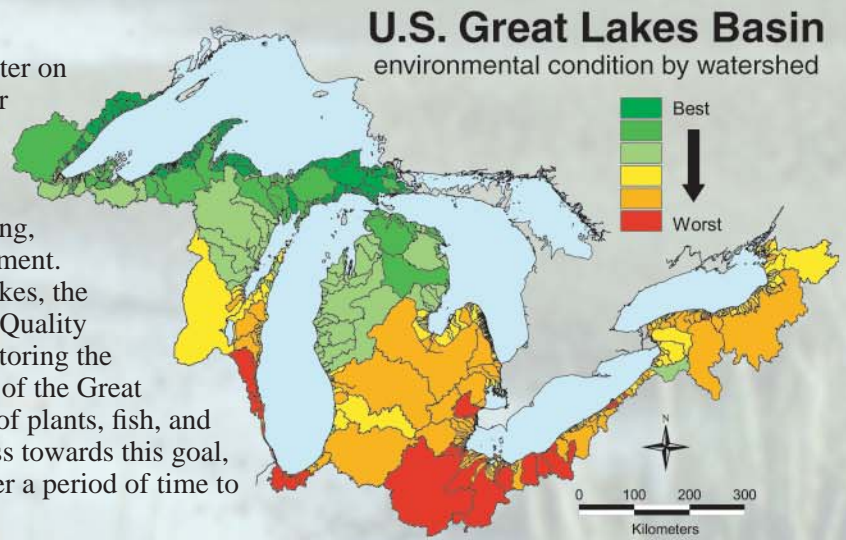
Ecological Indicator: Scientists with the Great Lakes Environmental Indicator (GLEI) Project (*http://glei.nrri.umn.edu*) have developed a Condition Index that indicates the region's environmental condition by watershed. The index is based on 207 individual stressors* that fall into five dominant human-derived stresses to ecological condition: 1) type of land use, 2) amount of agricultural activity, 3) point sources of pollution, 4) atmospheric deposition, and 5) human population density. The stresses in each watershed were summarized and the resulting scores were distributed over a gradient from worst (red) to best (green) indicating the Environmental Condition of each coastal watershed, as depicted on the map (right) of the U.S. Great Lakes basin. Using updated versions of appropriate databases and GIS techniques, managers can produce similar Condition Indexes for their area.

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* The use of all 207 stressors allowed a more complete synthesis of human impacts; however, something analogous could be done using only land-use classifications.

HUMAN STRESS GRADIENT OF COASTAL ZONES

GLEI researchers have developed a unique way to divide the coastal regions of the Great Lakes in the U.S. into 762 watersheds that encompassed the larger tributary streams and adjacent shoreline. For each of these watersheds a Condition Index was calculated, as described above, that reflects the amount and type of human stress within the watershed.

To link the land-based Condition Index to the health of Great Lakes coastal aquatic ecosystems (e.g., wetlands, beaches and bays), GLEI researchers sampled communities of birds, amphibians, diatoms, fish, macroinvertebrates, and wetland vegetation at sites across the range of the Condition Index. Water quality and contaminant levels were also sampled at

many of the sites. Indicators of biological condition based on these samples were found to be correlated with the Condition Index. Researchers have also identified linkages between the particular types of stressors (such as certain types of non-point source pollution) and the biological communities of the streams and shorelines. Based on these relationships, diagnostic indices of ecological condition have been developed. Diagnostic indices can be used to guide management toward targeting specific stressors for restoration or remediation goals. Several examples are available (although not yet published) from the researchers listed below.

Danz, N.P., R.R. Regal, G.J. Niemi, V. Brady, T. Hollenhorst, L.B. Johnson, G.E. Host, J.M. Hanowski, C.A. Johnston, T. Brown, J. Kingston, and J.R. Kelly. 2005. Environmentally Stratified Sampling Design for the Development of Great Lakes Environmental Indicators. *Environmental Monitoring and Assessment* 102:41-65. (http://glei.nrri.umn.edu)

Environmental Application: The Condition Index is a tool useful to environmental managers for prioritizing problems (e.g., loss of wetlands) across the Great Lakes region and placing these areas into a larger regional or national context. Generally, areas in the southern and eastern Great Lakes have much higher levels of human-induced stresses than do areas in the northern Great Lakes. This information can be used to identify areas 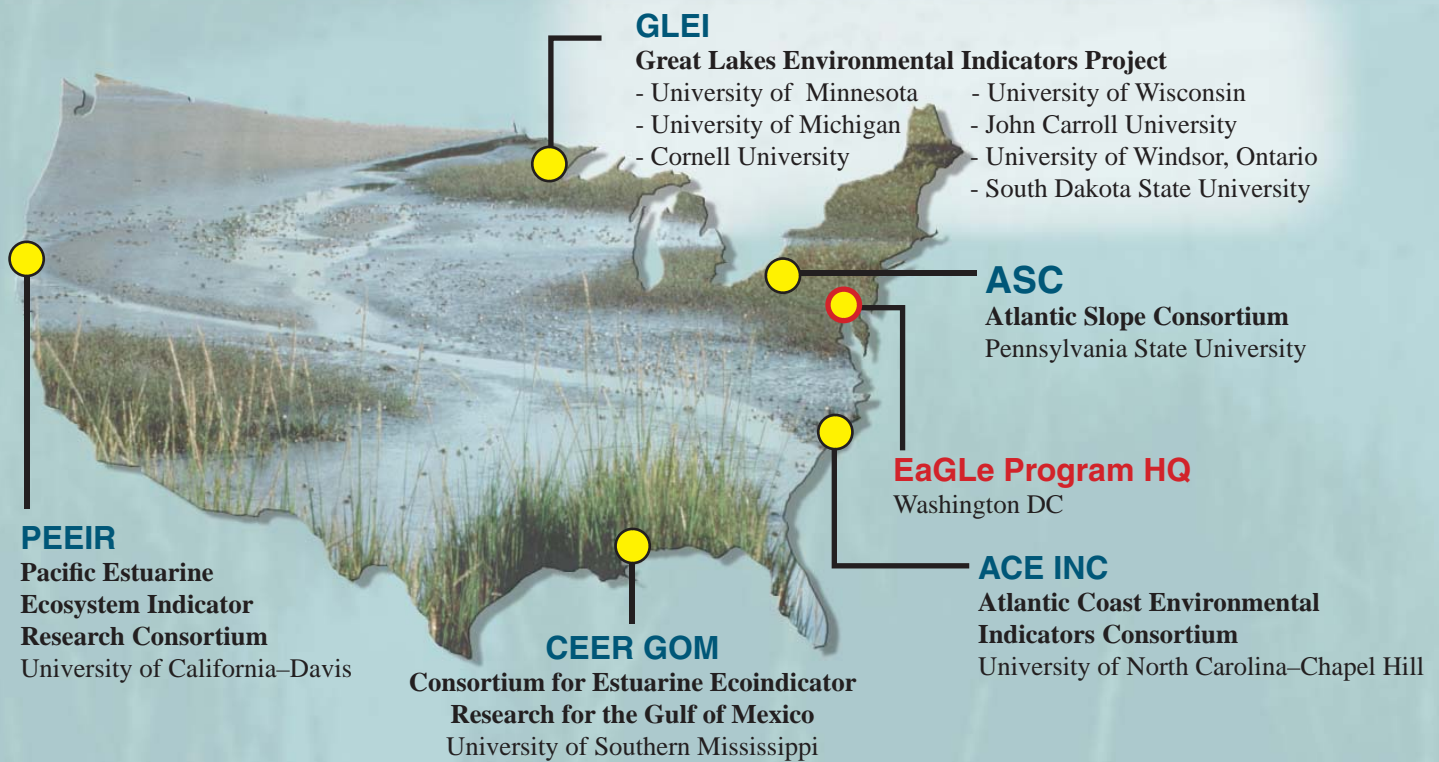that should be protected, and to prioritize areas in need of restoration. Although all of the datasets that make up the Condition Index are publicly available, no one has previously put them together to give an overall picture of the human pressures in this region.

The analyses also hold promise for EPA's Region V, the Great Lakes National Program Office, and other regional water programs in establishing a design framework for monitoring biological resources and diagnosing causes of human impairment across the Great Lakes coastal zone.

The Index of Environmental Condition map provides a tool for resource managers to identify areas vulnerable to loss of wetlands, coastal areas in need of protection or restoration, and a mechanism to monitor change over time in human use and its impact on watersheds.

EPA's Science to Achieve Results (STAR) Estuarine and Great Lakes (EaGLe) Program

GLEI
Great Lakes Environmental Indicators Project
- University of Minnesota
- University of Michigan
- Cornell University
- University of Wisconsin
- John Carroll University
- University of Windsor, Ontario
- South Dakota State University

ASC
Atlantic Slope Consortium
Pennsylvania State University

EaGLe Program HQ
Washington DC

ACE INC
Atlantic Coast Environmental Indicators Consortium
University of North Carolina–Chapel Hill

PEEIR
Pacific Estuarine Ecosystem Indicator Research Consortium
University of California–Davis

CEER GOM
Consortium for Estuarine Ecoindicator Research for the Gulf of Mexico
University of Southern Mississippi

NCER

EaGLe

Direct and indirect effects of human activities have taken a toll on the nation's estuaries, yet few direct linkages have been identified between human activities on land and responses in estuarine ecosystems. The Great Lakes Environmental Indicators (GLEI) project is one of five national projects funded by EPA's EaGLe program. The goal of the EaGLe program is to develop the next generation of ecological indicators that can be used in a comprehensive coastal monitoring program.