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.

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.

* 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.

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.