



# Great Lakes Environmental Indicators

EPA STAR EaGLE

## Summarizing Human Disturbances in the Great Lakes Basin

Measures of human disturbance have a prominent role in biological monitoring and assessment, with uses such as indicator calibration, characterizing stress/response relationships, and identifying areas at risk. Despite the importance of such measures, there are no universal guidelines for summarizing disturbance because of the varied purposes of the measures. For large geographic regions, disturbance is probably best summarized using geographic information system (GIS) techniques that allow disturbance variables to be quantified continuously over large spatial extents. There is an impressive amount of publicly available GIS data related to the primary human disturbances for most regions of the continental U.S. that can be used to summarize disturbance. The primary methodological concern is how to distill the information present in a large number of disturbance variables down into a small number of integrated measures of disturbance.

Scientists collaborating on the Great Lakes Environmental Indicators (GLEI) project developed a methodology to characterize disturbance to the US Great Lakes coastal region using over 200 GIS variables. The GLEI approach considered five different kinds of stress individually: agriculture, atmospheric deposition, land cover, human populations, and point source pollution. We outline below how disturbance was summarized for the disturbance variables in each category.

Disturbance variables were obtained from various public agencies at no cost. The variables were originally in various resolutions and source units, and were recalculated for 762 coastal watersheds defined by the GLEI project. A watershed-based approach was used to reflect the premise that human disturbance in coastal watersheds influences environmental conditions in (downstream) coastal ecosystems. Principal components analysis (PCA) was used to remove redundancy in the input variables. PCA creates a set of new variables (principal components, PCs) that are linear combinations of the original variables. Because the first few PCs often summarize the majority of the variation in the data, subsequent PCs can be excluded from further analyses, thereby reducing dimensionality and removing redundancy without losing information. Figures 1-5 represent the spatial patterns of the first PCs across the basin. For the figures, PCs were normalized by adding the minimum value and dividing by the maximum; this had the effect of rescaling all PCs to range between 0 and 1.

The first principal component was interpreted to be an overall gradient of stress for each type of disturbance. Due to the large number of variables representing various disturbances and the clear interpretations of the first principal components, we believe the disturbance gradients summarize the major threats to coastal ecosystems in the U.S. Great Lakes. Environmental responses such as water quality, fish community metrics, and bird abundances summarized by GLEI researchers have been shown to be strongly correlated with the disturbance gradients.

For more information about the GLEI project, visit our website (<http://glei.nrri.umn.edu>) or contact Dr. Gerald Niemi ([gniemi@nrri.umn.edu](mailto:gniemi@nrri.umn.edu)).

## Acknowledgements

This research was supported by a grant from the U.S. Environmental Protection Agency's Science to Achieve Results (STAR) Estuarine and Great Lakes (EaGLE) program through funding to the Great Lakes Environmental Indicators (GLEI) project, U.S. EPA Agreement EPA/R-8286750.