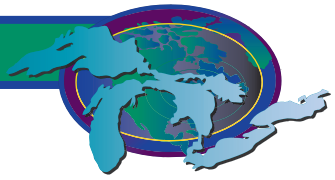

Benthos Diversity and Abundance - Aquatic Oligochaete Communities

Indicator #104

Overall Assessment

Status:	**Mixed**
Trend:	**Unchanging/Deteriorating**
Rationale:	**Some lakes or parts of lakes are good and unchanging, while other lakes or parts of lakes are fair to poor and are either unchanging or may be deteriorating.**

Lake-by-Lake Assessment

Lake Superior

Status: Good
Trend: Unchanging
Rationale: All sites had index values that ranged from 0 to 0.5, indicating oligotrophic conditions.

Lake Michigan

Status: Mixed
Trend: Unchanging, Deteriorating
Rationale: Most sites had index values that ranged from 0 to 0.5, indicating oligotrophic conditions. The two most southeastern, nearshore sites changed from oligotrophic status in 2000, mesotrophic status in 2001, mesotrophic/eutrophic status in 2002 through 2004, and back to mesotrophic in 2005. The most eastern central, nearshore site changed from oligotrophic (2000 through 2004) to mesotrophic (2005).

Lake Huron

Status: Mixed
Trend: Unchanging
Rationale: Saginaw Bay remained mesotrophic throughout the six years. All other sites were oligotrophic.

Lake Erie

Status: Mixed
Trend: Unchanging, Deteriorating
Rationale: Most sites were mesotrophic to eutrophic. Two western sites were oligotrophic to mesotrophic due to reduced numbers of oligochaetes. Eutrophic sites in the eastern part of the lake exhibited increasing index values.

Lake Ontario

Status: Mixed
Trend: Unchanging
Rationale: Most sites were oligotrophic. The three most southern, nearshore sites varied from oligotrophic to eutrophic on a year-to-year basis.

Purpose

- To assess species diversity and abundance of aquatic oligochaete communities in order to determine the trophic status and relative health of benthic communities in the Great Lakes

Ecosystem Objective

Benthic communities throughout the Great Lakes should retain species abundance and diversity typical for benthos in similar unimpaired waters and substrates. A measure of biological response to organic enrichment of sediments is based on Milbrink's (1983) Modified Environmental Index (MEI). This index was modified from Howmiller and Scott's (1977) Environmental Index. This measure will have wide applicability for nearshore, profundal, riverine, and bay habitats of the Great Lakes. This indicator supports Annex 2 of the Great Lakes Water Quality Agreement (United States and Canada 1987).

State of the Ecosystem
Shortly after intensive urbanization and industrialization during the first half of the 20th century, pollution abatement programs were initiated in the Great Lakes. Degraded waters and substrates, especially in shallow areas, began to slowly improve in quality. By the early 1980s, abatement programs and natural biological processes changed habitats to the point where aquatic species that were tolerant of heavy pollution began to be replaced by species that were intolerant of heavy pollution.

The use of Milbrink's index values to characterize aquatic oligochaete communities provided one of the earliest measures of habitat quality improvements (e.g., western Lake Erie). This index has been used to measure changing productivity in waters of North America and Europe and, in general, appears to be a reasonable measure of productivity in waters of all the Great Lakes (Figure 1, Figure 2). The index values from sites in the upper lakes continue to be very low (less than 0.6), indicating an oligotrophic status for these areas. Index values from sites such as the nearshore areas of southeastern and east-central Lake Michigan and Saginaw Bay in Lake Huron, which are known to have higher productivity, exhibited higher index values that indicate mesotrophic (0.6 to1.0) to eutrophic (greater than 1.0) conditions. Nearshore sites in southern Lake Ontario continued to be classified as mesotrophic to eutrophic, while offshore sites were oligotrophic. Sites in Lake Erie exhibited the highest index values; nearly all of them fell within the mesotrophic or eutrophic category (one site in western Lake Erie had low values characterized by low numbers of oligochaetes). Over the last six years, a trend of increasing index values was observed for eastern Lake Erie.

Pressures
Future pressures that may change suitability of habitat for aquatic oligochaete communities remain unknown. Pollution abatement programs and natural processes will assuredly continue to improve water and substrate quality. However, measurement of improvements could be overshadowed by pressures such as zebra and quagga mussels, which were an unknown impact only 10 years ago. Other possible pressures include non-point source pollution, regional temperature and water level changes, and discharges of contaminants such as pharmaceuticals, as well as other unforeseen sources.

Management Implications
Continued pollution abatement programs aimed at point source pollution will continue to reduce undesirable productivity and past residual pollutants. As a result, substrate quality will improve. Whatever future ecosystem changes occur in the Great Lakes, it is likely aquatic oligochaete communities will respond early to such changes.

Comments from the author(s)
Biological responses of aquatic oligochaete communities are excellent indicators of substrate quality, and when combined with a temporal component, they allow for the determination of subtle changes in environmental quality, possibly decades before single species indicators. However, it is only in the past several years that Milbrink's MEI has been applied to the open waters of all the Great Lakes. Therefore, it is critical that routine monitoring of oligochaete communities in the Great Lakes continue. Additionally, oligochaete taxonomy can be a specialized and time-consuming discipline, and the taxonomic classification of species and their responses to organic pollution is continually being updated. As future work progresses, it is anticipated that the ecological relevance of existing and new species comprising the index will increase. Modifications to this index must be incorporated in future work, which includes the assignment of index values to several taxa that are currently not included in the index, and the re-evaluation of index values for a few of the species that are included in the index. It should be noted that even though the index only addresses responses to organic enrichment in sediments, it may be used with other indicators to assess the effects of other sediment pollutants.

Acknowledgments
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Sources
U.S. Environmental Protection Agency, Great Lakes National Program Office, Biological Open Water Surveillance Program of the Laurentian Great Lakes (2000-2005), through cooperative agreement GL-96513791 with the University of Wisconsin-Superior.

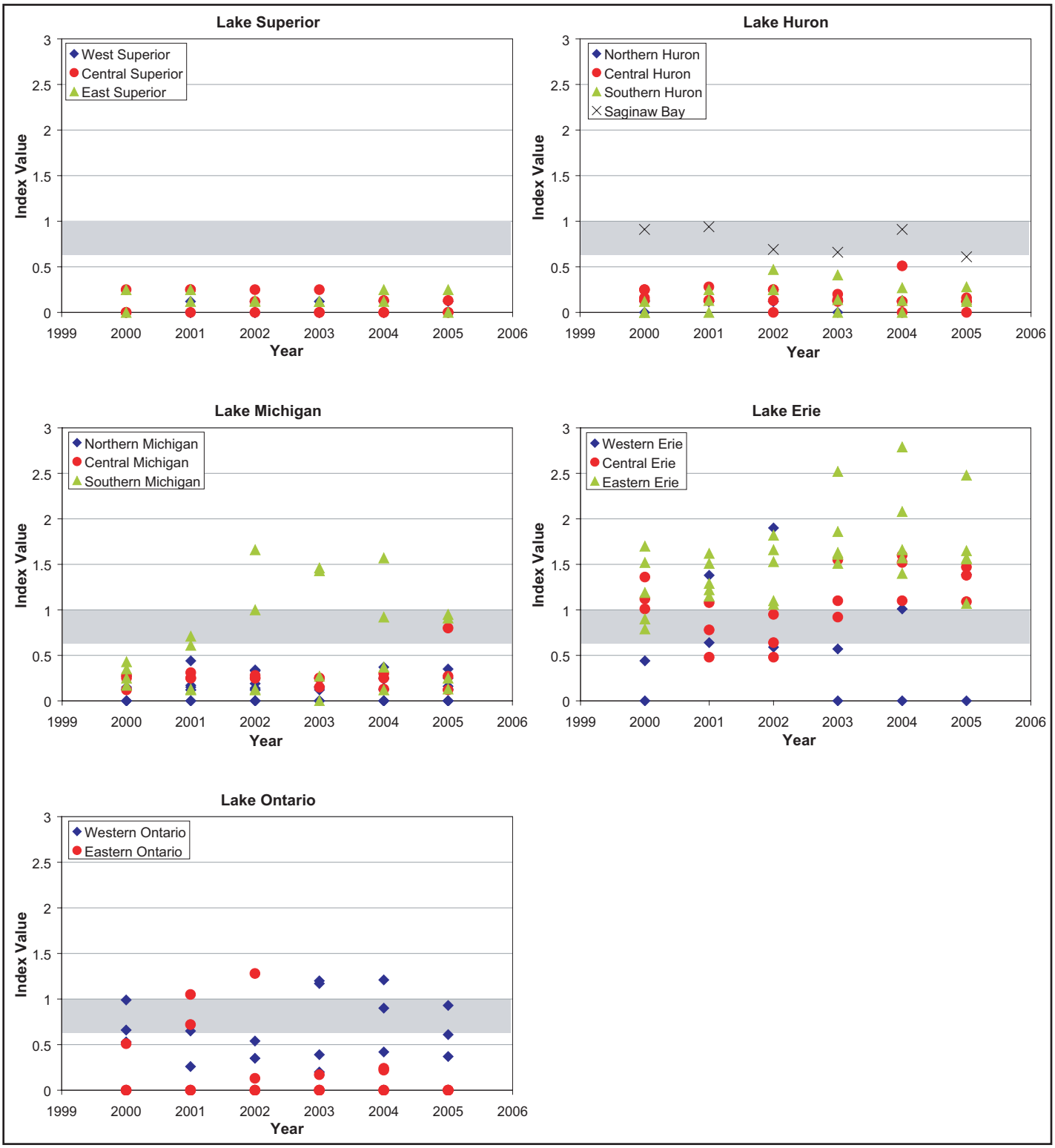

Figure 1. Scatter plots of index values for Milbrink's (1983) Modified Environmental Index, applied to data from GLNPO's 2000-2005 summer surveys.

Values ranging from 0-0.6 indicate oligotrophic conditions; values from 0.6-1.0 indicate mesotrophic conditions (shaded area); values above 1.0 indicate eutrophic conditions. Index values for the taxa were taken from the literature (Milbrink 1983, Howmiller and Scott 1977); immature specimens were not included in any calculations. Data points represent average of triplicate samples taken at each sampling site.

Source: U.S. Environmental Protection Agency, 2000-2005

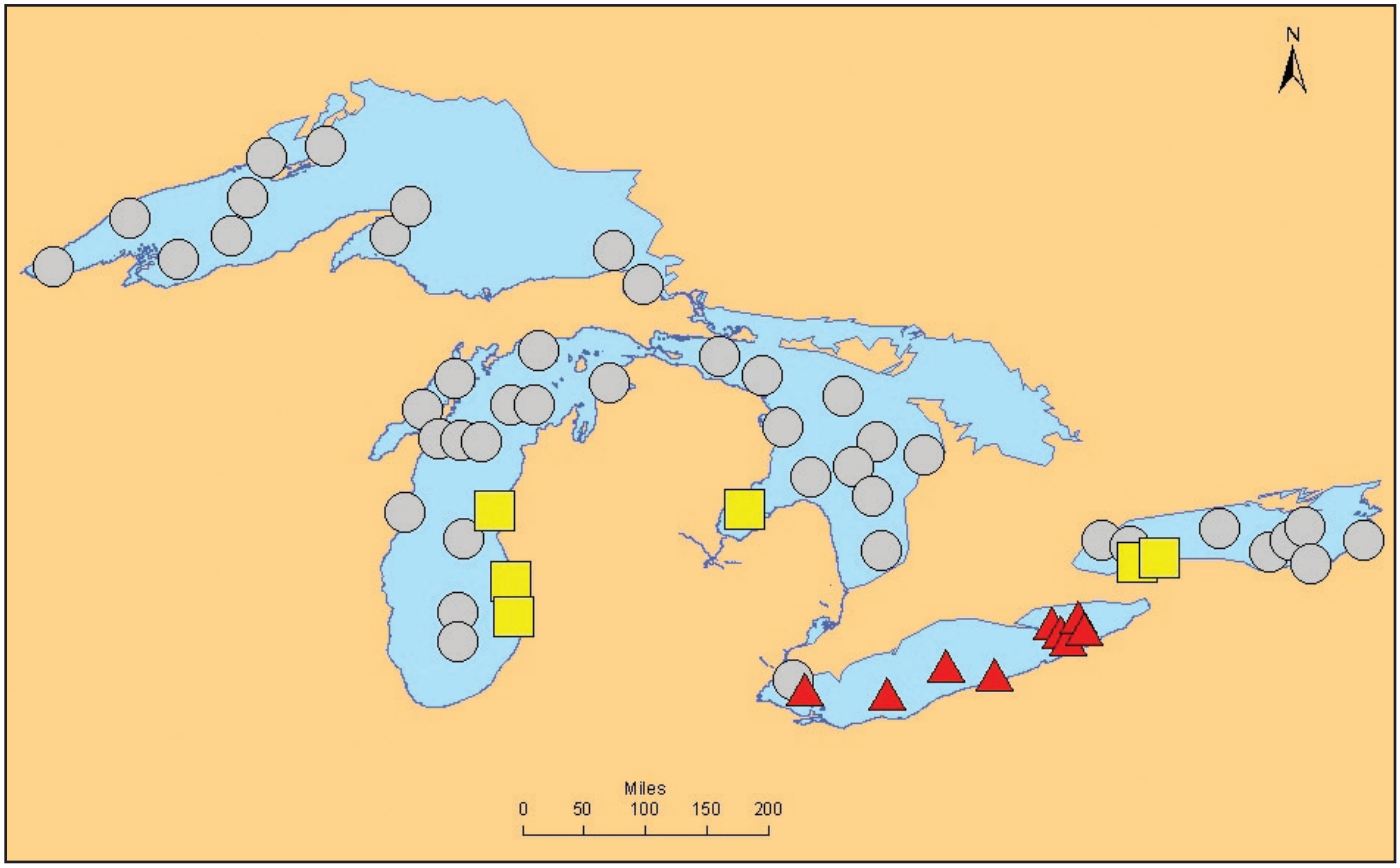

Figure 2. Map of the Great Lakes showing trophic status based on Milbrink's (1983) Modified Environmental Index using the oligochaete worm community.
Data taken from 2005. Gray circles = oligotrophic; yellow squares = mesotrophic; red triangles = eutrophic

Howmiller, R.P., and Scott, M.A. 1977. An environmental index based on relative abundance of oligochaete species. *J. Wat. Poll. Cont. Fed*. 49:809-815.

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