

2003 Progress Report: Great Lakes Diatom and Water Quality Indicators

EPA Grant Number: R828675-01

Subproject: *This is subproject number 01, established and managed by the Center Director under grant R828675*

Center: [Great Lakes Environmental Indicators Project](#)

Center Director: [Gerald J. Niemi](#)

Title: [Great Lakes Diatom and Water Quality Indicators](#)

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EPA Project Officer: Barbara Levinson

Project Period: January 10, 2001 to January 9, 2005

Project Amount: \$6,000,000

RFA: [Environmental Indicators in the Estuarine Environment Research Program \(2002\)](#)

Research Category: [Ecological Indicators/Assessment/Restoration](#)

Description:

Objective:

To quantify the extent to which pressure indicators influence diatom community structure in nearshore wetlands, estuaries, and reaches of the Laurentian Great Lakes including the following.

1. Develop predictive models through multivariate analyses of communities and ecosystems to:
 - a. infer ecological status at local and regional scales, and
 - b. describe pre-disturbance-to-recent baselines, trends, and magnitudes of change in restricted river-influenced and other wetlands.
2. Evaluate and modify existing diatom metrics, and devise and validate new diatom metrics, so that a number of state indicators for nutrient loading, siltation, and salinity in nearshore waters of the Great Lakes will be available to federal and state agencies.
3. Construct multimetric diatom indices from the best of these state or condition metrics.
4. Develop integrated indices of biotic integrity based on a combination of selected metrics developed in the diatom subprogram and by other teams in the larger program.
5. Develop a QA/QC infrastructure for the diatom subprogram and future assessment efforts.
6. Conduct a limited water quality survey (field and lab measurements) of nearshore sites contemporaneously with diatom sampling to:
 - a. calibrate diatom indices,
 - b. further characterize sampling sites for all GLEI subprojects and related EPA-MED Great Lakes coastal wetlands projects,

- c. evaluate the efficacy of several relatively inexpensive, *field-friendly* measurements as surrogates for more expensive analytes typically used to characterize water quality.

Progress Summary: Diatom and water quality samples were collected from approximately 240 segment sheds of shoreline from 2001-2003 distributed across the US shoreline of all 5 Great Lakes and 5 geomorphic units. The sampling effort generated >500 discrete water samples that were analyzed in the laboratory for nutrients, chlorophyll, suspended solids, DOC, chloride and several other parameters. At least 4 times that number of samples were also analyzed in the field for additional water quality characteristics. Sediment core subsamples (discrete surficial and deep strata), and grabs where soft sediments were not available, were field sectioned for diatom community analysis at all segmentsheds. An additional ~90 discrete samples from deeper water cores were collected in collaboration with EPA “guardian” cruises in 2002 and 2003. Whenever possible, sections were taken from the surface (recent history) and ~40 cm to provide information about decadal historical trends. Diatom samples were processed in Ely, MN (NRRI-UMD sampling) and University Heights, OH (for JCU sampling). Water Quality analyses were all performed at the NRRI – UMD Central Analytical Laboratory in Duluth, MN with the exception of DOC (dissolved organic carbon) which was graciously analyzed by EPA-MED in Duluth. Databasing activities were coordinated at NRRI -UMD, and data entry via the Web has been developed to provide unified methods for entry and suitable quality control of the procedures.

Expected Results

The research will develop and evaluate indicators by local habitat, by lake, by ecoregion, and by stressor activity/intensity. The diatom project will provide linkages from ecosystem function to water quality and to pressure indicators documented by other subproposals. We are confident that a suite of powerful diatom indicators can be developed for key pressure indicators for use throughout the Great Lakes basin.

Progress

Diatom community analysis - Enumerations are not yet complete. Submergent zone samples have been prioritized and taxonomy will be completed by August 2004. Field data documenting site and sediment characterization and condition have been entered into the database and taxonomic images are being uploaded into the web-based database. A taxonomic meeting will be held early summer to ensure taxonomic harmony between researchers enumerating diatoms at the three universities, and for ultimate use by other Great Lakes researchers and agencies.

Diatom - Stressor relationships - Significant relationships between surficial taxa and water chemistry (specific conductivity [salinity] and nitrate-N) were found from the 90 grab samples used for an MS thesis (Yanko, 2002) for all five lakes in the 2001 pilot. Many of these sites were sampled prior to the completion of the final experimental design and so these relationships will be re-examined in regard to their segmentshed locations.

Water Quality - All water samples have now been analyzed, quality assured and analyte values entered into the GLEI database. Field profiles of temperature, DO, EC25, secchi and transparency tube depth, pH, turbidity and soluble and particulate “chlorophyll”- fluorescence

were also entered. Metadata are being created for all parameters along with queries to expedite retrieval of appropriate data sets for statistical analyses. An effort has begun to expedite including field data from the Fish-Invertebrate subproject to the larger Diatom subproject dataset as well as EPA-MED field and lab water chemistry data from their 2002-2004 wetland and high energy/embayment sites. Since a common experimental unit, the “segment-shed” was used for all four subgroup studies, and similar methodology and QA/QC protocols, combining the data will provide us with better estimates of interannual and seasonal variation. Examples of preliminary analyses are shown in several figures below.

Future Activities: The project is now focused on (1) completing diatom enumerations; (2) integrating all available water quality data into the GLEI database (Diatom, Fish-Invert, and EPA-MED collaborators) for all subprojects to use; (3) analysis of “surrogate “ measures of water quality; and (4) exploratory analysis of relationships between landscape-scale stressors and coastal zone water quality; (5) completion of the Web-based electronic diatom image library for use by project scientists and for quality control comments from a broader scientific audience; and (6)

Theses

Yanko, Kristin. 2002. An analysis of the benthic diatom flora of the Laurentian Great Lakes, and their use as indicators of water quality. GLEI master of science thesis. John Carroll University, Ohio, 156 pp.

Ferguson, M. In progress. Analysis of the Benthic Diatom Flora in Variable Habitat Regions of the Laurentian Great Lakes. M.S. thesis. John Carroll University, Cleveland, OH, USA.

Publications and Presentations: Total Count: 8

<u>Type</u>	<u>Citation</u>
Presentation	Kingston, J.C. Great Lakes Environmental Indicators: Diatom-Based Assessment Tools In Coastal Wetlands. International Association of Great Lakes Research. Winnipeg, Manitoba, 2-6 June 2002.
Presentation	Kingston, J.C. Freshwater Diatoms and their Role as Ecological Indicators in Rivers and Lakes. International Diatom Symposium. Ottawa, Ontario, 29 August 2002.
Presentation	Kingston, J.C. G.V. Sgro, F.R. Johansen, K. Yanko, E.F. Stoermer, R. P. Axler. Diatom Indicators of Water Quality for the Coastal Zone of the Laurentian Great Lakes. EaGLe Symposium at ASLO aquatic sciences meeting. Salt Lake City, UT, 9-14 Feb 2002.

- Journal Axler, R., J.Henneck, A. Kireta, J. Sgro and J.Kingston. In prep. Surrogate water quality indicators for use in monitoring the Great Lakes coastal zone. Environmental Monitoring and Assessment.
- Journal Danz, N.P., R.R. Regal, G.J. Niemi, V.J. Brady, T. Hollenhorst, L.B. Johnson, G.E. Host, J.M. Hanowski, C. Johnston, T. Brown, J. Kingston, J.R. Kelly. 2004. Environmentally Stratified Sampling Design for the Development of Great Lakes Ecological Indicators. Environmental Monitoring and Assessment. In press.
- Journal Ector L., J.C. Kingston, D.F. Charles, L. Denys, M.S.V. Douglas, K. Manoylov, N. Michelutti, F. Rimet, J.P. Smol, R.J. Stevenson, J.G. Winter (2004). Workshop report. Freshwater diatoms and their roles as ecological indicators. Proceedings of the 17th International Diatom Symposium 2002, Ottawa, Canada (M. Poulin, ed.), pp.469-480, Biopress Limited, Bristol.
- Presentation Kingston, John, Daniel Engstrom, Edward Swain, Eugene F. Stoermer, Jeffrey Johansen, Gerald Sgro, Kristin Yanko, Amy Kireta and Richard Axler. 2003. Paleolimnological assessment of ecosystem condition in Great Lakes drowned river mouths. (Abstract) Society for Conservation Biology Annual Meeting, Duluth, MN, June 28 – July 2, 2003.
- Presentation Stoermer, E. F. and J. L. Pappas Abstract 2004. (Abstract) Atypical *Tabularia* in coastal Lake Erie. 2003 North American Diatom Symposium. In prep for submission to Diatom Research.

Supplemental Keywords: *diatom, algae, water quality, metrics, multimetric indices, nutrients, salinity, siltation, Great Lakes, coastal wetlands, environmental indicators*

Relevant Web Sites: <http://glei.nrri.umn.edu>

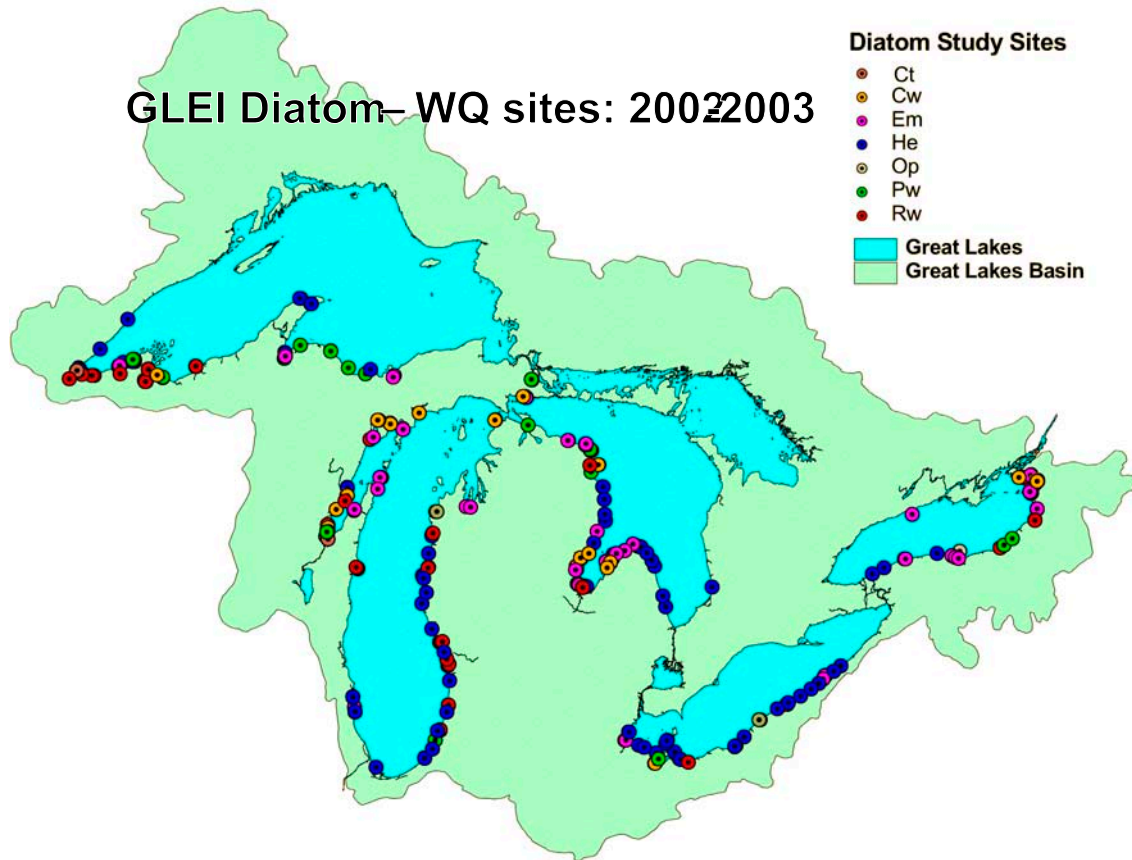


Figure 1. GLEI Diatom Water Quality Sampling Sites for 2002-2003. Yet to be added are ~ 100 sites sampled during the 2001 Pilot.

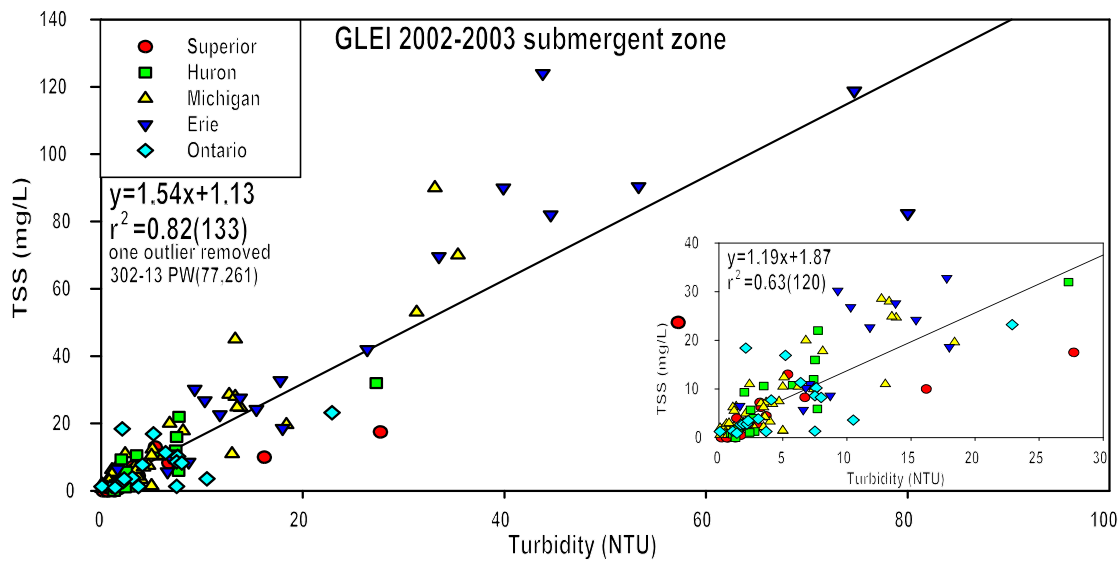
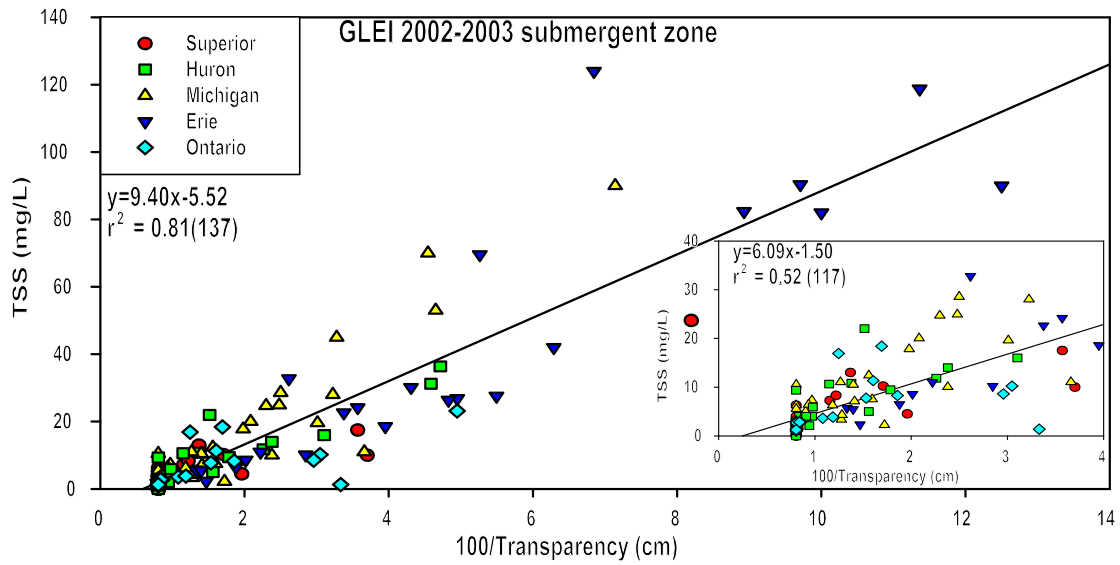


Figure 2. Relationships between lab measured TSS and field measured turbidity and transparency tube clarity. All values from submergent zone.

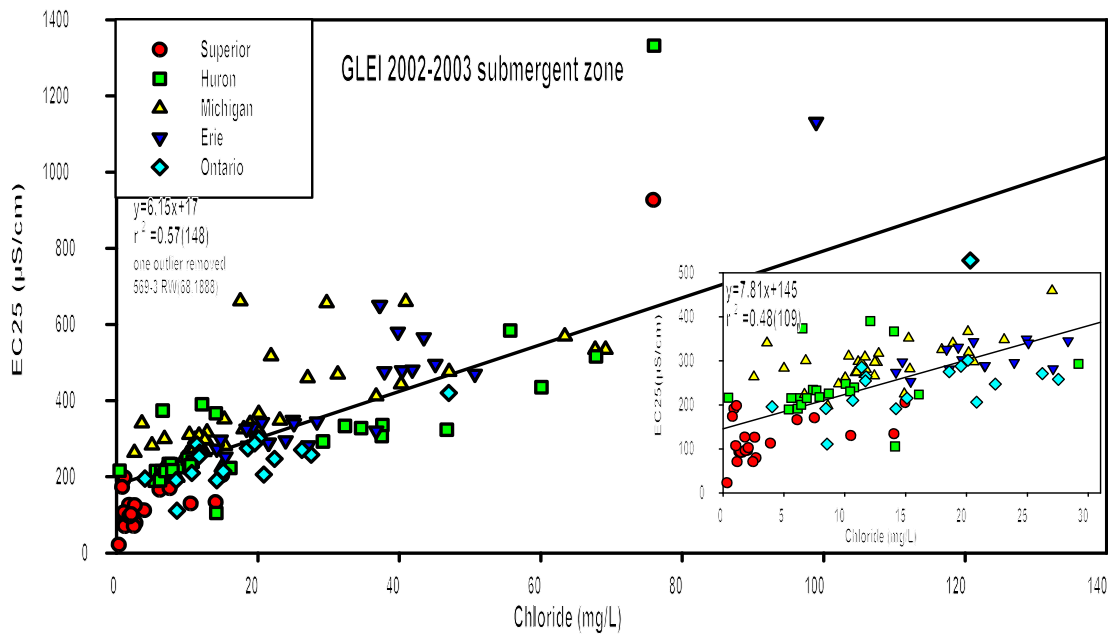
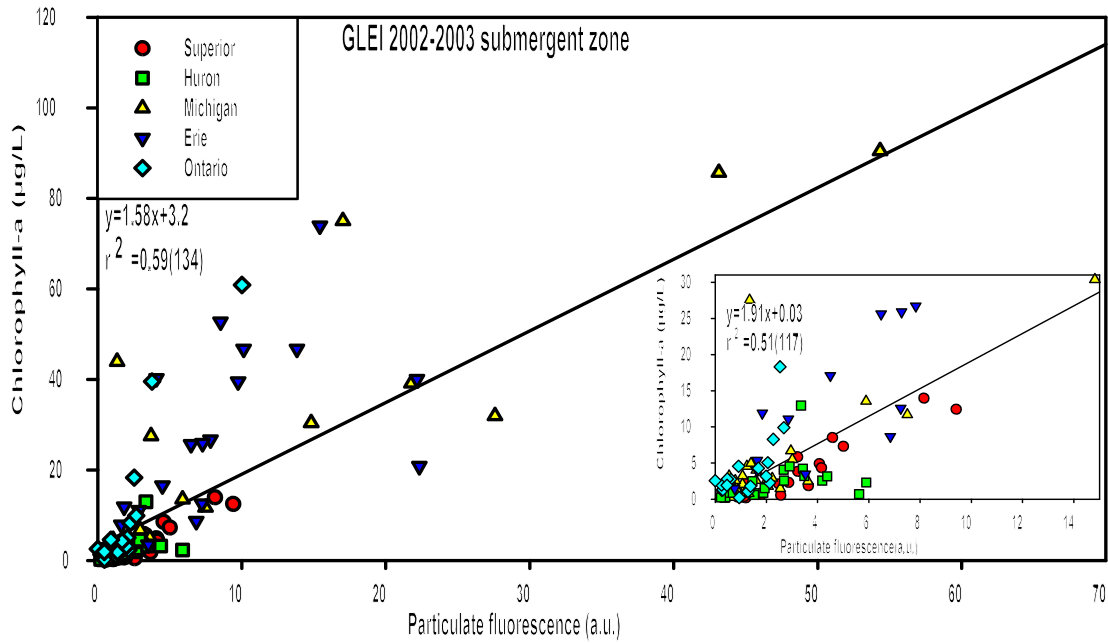


Figure 3. Upper: Relationship between lab measured chlorophyll-a and field measured particulate chlorophyll fluorescence. Lower: Relationship between field measured EC25 and lab measured chloride.

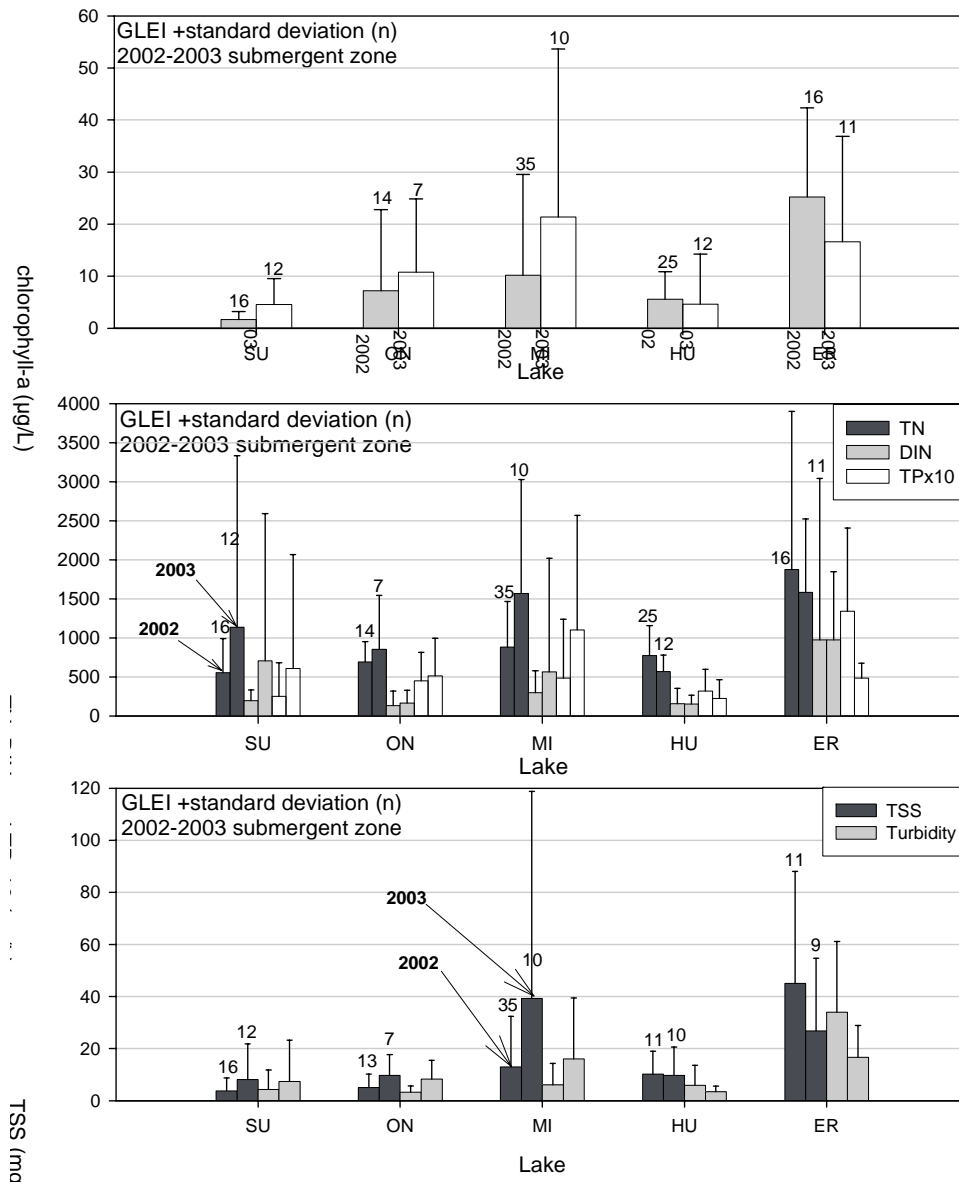


Figure 4. Summary of submergent zone nutrient, suspended sediment and turbidity values for all five Great Lakes, 2002-2003.