



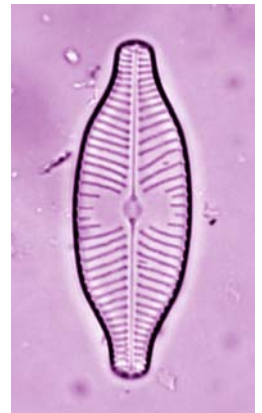
Great Lakes Ecological Indicators: Diatoms

Investigators

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Objectives

(A) Devise and test new diatom metrics, and evaluate and modify existing diatom metrics, so that indicators for environmental disturbance in coastal Great Lakes areas will be available to water quality managers. (B) Develop integrated indices of biotic integrity based on metrics developed in the diatom subprogram and by other teams in the larger GLEI program.



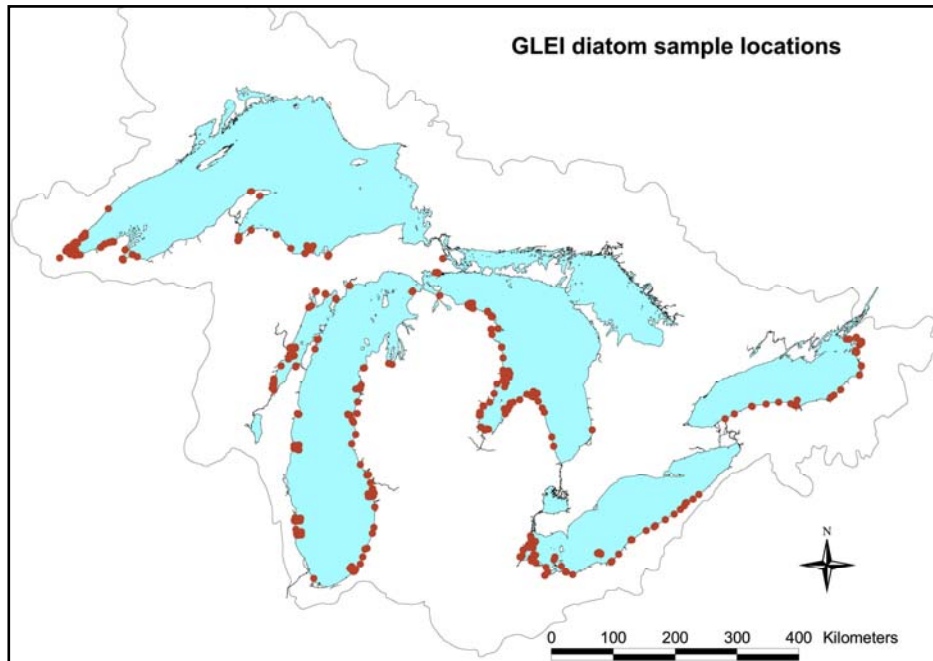
The Indicator

Diatoms (e.g., Fig. 1), the siliceous yellow-brown algae, have been used extensively as indicators of water quality conditions. They are well-accepted as indicators by the US EPA and other agencies, and have been used to evaluate aquatic stressors worldwide, including Europe and several areas of North America (including the Great Lakes). Diatom species respond with great fidelity to stressors associated with major “pressure” indicators in the Great Lakes (e.g., nutrient and salinity loading, sedimentation, and factors affecting water clarity, including exotic species). Diatom remains preserve well in sediment, so they also provide opportunities to reconstruct historical information at a site (paleolimnology). A number of other features make diatoms robust environmental indicators:

- ubiquitous; occur in virtually any aquatic environment
- diverse; can provide a fine-grained assessment of environmental conditions
- versatile; sensitive to a variety of stressors, particularly water chemistry
- short turnover rate; respond rapidly to changing conditions
- more time-integrative than “snapshot” environmental measurements
- narrow tolerances and specific optima to environmental conditions

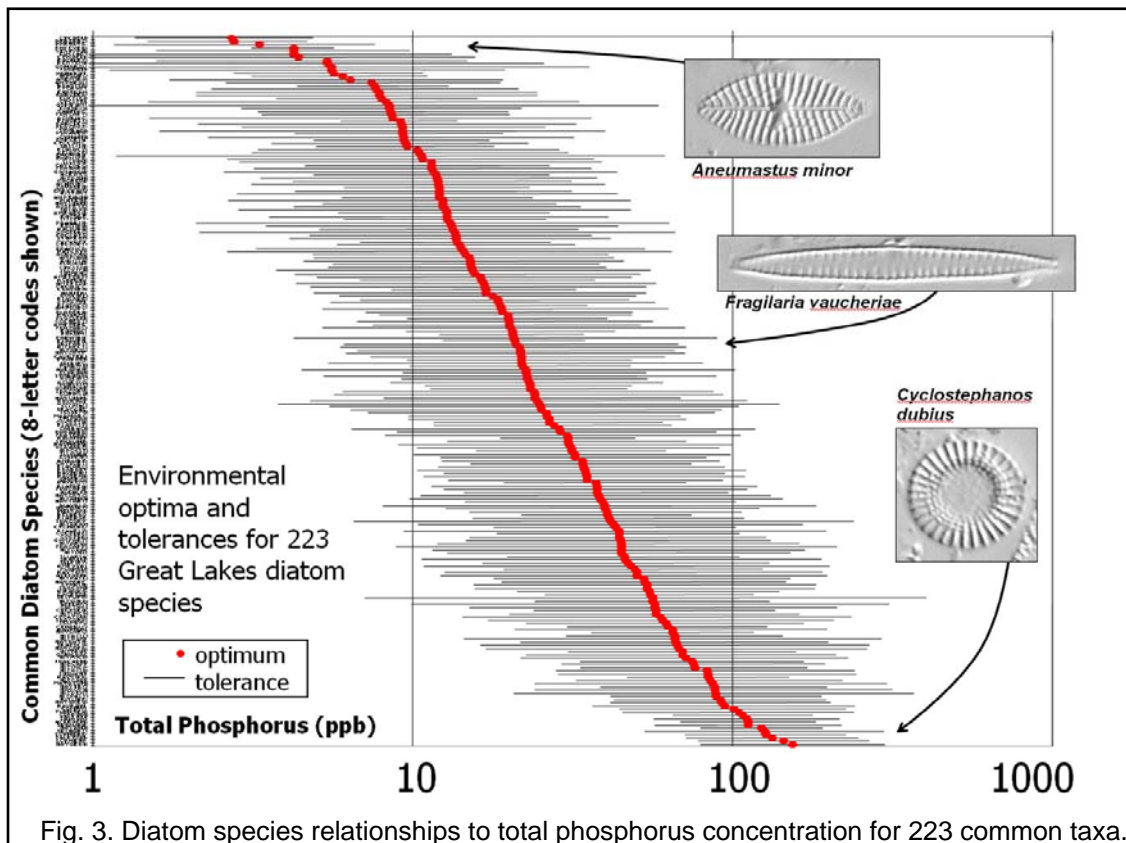
Sampling Design

Diatom and chemical samples were collected from 237 coastal sites (Fig. 2). At each site, a suite of important water quality parameters was collected, including chemical (e.g., nutrients) and physical (e.g., water clarity) variables. Diatom assemblages from each site were counted and identified to the most specific taxonomic level possible. Diatom data were compiled for comparison to corresponding environmental data and development of indicator models.



Indicator Application

Evaluations include the development of a diatom-based model to infer total phosphorus concentration (usually caused by increased nutrient load and cultural eutrophication). So far, 223 species have been identified as comprising the majority of the coastal diatom population in the Great Lakes, and their environmental optima and tolerances have been identified (Fig. 3).



Model testing (weighted average regression and calibration) has confirmed that the environmental characteristics of the diatoms provide a robust means to infer phosphorus concentrations for a study site (Fig. 4). In the future, the evaluation of diatoms in coastal ecosystems will provide cost-effective management advantages over traditional chemical measurements; the diatom assemblages are a direct measure of the health of the primary producer community, and diatom-inferred data integrate conditions that can be overlooked with instantaneous sampling of chemical parameters. For instance, the diatom assemblage in a periphytic sample can provide a time-integrated

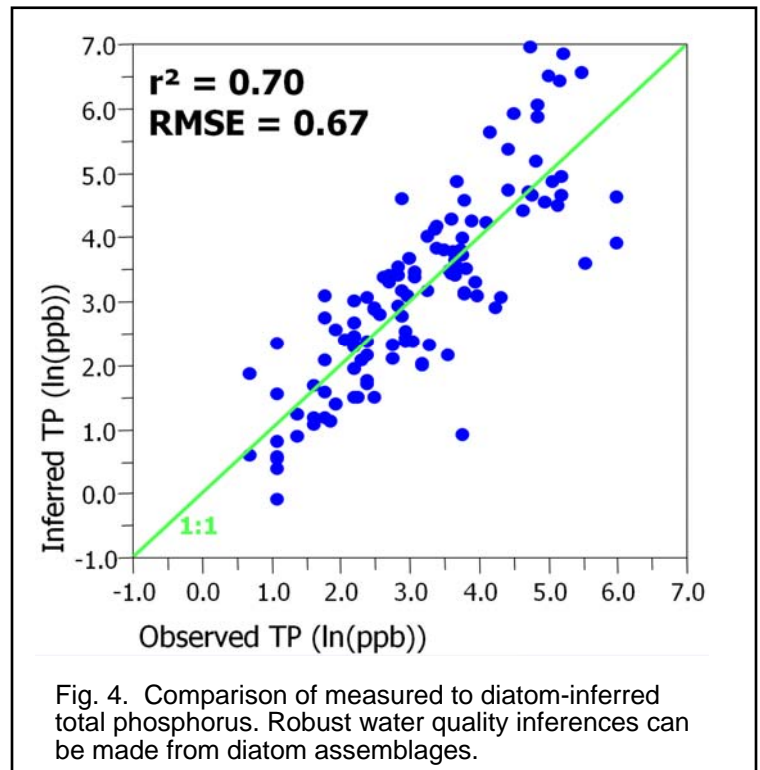


Fig. 4. Comparison of measured to diatom-inferred total phosphorus. Robust water quality inferences can be made from diatom assemblages.

In addition to specific chemical parameters, this evaluation is being expanded to develop the diatoms as a more general indicator of pollution (i.e., an index providing a more holistic integration of stressors, including nutrients, salinity and water clarity). The diatom taxa will be assigned index values that can then be used to predict environmental disturbance at a site, without the need for complex statistics. The same approach will also be evaluated using the diatom genera, to test the feasibility of an indicator-based tool that would provide more rapid and user-friendly assessments when a detailed, species-based approach is not feasible. These diatom-based tools will be developed and tested for the entire Great Lakes system, and for particular habitats (wetlands, high energy shorelines, bays) so that the most appropriate model may be selected.