

Phytoplankton Populations

Indicator #109

This indicator report was last updated in 2003.

Overall Assessment

Status: **Mixed***

Trend: **Undetermined**

**This assessment is based on historical conditions and expert opinion. Specific objectives or criteria have not been determined.*

Lake-by-Lake Assessment

Separate lake assessments were not included in the last update of this report.

Purpose

- To directly assess phytoplankton species composition, biomass, and primary productivity in the Great Lakes
- To indirectly assess the impact of nutrient and contaminant enrichment and invasive non-native predators on the microbial food-web of the Great Lakes

Ecosystem Objective

Desired objectives are phytoplankton biomass size and structure indicative of oligotrophic conditions (i.e. a state of low biological productivity, as is generally found in the cold open waters of large lakes) for Lakes Superior, Huron and Michigan; and of mesotrophic conditions for Lakes Erie and Ontario. In addition, algal biomass should be maintained below that of a nuisance condition in Lakes Erie and Ontario, and in bays and in other areas wherever they occur. There are currently no guidelines in place to define what criteria should be used to assess whether or not these desired states have been achieved.

State of the Ecosystem

This indicator assumes that phytoplankton populations respond in quantifiable ways to anthropogenic inputs of both nutrients and contaminants, permitting inferences to be made about system perturbations through the assessment of phytoplankton community size, structure and productivity.

Records for Lake Erie indicate that substantial reductions in summer phytoplankton populations occurred in the early 1990s in the western basin (Figure 1). The timing of this decline suggests the possible impact of zebra mussels. In Lake Michigan, a significant increase in the size of summer diatom populations occurred during the 1990s. This was most likely due to the effects of phosphorus reductions on the silica mass balance in this lake, and it suggests that diatom populations might be a sensitive indicator of oligotrophication in Lake Michigan. No trends are apparent in summer phytoplankton from Lakes Huron or Ontario, while only three years of data exist for Lake Superior. Data on primary productivity are no longer being collected. No assessment of “ecosystem health” is currently possible on the basis of phytoplankton community data, since reference criteria and endpoints have yet to be developed.

It should be noted that these findings are at variance with those reported for SOLEC 2000. This is due to problems with historical data comparability that were unrecognized during the previous reporting period. These problems continue to be worked on, and as such, conclusions reported here should be regarded as somewhat provisional.

Pressures

The two most important potential future pressures on the phytoplankton community are changes in nutrient loadings and continued introductions and expansions of non-native species. Increases in nutrients can be expected to result in increases in primary productivity and possibly also in increases in phytoplankton biomass. In addition, increases in phosphorus concentrations might result in shifts in phytoplankton community composition away from diatoms and towards other taxa. As seen in Lake Michigan, reductions in phosphorus loading might be expected to have the opposite effect. Continued expansion of zebra mussel populations might be expected to result

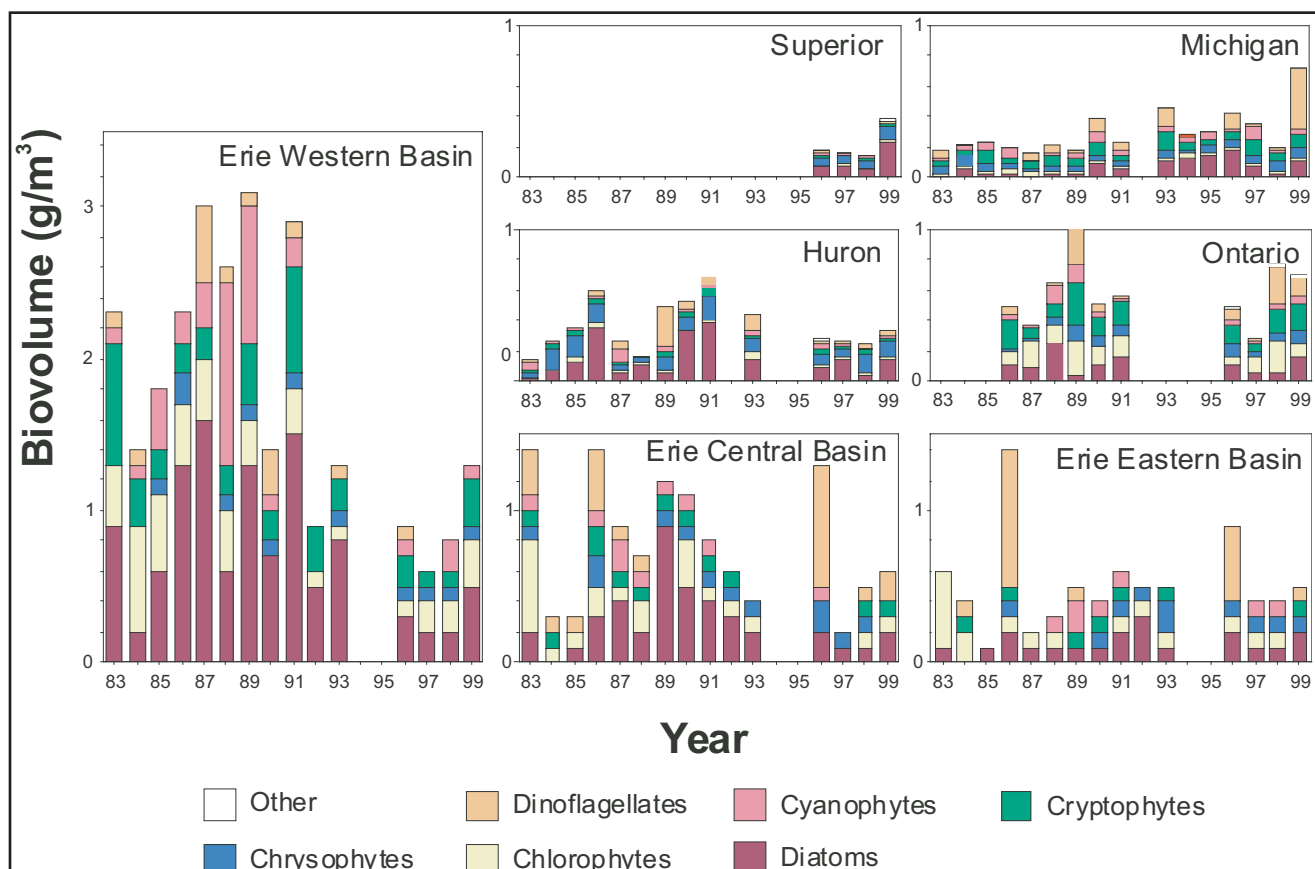


Figure 1. Trends in phytoplankton biovolume (g/m^3) and community composition in the Great Lakes 1983-1999. Samples were collected from offshore, surface waters during August. Source: U.S. Environmental Protection Agency, Great Lakes National Program Office

in reductions in overall phytoplankton biomass, and perhaps also in a shift in species composition, although these potential effects are not clearly understood. It is unclear what effects, if any, might be brought about by changes in the zooplankton community.

Management Implications

The effects of increases in nutrient concentrations tend to become apparent in nearshore areas before offshore areas. The addition of nearshore monitoring to the existing offshore monitoring program might therefore be advisable. Given the greater heterogeneity of the nearshore environment, any such sampling program would need to be carefully thought out, and an adequate number of sampling stations included to enable trends to be discerned.

Comments from the author(s)

A highly detailed record of phytoplankton biomass and community structure has accumulated, and continues to be generated, through regular monitoring efforts. However, problems exist with internal comparability of this database. Efforts are currently underway to rectify this situation, and it is essential that the database continue to be refined and improved.

In spite of the existence of this database, its interpretation remains problematic. While the use of phytoplankton data to assess “ecosystem health” is conceptually attractive, there is currently no objective, quantitative mechanism for doing so. Reliance upon literature values for nutrient tolerances or indicator status of individual species is not recommended, since the unusual physical regime of the Great Lakes makes it likely that responses of individual species to their chemical environment in the Great Lakes will vary in fundamental ways from those in other lakes. Therefore, there is an urgent need for the development of an objective, quantifiable index specific to the Great Lakes to permit use of phytoplankton data in the assessment of “ecosystem health”.

STATE OF THE GREAT LAKES 2009 - DRAFT

Acknowledgments

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Sources

U.S. Environmental Protection Agency, Great Lakes National Program Office. Unpublished data. Chicago, IL.

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