Indicator: Plankton Communities

Background

Studies of zooplankton and phytoplankton communities of the western basin of Lake Erie extend back to the late nineteenth/early twentieth centuries (Herdendorf 2005). More recently, research associated with the 1970 "Project Hypo" study of the central basin provided important information on the spatial and temporal dynamics of both phytoplankton (Munawar and Munawar 1976) and zooplankton (Watson 1976) for the western basin. Data collected and analyzed from this "Project Hypo" study provide us with information regarding the western basin of Lake Erie at its most degraded state (Kane et al. 2005).

Degradation of the plankton communities was already evident by the mid-twentieth century (Beeton 1965), with evidence for increases in abundance of phytoplankton (Davis 1964) and zooplankton (Bradshaw 1964) associated with eutrophic conditions (high productivity associated with phosphorus enrichment), and decreases in abundance of pollution-intolerant zooplankton taxa (i.e., *Limnocalanus macrurus*) (Kane et al. 2004). Since the late 1970s, the U.S. Environmental Protection Agency has monitored the phytoplankton and zooplankton communities of western Lake Erie (Makarewicz 1993a,b). The data available from the different studies mentioned above, combined with more recent data collected, allow for the determination of the biological integrity of the offshore waters of the western basin of Lake Erie.

One measure of the biological integrity of offshore waters of Lake Erie is the Planktonic Index of Biotic Integrity (P-IBI) (Kane et al. 2005). This indicator is based on the abundance and different kinds of phytoplankton and zooplankton. The P-IBI integrates information about both phytoplankton and zooplankton communities in the open waters of western Lake Erie to help determine trophic status, the productivity associated with levels of phosphorus enrichment (oligotrophic = low productivity associated with low phosphorus levels; mesotrophic = moderate productivity associated with moderate phosphorus levels; eutrophic = high productivity associated with high phosphorus levels).

Status and Trends

The Planktonic Index of Biotic Integrity uses five characteristics or metrics (Table 1). Values obtained for these planktonic metrics are classified to reflect different levels of productivity by nutrients, especially phosphorus. Each metric is scored as a 1, 3, or 5, with 5 representing the most oligotrophic conditions. Because both phytoplankton and zooplankton communities change throughout the year (Sommer et al. 1986), each metric has a specific time component during which it is measured (June-August; Table 1). The metric scores for all of the months are then averaged.

Table 1. Metrics used to calculate Planktonic Index of Biotic Integrity (P-IBI).

Metrics	Months Measured
Phytoplankton Metrics	
Biomass of edible algal taxa	June
% *Microcystis*, *Anabaena*, and *Aphanizomenon* of total phytoplankton biomass	June
Zooplankton Metrics	
Zooplankton ratio (calanoid copepod abundance/cyclopoid copepod + cladoceran abundance)	June, August
Limnocalanus macrurus density	July
Crustacean zooplankton biomass	August

The P-IBI suggests that the overall condition of the western basin of Lake Erie's offshore waters for the most recent years is eutrophic (Figure 1). During 1995 and 1997 the P-IBI scores were higher, reflecting a more mesotrophic western basin. During 2000-2003 the P-IBI scores were below 3 and similar to the score for 1970 (Figure 1), reflecting eutrophic conditions. These scores reflect increased frequency of blooms of the toxic phytoplankter *Microcystis* (Budd et al. 2002), increases in phytoplankton community biomass (Conroy et al. 2005b), and declines in the zooplankton ratio (Conroy et al. 2005a).

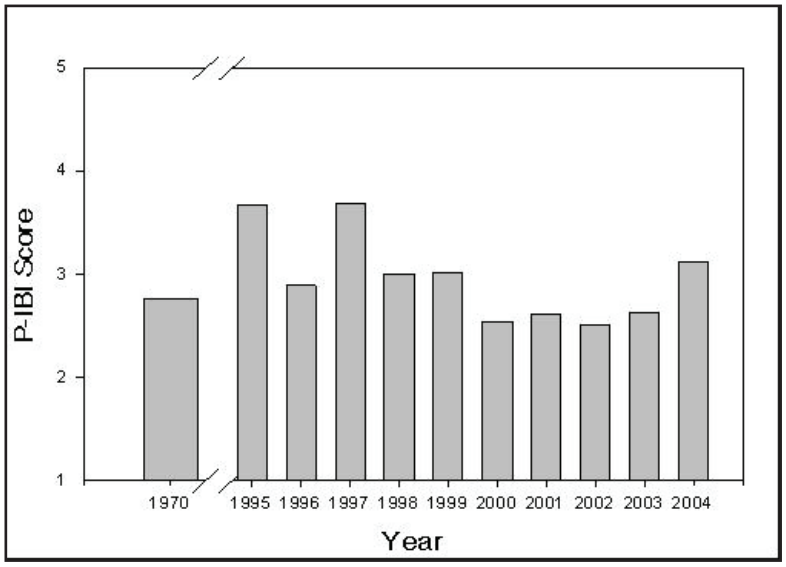

Figure 1. P-IBI scores in the western basin of Lake Erie, 1970 and 1995-2004. Trophic status classifications are based on IBI scores and are based on the scale of < 3 reflecting eutrophic conditions, 3-4 reflecting mesotrophic conditions, and > 4 reflecting oligotrophic conditions.

Management Next Steps

A number of different agencies and academic researchers collect plankton samples in the western basin of Lake Erie (Figure 2). However, there is no coordinated effort to maximize spatial and temporal coverage, standardize methods among research/management agencies, or share the results among all interested parties. A binational "plankton monitoring summit" would be helpful for all of the parties involved, as a coordinated monitoring effort would have greater spatial and temporal coverage, greater comparability of data, and likely be more cost-efficient.

Research/Monitoring Needs

Phytoplankton and zooplankton are good indicators of changes in nutrient pollution over time in Lake Erie because they respond quickly to changes in nutrient input to the lake. Further, they can be sampled extensively in many locations with relative ease. Future monitoring of plankton dynamics in Lake Erie will enable us to evaluate the biological water quality of Lake Erie's offshore waters. The Ohio Department of Natural Resources, the National Water Research Institute in Canada and other state, provincial, and federal agencies have shown a long-term commitment to plankton monitoring, which has allowed for the calculation of P-IBI scores for nearly 10 years' worth of data. This monitoring has also allowed for the early detection of invasive species new to the western basin of Lake Erie (i.e., fishhook waterflea *Cercopagis pengoi*) (Therriault et al. 2002) and needs to continue in the future in order to detect changes in the lake.

Figure 2. Researcher taking a zooplankton sample in the western basin of Lake Erie near the Bass Islands (Photo credit: Doug Kane).

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Links for More Information

Great Lakes Environmental Research Laboratory. Great Lakes Water Life Photo Guide: http://www.glerl.noaa.gov/seagrant/GLWL/GLWLife.html

Ohio Lake Erie Commission. *State of the Lake Report 2004*, Lake Erie Quality Index: http://www.epa.state.oh.us/oleo/reports/leqi/leqi2004/pdf/2004lakeeriequalityindex.pdf

U.S. EPA. Great Lakes plankton monitoring: http://www.epa.gov/glnpo/monitoring/plankton/images/index.html

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