GETTING REAL

REAL-TIME TECHNOLOGY PROVIDES GREATER INSIGHT ON WATER QUALITY ISSUES

by **Jill Crossman, Elizabeth Striano, and Aaron Fisk**

Harmful algal blooms (HABs) and the low dissolved oxygen concentrations associated with them are a growing concern for large water bodies throughout the world. HABs have resulted in fish kills and drinking water advisories, which collectively have caused estimated economic losses of up to US$71 million per year within Lake Erie alone. HABs have been linked to excessive nutrient inputs, specifically those of nitrogen and phosphorus, and in the 1980s, were successfully managed by reducing phosphorus inputs to lakes. Recently, however, bloom frequency and toxicity have increased. Scientists and resource managers have proposed several hypotheses for this bloom resurgence, including changes in phosphorus bioavailability and increases in water temperatures, turbidity, and internal nutrient loads. Determining the specific sources of these water quality issues is challenging in the constantly changing Great Lakes environment with its multiple stressors. Without knowing the cause, it is impossible to find a solution; as a result, HABs issues persist within the Great Lakes. However, new technologies that enable real-time monitoring of nutrients in these water bodies are helping to provide some answers.

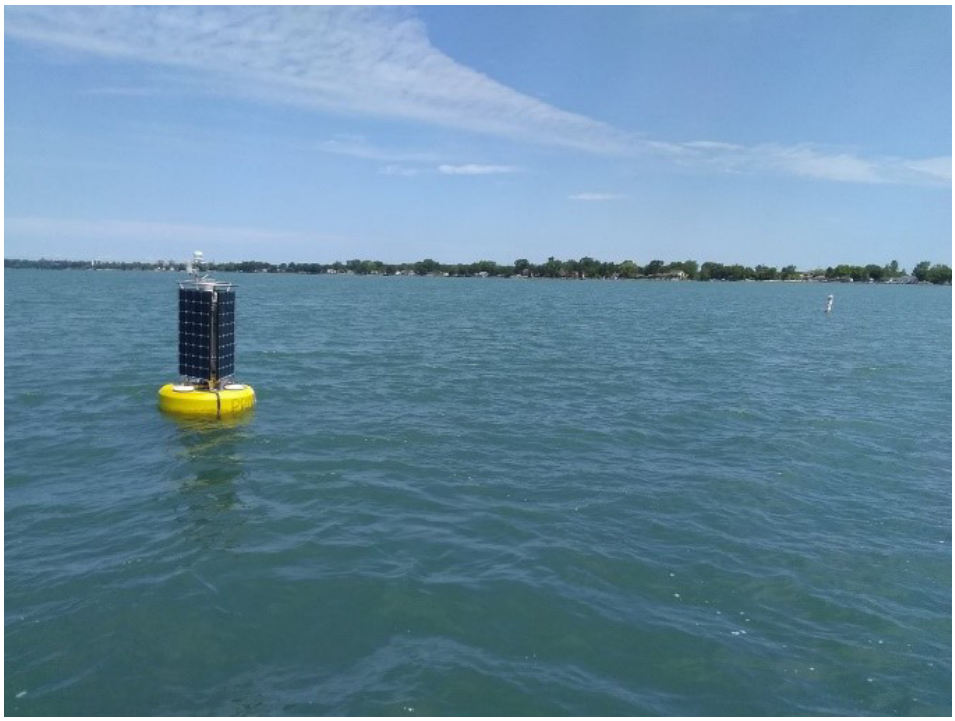

Photo by Jill Crossman

An ErieWatch buoy in the Lake Erie western basin at the mouth of the Detroit River.

Traditional water quality monitoring practices such as discrete sampling and laboratory analyses are expensive and labor intensive. As a result, nutrient samples are typically only taken at monthly or bimonthly intervals. The limited amount of data that results from this low sampling frequency combined with high rates of environmental flux create uncertainty in quantification of lake conditions. For example, concentrations of soluble reactive phosphorus (SRP), generally considered to be the most bioavailable phosphorus fraction, can vary greatly throughout the day. During heavy rainfall, SRP values can change by hundreds of micrograms per liter over just a few hours. In addition, nutrient concentrations in collected samples can change during transport to the laboratory as is the case for SRP, which is particularly sensitive to both microbial uptake and release as compared to total phosphorus (TP). Because of this variability, meaningful representations of lake phosphorous conditions require near-continuous measurements of both SRP and TP levels.

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Due to these limitations in data resolution, scientists have, to date, been unable to measure the impact of nutrient management strategies on the relative bioavailability of phosphorus in large water bodies. The Real-time Aquatic Ecosystem Observation Network (RAEON) aims to address this technical hurdle by providing Canadian researchers with the infrastructure, staff, and data management needed to enable collection of nutrient and other HABs-related data in real time. Based at the University of Windsor, RAEON is directed by Katelynn Johnson and funded by a CA$15.9 million grant

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recently awarded to RAEON lead Aaron Fisk by the Canadian Foundation for Innovation.

RAEON supports research that contributes to management, rehabilitation, and enhancement of ecosystem services. One such program is ErieWatch, developed and run by Jill Crossman, an early career researcher at the University of Windsor. ErieWatch, which consists of a network of four biogeochemical monitoring platforms located across the western basin of Lake Erie, aims to identify drivers of HABs in the region. The platforms support new real-time wet chemical analyzers called WIZprobes, in addition to meteorological stations and more traditional *in situ* monitoring technologies for dissolved oxygen, light, chlorophyll *a*, and temperature. Every hour, the WIZprobes can sample the water to analyze three types of phosphorus present: dissolved, soluble, and total. This represents the first time that TP can be analyzed in remote locations, aided by the WIZprobes' new low-power digestion techniques. Solar-powered portable units transmit live results to in-office computers using telemetry.



Photo by Jill Crossman

An ErieWatch buoy in Pigeon Bay, in the western basin of Lake Erie. A WIZprobe is deployed below the waterline.

These platforms, and the WIZprobes specifically, have provided scientists with the ability to more accurately quantify phosphorus concentrations in large water bodies and to monitor biochemical variables at resolutions that better capture process interactions. Scientists are only just starting to use WIZprobes in North America as they require large networks of instruments and regular maintenance by highly qualified personnel, including calibration and validation in the field; obstacles that RAEON is helping to address.

The four biogeochemical research platforms of ErieWatch are part of the first international smart-sensor network in the Great Lakes, created by both RAEON and NOAA's Great Lakes Environmental Research Laboratory. This network is monitoring hydrodynamics as well as nutrient, dissolved oxygen, phycocyanin, and chlorophyll *a* levels across Lake Erie's western basin. Data are uploaded to the Great Lakes Observing System for public access and to help answer many questions such as the following: What effects are management strategies having on SRP:TP ratios? Does a short-term change in SRP:TP encourage algal bloom formation? Is there a specific trigger that causes an entire bloom to become toxic?

The revolutionary real-time network approach of these technologies offers a better alternative to traditional sample collection methods that can limit the frequency, duration, and scope of environmental research programs. By implementing novel technologies for analyzing underlying process interactions, programs such as RAEON and ErieWatch have the potential to reduce threats posed by HABs and, more broadly, to transform conventional approaches to freshwater resource management to the benefit of policy makers, managers, residents, other users of Ontario watersheds, and the global research community.



Photo by Jill Crossman

A WIZprobe and reagent canister (center), pump (left), filters (bottom center), and distilled water (right).

Jill Crossman is an assistant professor in the School of Environment at the University of Windsor and developed the new research program ErieWatch. Elizabeth Striano is a science writer and principal of A Green Footprint LLC. Aaron Fisk, a Tier 1 Canada Research Chair in Changing Great Lakes Ecosystems at the University of Windsor, is the program leader of RAEON.