Development and Validation of Early Detection and Sustained Treatment Methods to Control HABs in Inland Source Waters in Ohio

Lead: Young Seo, University of Toledo, Youngwoo.Seo@UToledo.edu
Co PIs: Thomas Bridgeman, Dae-Wook Kang, and Yakov Lapitsky, University of Toledo

USACE Harmful Algal Bloom Research & Development Initiative

Delivering scalable freshwater HAB prevention, detection, and management technologies through collaboration, partnership, and cutting-edge science.

Problem

Many freshwater systems in Ohio have suffered from chronic cyanobacterial harmful algal blooms (cHABs), which compromise the quality of water for consumption, aquaculture, and recreation. There are significant research needs to develop field-applicable rapid detection and monitoring methods in conjunction with sustained treatment technologies for HAB-associated risk management.

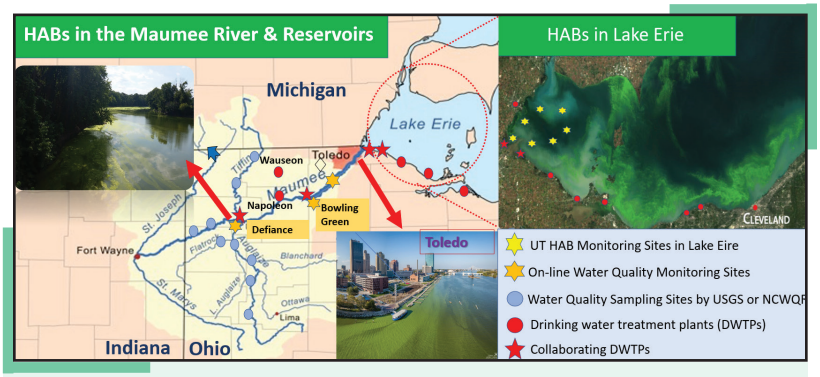

Figure 1. *cHAB in inland source waters in Ohio.*

Objective

Provide detection methods to better assess bloom dynamics in near real-time, over the long term, and in response to HAB treatment. Provide data-driven guidance for the optimal application of treatment methods in HAB-impacted inland waters.

Approach

Develop cost-effective, field-applicable technologies to mitigate HAB risks via (1) improved fluorometric sensors and identification of novel early-warning biomarkers that rapidly monitor the state of HABs, (2) nature-inspired biological and chemical treatment methods for the removal of cyanobacteria and their toxins (e.g., sustained algaecide release and/or biological treatment), and (3) the integration of these developed methods with currently applied HAB management processes.

Results

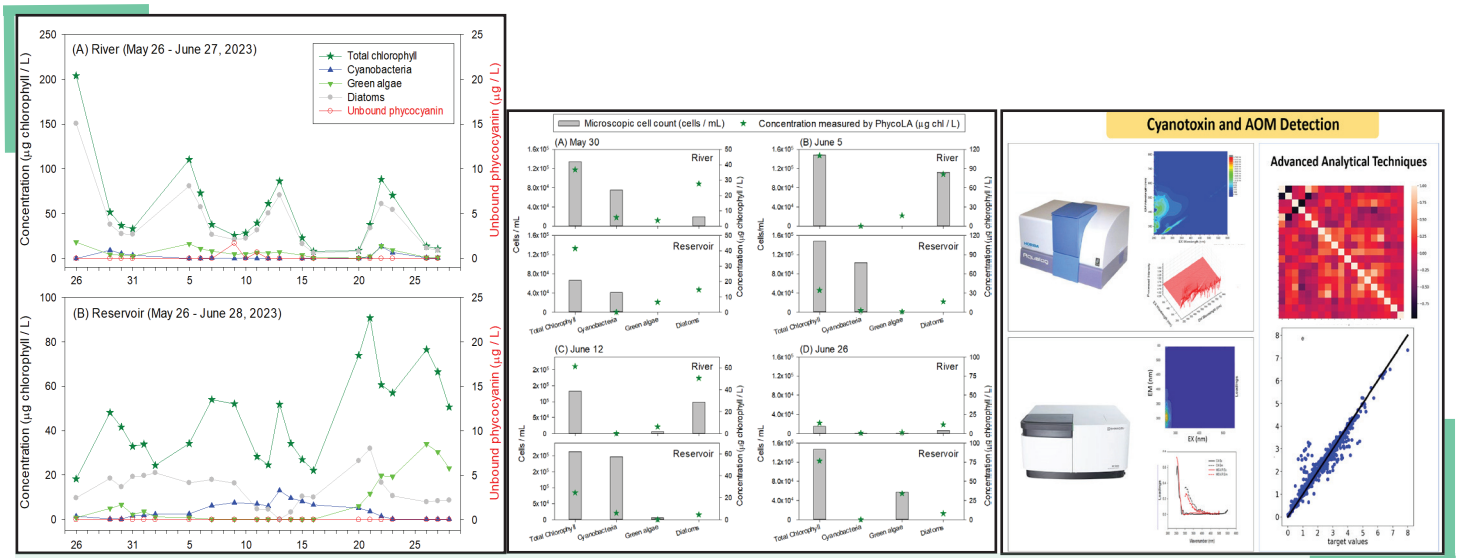

Figure 2. *Examples of the performance of fluorometric monitoring systems for cHABs and their toxins (further data collection is ongoing).*

EL ENVIRONMENTAL LABORATORY
ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

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Results (cont.)

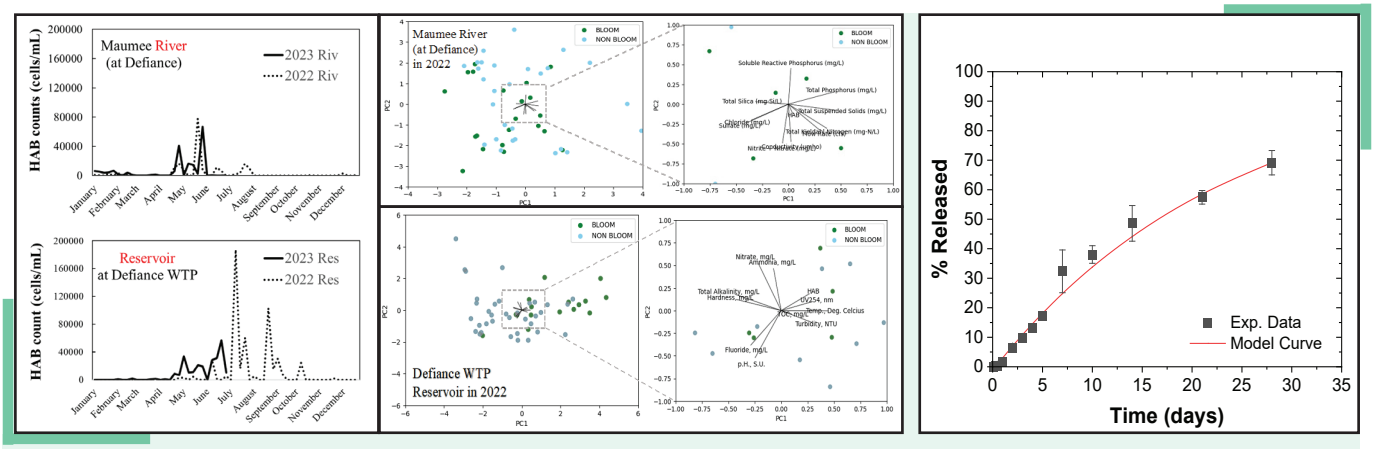

Figure 3. Left, changes in HAB counts and, middle, PCA plots of HAB counts and environmental factors at Maumee River and a Reservoir (Defiance, Ohio). Right, partial algaecide release profile from a scaled-down algaecide-releasing buoy (further data collection is ongoing).

Major Milestones

Deliverable	Description
Publications	**Tech Report:** Seo et al. In preparation. "Development and Validation of Early Detection and Sustained Treatment Methods to Control HABs in Inland Source Waters in Ohio." **Journal Publications:** • "Application of Machine Learning to Omics-Based Data: A Review of Recent Advances in Understanding of Microbial Dynamics in Natural and Engineered Systems" (under review) • "The Use of Fluorometry to Guide the Tracking and Treatment of Algal Blooms in Inland Reservoirs" (in preparation) • "Long-Term and Seasonal Trend of Phytoplankton Dynamics in Maumee River and a Reservoir" (in preparation) • "Spatial Dynamics of Microbial Consortia and Harmful Algal Blooms in Maumee River" (in preparation) • "Reservoir Management Practice that Affects Microbiome Dynamics and Water Quality" (in preparation) • "Algaecide-Releasing Buoys for Sustained Harmful Algal Bloom Control" (in preparation) • "Application of Machine Learning to Detect Algal Organic Matter and Cyanotoxins" (in preparation) • "Biological Treatment of Nutrients and Cyanotoxins" (in preparation)

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Major Milestones (cont.)

Deliverable	Description
Products	**Data and Code Repository**
Demonstrations	Demonstration and training in the use of PhycoLA algal fluormeter at Defiance Drinking Water Treatment Plant (DWTP), May 2023 Algaecide treatment to control HAB and other phytoplanktons. Defiance Reservoir, Ohio. June–August 2023 Mesocosm and macrocosm (field) testing/demonstrations of the algaecide releasing buoys at the Bowling Green and Defiance DWTP Reservoirs (in Northwest Ohio) beginning 2024
Marketing Video	University of Toledo. 2021. "Safeguarding Water." https://www.youtube.com/watch?v=pZexjP-W7JGs&t=1s
Tech Development	Kober, U. A., Y. Seo, and Y. Lapitsky. In preparation. "Algaecide-Releasing Buoys for Sustained Harmful Algal Bloom Control (An Invention Disclosure)"

Partnership/Leveraging Opportunities

This work leverages multiple collaborations with municipalities in Ohio (Cities of Toledo, Bowling Green, Defiance, and Waseon), industry partners (bbE Moldaenke, SePRO, and Horiba), and the US Environmental Protection Agency.

Value to USACE Mission

The outcomes of the successful project will lead to the development of advanced detection methods to better assess bloom dynamics in near real-time, over the long term, and in response to HAB treatment. They also provide data-driven guidance for optimal application of treatment methods in HAB-impacted inland source waters.

Figure 4. *Images taking during research in the laboratory and during field test.*