Light-Based Mitigation Technology (LBMT) for the Reduction of Harmful Algal Blooms (HABs)

Lead PI: Elizabeth Gao, ERDC CERL, Elizabeth.J.Gao@usace.army.mil

USACE Harmful Algal Bloom Research & Development Initiative

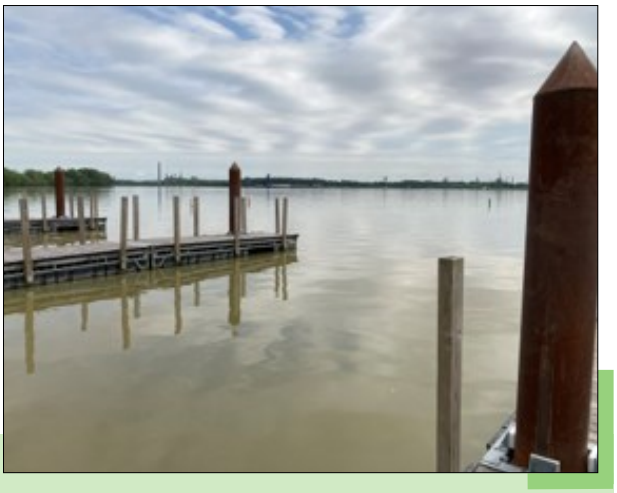
Delivering scalable freshwater HAB prevention, detection and management technologies through collaboration, partnership and cutting-edge science

Problem Current physical, chemical, and biological technologies for managing HABs have unintended adverse impacts on the surrounding ecosystem, limited deployability and scalability, and often require personnel to come into close proximity of HABs.

Objective Validate and optimize the performance of an ultraviolet (UV) light-based mitigation technology that does not require the use of chemicals, and assess its potential for integration with remotely operated vehicle (ROV)UV-C enabled boat technology for safe and effective, large-scale HAB mitigation.

Figure 1: *Image of EGET LIBER used for research*

Approach 1) Perform bench scale studies to verify and optimize the UV dose requirements for inactivation of cyanobacteria and degradation of cyanotoxins as a function of ambient water quality; 2). Evaluate the degradation of cyanotoxin microcystin-LR (MC-LR); 3) Assess whether degradation of cyanotoxins by UV-C radiation produces harmful byproducts; 4) Evaluate and demonstrate the performance of a UV-equipped ROV remotely operate vehicle (ROV) at pilot scale; and 5) Assess performance, required enhancements, scalability, applicability, and environmental impact of a UV-C enabled boat system.



Figures 2 & 3: *Images taken during a site visit on June 4th, 2022. Site is Cullen Park in Toledo Ohio*

Results Our preliminary bench-scale studies focused on assessing the effect of UV-C irradiation at 254nm to control algal growth using field-collected water samples. The results suggested that UV-C irradiation at 40mJ/cm2 can suppress cyanobacteria growth in a dose-dependent manner. In addition, we investigated the capability of UV radiation at 254nm to degrade cyanotoxin microcystin-LR (MC-LR). Results showed the quantum yield for direct photolysis at 254mn was 0.53.

Light-Based Mitigation Technology (LBMT) for the Reduction of Harmful Algal Blooms (HABs)

Lead PI: Elizabeth Gao, ERDC CERL, Elizabeth.J.Gao@usace.army.mil

USACE Harmful Algal Bloom Research & Development Initiative

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

Major Milestones

Date	Milestone
FY21	Establish Cooperative Research and Development Agreement with Eget Liber, Inc. (Complete)
FY21	Assess the effects of UV-C irradiation on inactivation of cyanobacteria, degradation of cyanotoxins, and byproduct generation
FY22	Bench-scale testing of UV-C inactivation of cyanobacteria and investigating UV toxicity on non-target model organism
FY22	Reactor modelling to assess UV-C reactor performance under various conditions
FY22	Validate UV-C enabled boat technology in a field pilot study, optimize operation, and assess scalability (Planning Phase).
FY22	A peer-reviewed journal article on UC-C degradation of Microcycstin-LR) (Draft Submitted)
FY23, Q1	Conference: Oral presentation at 11th U.S. Symposium on Harmful Algae
FY23 , Q1	Prepare an ERDC Technical Report on UV-C irradiation on inactivation of cyanobacteria
FY23, Q1	Prepare a journal article on UV-C inactivation of cyanobacteria
FY23, Q2-Q4	Field demonstration at Lake Erie, Ohio
FY23, Q2-Q4	Draft a guidance brief for USACE water managers describing when and how to use UV-C enabled boat for HAB treatment.
FY23, Q2-Q4	An ERDC Technical Report on lesson learned from the field demo
Costs	**FY21:**$183K **FY22:**$131K **FY23:**$44K **TOTAL:**$358K

Partnership/Leveraging Opportunities

This project will leverage with the Aquatic Nuisance Species Research Program Project entitled "Mitigation of HABs Toxins Using Deployable 3D Printed Photocatalytic Devices" (PI-Alan Kennedy) by using 3D printed devices as a polishing step to reduce microcystin concentrations after UV-C inactivates the cells.

Figure 4: *Water samples were collected from Burncoat Pond, Worcester MA*

Value to USACE Mission

The UV-C enabled boat may give USACE water managers confronted with a HAB the ability to rapidly and safely "pause" a bloom for an extended period or destroy it, all remotely, so that personnel are kept out of harm's way. The technology may also enable effective inactivation of cyanobacteria and reduction of cyanotoxins without causing deleterious, off-target ecological effects.