# Light-Based Mitigation Technology for the Reduction of HABs

**Co PI:** Elizabeth Gao, ERDC-CERL, Elizabeth.J.Gao@usace.army.mil
**Co PI:** Taylor Rycroft, ERDC-EL, Taylor.E.Rycroft@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 harmful algal blooms (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 (UVC) light–based mitigation technology that does not require the use of chemicals, and assess its potential for integration with remotely operated vehicle (ROV) for safe and effective, large-scale HAB mitigation.

## Approach

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


**Figure 1.** *ERDC CyanoSTUN.*

## Results

The ERDC CyanoSTUN (Cyanobacterial Suppression Through Ultraviolet-C Neutralization) was developed and system tested (Figures 1 and 2). Modelling results suggested that CyanoSTUN can suppress a 1-acre bloom at a depth of 7 in. in 10 hr, assuming 60% UVC transmittance within the bloom. Lab studies showed that UVC can transform toxic MC-LR into nontoxic photolytic products (Figure 3).

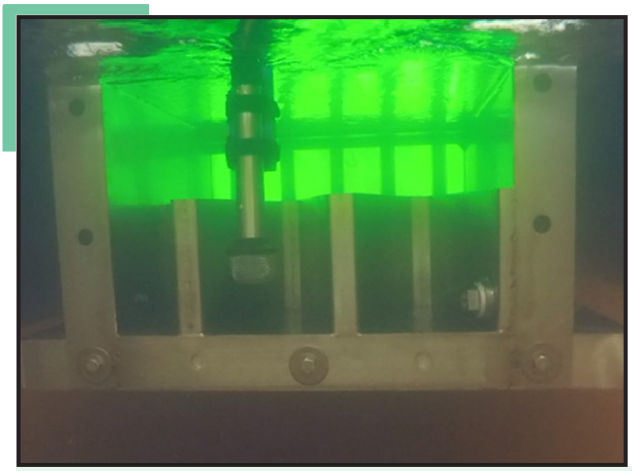

**Figure 2.** *Testing CyanoSTUN's UVC reactor.*

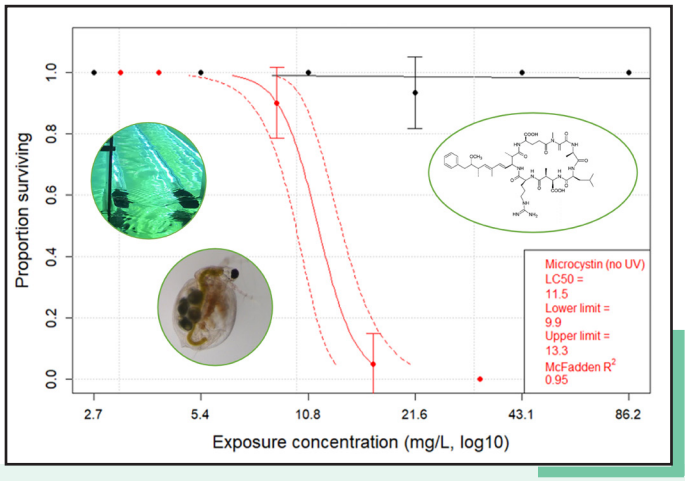


**Figure 3.** *$UV_{254}$ transforms toxic MC-LR into non-toxic photolytic products in laboratory.*

# Light-Based Mitigation Technology for the Reduction of HABs

**Co PI:** Elizabeth Gao, ERDC-CERL, Elizabeth.J.Gao@usace.army.mil
**Co PI:** Taylor Rycroft, ERDC-EL, Taylor.E.Rycroft@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

| Deliverable | Description |
|---|---|
| Publications | **Journal article:** Moores et al. In review. "Reduced toxicity of microcystin after photolytic treatment." *Water Environment Research*.<br>**Tech report:** Rycroft et al. In prep. "CyanoSTUN: An Ultraviolet-Enabled Boat for the Suppression of Cyanobacterial Harmful Algal Blooms." ERDC TR.<br>**Special report:** Rycroft et al. In review. "Guidance for USACE Water Managers on Using ERDC's CyanoSTUN for Suppression of Cyanobacterial Harmful Algal Blooms." ERDC SR. |
| Products | **CyanoSTUN (Cyanobacterial Suppression Through Ultraviolet-C Neutralization):** An agile pontoon boat equipped with a wastewater-grade UV-C reactor that irradiates raw HAB-contaminated surface water with UVC germicidal light (254 nm). No chemicals are added to the water. There is no pretreatment other than an aluminum screen with 0.5 in. round holes. The UV reactor is mounted to the bottom of a pontoon boat platform such that target surface water is not removed from the waterbody; treatment occurs in situ where the top 7 in. of the water column passes through the UV reactor as the boat traverses the surface.<br>The speed of the boat is expected to range (e.g., between 0.3 and 1.3 mph), depending on the UV transmittance of the HAB-contaminated water; and water residence time as it flows through the channel reactor is expected to range between 4 and 14 s. We expect to be able to drive the boat at a rate of 0.94 ft/s (0.64 mph) to suppress 1 acre of a bloom at 7 in. depth in 10 hr, assuming a 60% UV transmittance within the bloom. (Developed by Taylor Rycroft, Chris Donnelly, and Zach Tomberg).<br>**Patent:** Lead inventor: Taylor Rycroft. Utility patent application filed at USPTO 3QFY23. |
| Demonstration | **Field Demonstration** of ERDC's UV-Enabled Boat. Location Worcester, MA. 4QFY23. |
| | |

## Partnership/Leveraging Opportunities

This project will integrate with the Aquatic Nuisance Species Research Program project entitled "Mitigation of HABs Toxins Using Deployable 3D Printed Photocatalytic Devices" by using 3D-printed devices as a polishing step to reduce microcystin concentrations after UV-C stuns the cyanobacterial cells.

## Value to USACE Mission

CyanoSTUN may give USACE water managers confronted with HABs the ability to rapidly and safely "pause" a bloom for an extended period, or destroy it entirely. The technology may also enable effective inactivation of cyanobacteria and reduction of cyanotoxins without causing deleterious, off-target ecological effects.