Identification and Preventative Treatment of Overwintering Cyanobacterial Cells in Sediments

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USACE Harmful Algal Bloom Research & Development Initiative

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

Problem

Overwintering cyanobacterial cells in the sediment can contribute to harmful algal blooms (HABs), yet there are limited data on the identification and treatment of these "resting" cells.

Objective

The objective is to detect and treat overwintering cells in sediments to decrease seasonal severity of blooms.

Approach

First, conduct a literature review to determine detection methods, site selection criteria, and answer initial feasibility-related questions regarding algaecide applications to overwintering cells. Second, conduct bench-scale testing to evaluate analytical detection methods for overwintering cells and measure responses of cells to candidate algaecide exposures. Finally, evaluate performance of preventative algaecide applications at one or more field sites with known HAB history and confirmed overwintering cells in sediments (Figure 1).

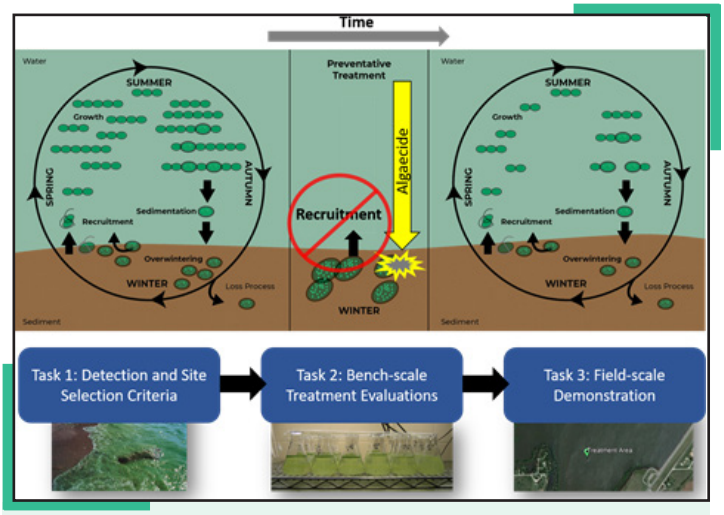

Figure 1. *Approach of identification and preventative treatment of overwintering cyanobacteria cells in sediment.*

The literature review demonstrated that there are multiple lines of evidence supporting algaecide efficacy for preventative treatments, which include (1) multiple field studies demonstrating scalability and efficacy of algaecides against benthic algae, (2) data suggesting similar sensitivities of overwintering and planktonic *Microcystis* cells to a peroxide algaecide (a commonly used active ingredient for algaecides in situ), and (3) a mesocosm study demonstrating a decrease in HAB severity following preventative treatments. This review informed data needed for identification and prioritization of potential treatment sites, metrics for measuring treatment success and potential efficacy of algaecides for preventative treatments of overwintering cells. These results provided bench-scale efficacy data for selected USEPA registered peroxide and copper-based algaecides (graphical abstract Figure 2), to inform future field scale demonstrations.

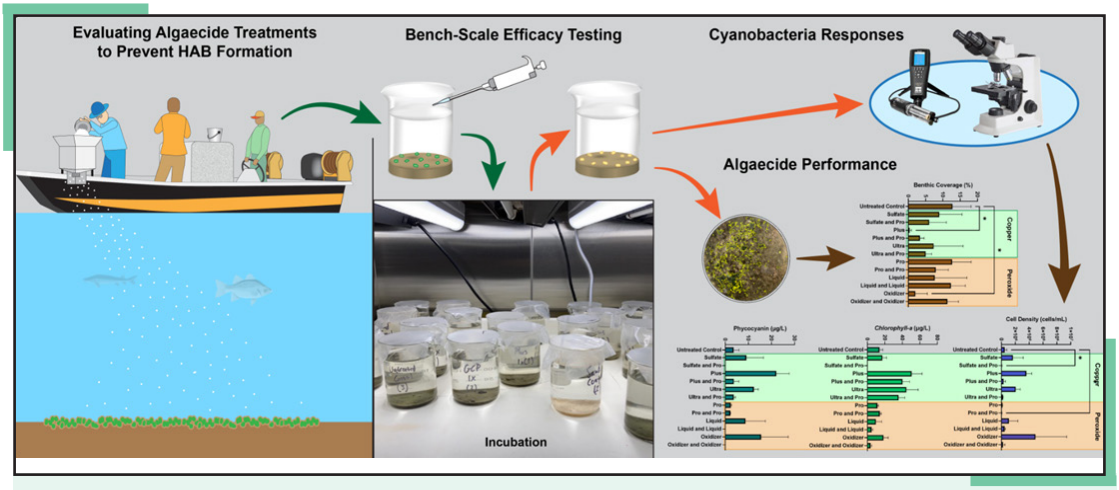

Figure 2. *Measure the efficacy of copper and peroxide-based algaecides for preventative treatment of overwintering cyanobacteria.*

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Results

Bench-scale treatment efficacy data indicated that peroxide-based algaecides were effective at decreasing the growth potential of overwintering cells. Cell density and phycocyanin concentrations were useful response measurements (Figure 3).

Task 3 field demonstration was conducted in FY23. Early trials in an 80-acre pond in Kansas indicated that, following the preventative treatments, average cell densities of HAB-forming cyanobacteria were consistently lower in the water column of the treatment zone as compared to the untreated zone for the post-treatment sampling events in May through October (Figure 4).

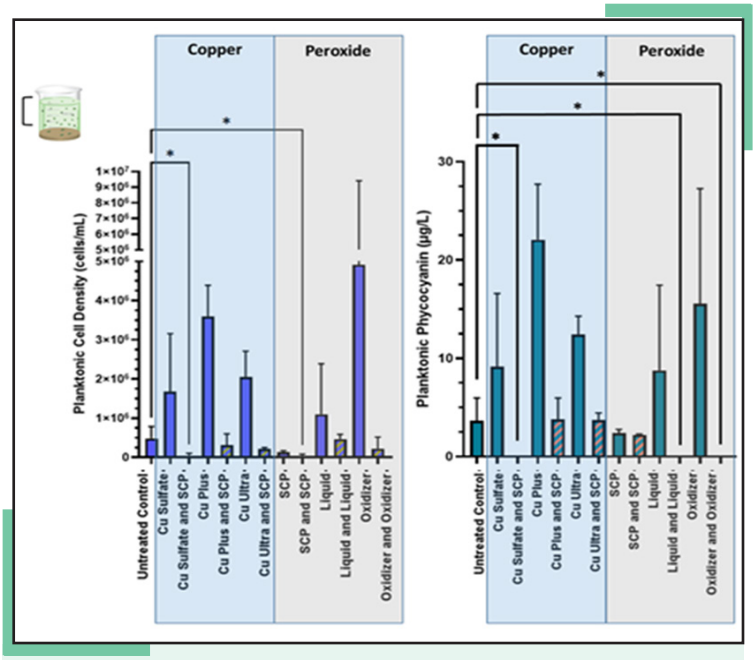

Figure 3. *The graph shows Planktonic responses of cyanobacteria from sediments containing overwintering cells following algaecide exposure and a 14-day incubation.*

Partnership/Leveraging Opportunities

This work is leveraging multiple collaborations and other work units including the Kansas Department of Health and Environment (KDHE), USACE Tulsa District (SWT), and USACE Kansas City District (NWK). Successfully collaborated with KDHE and USACE-SWT on a field-scale demonstration in Kansas leveraging funds from KDHE. Additional collaboration is planned in FY23.

Value to USACE Mission

Early detection and preventive treatment of overwintering cells can provide substantial value to operations by potentially decreasing severity of bloom events, delaying seasonal onset of blooms, minimizing ecological and human health risks, and minimizing costs of mitigation.

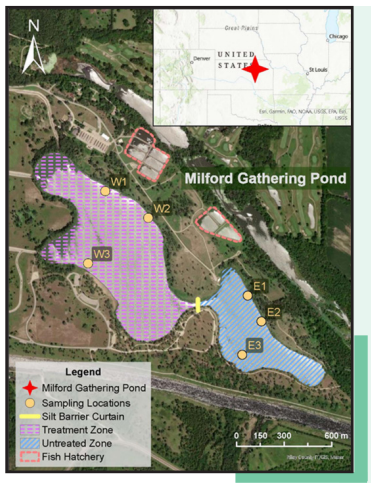

Figure 4. *Initial field-scale demonstrations (Milford Gathering Pond, Kansas) treating overwintering cells in sediments indicate decreased severity of HAB. The map depicts the treated and untreated (control) areas of the lake.*

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Major Milestones

Deliverables	Description
Publications	**Tech Report:** Calomeni et al. 2022. I*dentificatoin and Preventative Treatment of Overwintering Cyanobacteria in Sediments: A Literature Review.* ERDC TR-22-10. Vicksburg, MS: US Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/45063. **Journal article:** Calomeni et al. 2023. "Approach for Identification and Prioritization of Sites for Preventative Management of HABs by Targeting Overwintering Cyanobacteria in Sediments." *Journal of the Aquatic Plant Management Society* 61:30–41. https://apms.org/journal/. **Journal article:** Calomeni et al. 2023. In review. "Bench-Scale Evaluation of Algaecides for the Preventative Treatment of Overwintering Cyanobacteria in Sediments from a HAB Impacted Pond." *Ecotoxicology and Environmental Safety* **Journal article:** Calomeni et al. 2023. In review. "Overwintering Cyanobacteria: Contribution to HABs and Implicatons for Preventative Management in Freshwater Resources of the US." *Journal of Applied Ecology*. **Journal article:** Kinley-Baird et al. 2023. In review. "Evaluation of Preventative Algaecide Treatments for Overwintering Cyanobacteria in Sediments of a Central USA Lake." **Tech report:** McQueen et al. In prep. "A Management Plan for the Monitoring and Preventative Treatment of Overwintering Cyanobacteria." ERDC TR. **Articles:** • **Seiter-Moser et al. 2021.** "Creating Scalable Solutions for HABs." *The Military Engineer.* https://samenews.org/creating-scalable-solutions-for-harmful-algae-blooms/. • **Kuzmitski. 2022.** ERDC Builds Robust Research Portfolio of HAB Solutions for USACE, Nation. *The Corps Environment.* https://media-cdn.dvidshub.net/pubs/pdf_62208.pdf.
Demonstrations	**110-acre field-scale Peroxide Algaecide Treatment Efficacy Demonstration** on a Historically HAB impacted waterbody. Milford Gathering Pond, Kansas. April 2022 **Field-scale Peroxide Algaecide Treatment Efficacy Demonstration** on a Historically HAB impacted waterbody. Big11 Pond, Kansas. March 2023