Identification and Preventative Treatment of Overwintering Cyanobacterial Cells in Sediments

Lead PI: Dr. Andrew McQueen, ERDC, Andrew.D.McQueen@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 Overwintering cyanobacterial cells in the sediment can contribute to harmful algal blooms, 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. Then, conduct bench-scale testing to evaluate analytical detection methods for overwintering cells and measure responses of cells to candidate algaecide exposures. Next, evaluate performance of preventative algaecide applications at one or more field sites with known HAB history and confirmed overwintering cells in sediments (Fig. 1).

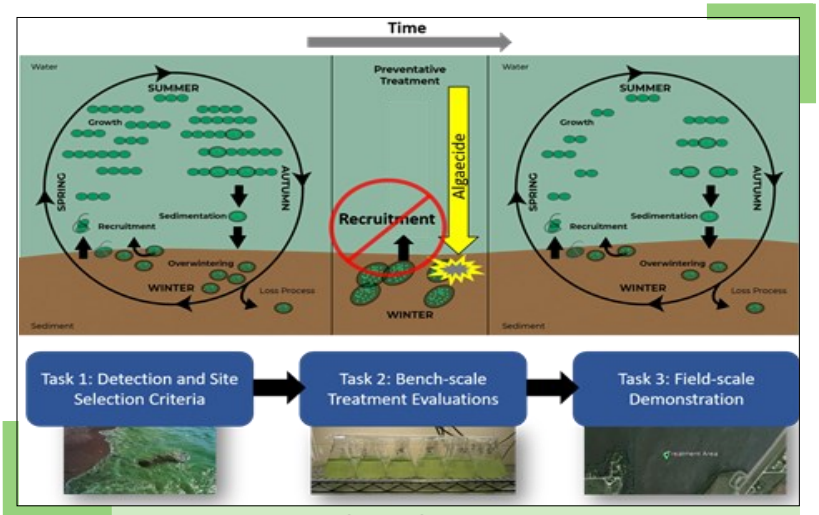

Figure 1: *Approach of Identification and Preventative Treatment of Overwintering Cyanobacterial Cells in Sediments*

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. Based on these results, Task 2 provided bench-scale efficacy data for selected USEPA registered peroxide and copper-based algaecides (graphical abstract Fig. 2), to inform future field scale demonstrations.

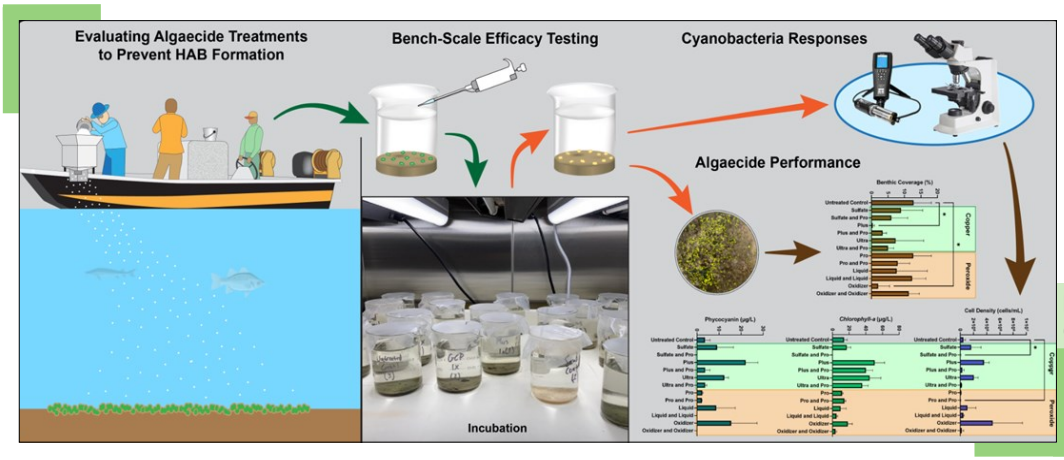

Figure 2: *Measure the efficacy of copper and peroxide-based algaecides for the preventative treatment of overwintering cyanobacteria.*

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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 (Fig. 3).

Task 3 field demonstration is planned for FY23. However, early trials in an 80-acre pond in Kansas indicate 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 (Fig. 4).

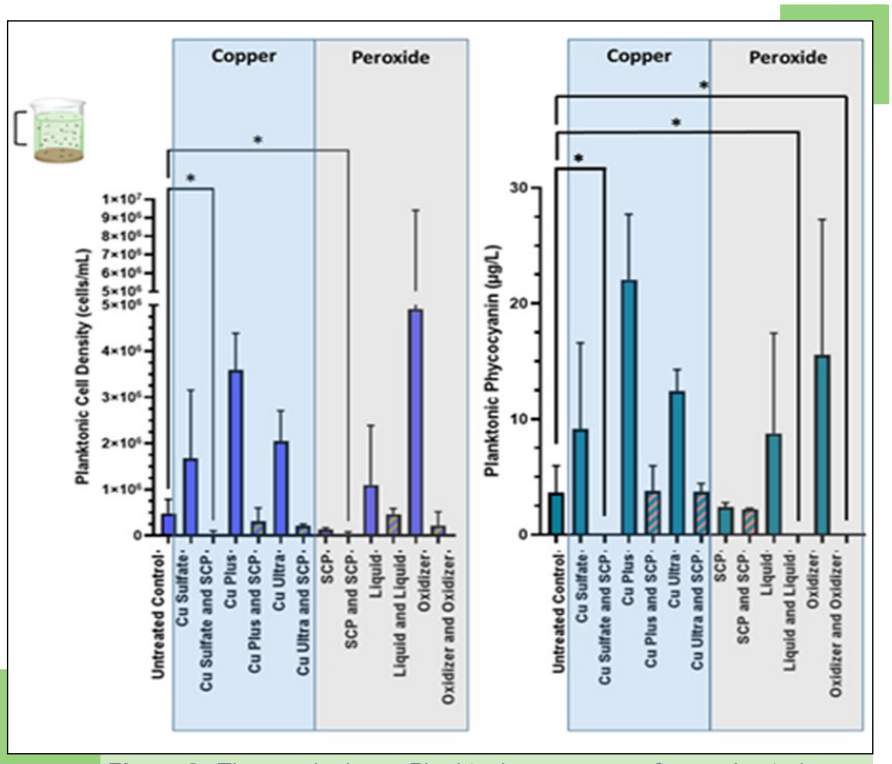

Figure 3: *The graph shows Planktonic responses of cyanobacteria from sediments containing overwintering cells following algaecide exposure and a 14-day incubation.*

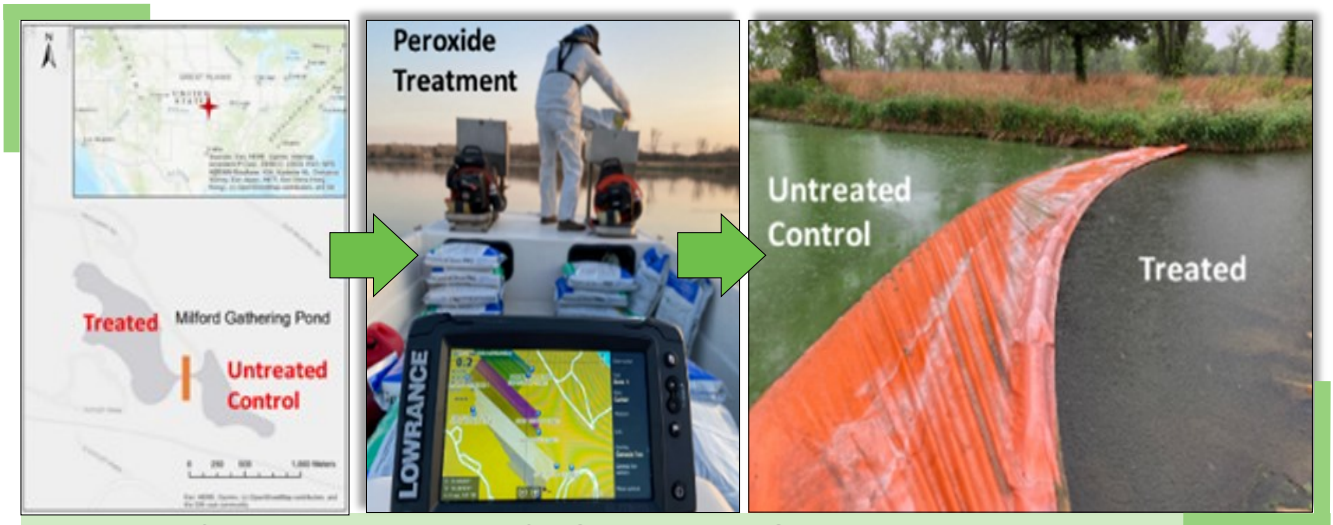

Figure 4: *Initial field-scale demonstrations (Milford Gathering Pond, KS) treating overwintering cells in sediments indicate decreased severity of HAB. The map depicts the treated and untreated (control) areas of the lake. The images show researchers administering treatment and the subsequent results.*

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Major Milestones

Date	Milestone
FY21, Q3,4	Literature review of detection, monitoring, and life-cycle of cells
FY21, Q3-4	Field collection of sediment and water for bench-scale testing
FY21, Q3-4	Validate detection methods and development of selection criteria
FY21, Q4	Technical Report: Identification and preventative treatment
FY21, Q4	Go/No-Go Decision Point based on Feasibility
FY22, Q1-4	Bench-scale testing of overwintering cells and grow-out studies
FY22, Q2-4	Identification of effective algaecides and formulations
FY22, Q2-4	Journal Article: Responses of overwintering cells to algaecide formulations (In Progress)
FY23, Q2-3	Journal Article: Review of detection and monitoring approaches (In Progress)
FY23, Q2-3	Journal Article: Field-scale demonstration Milford Gathering Pond (In Progress)
FY23, Q2-3	Field-scale treatment demonstrations (In Progress)
FY23, Q4	Journal Article: Responses of overwintering cells to algaecide applications (In Progress)
FY23, Q4	Technical Report: Management plan for the treatment of overwintering cells (In Progress)
Costs	**FY21:**$218K **FY22:**$212K **FY23:**$230K **TOTAL:**$660K

Partnership/Leveraging Opportunities

This work is leveraging multiple collaborations and other work units including Kansas Department of Health and Environment (KDHE), USACE Tulsa District (SWT), and USACE Kansas City District. 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.

USACE District Liaisons: Dr. Tony Clyde Jr. of Tulsa District and Marvin Boyer of Kansas City District