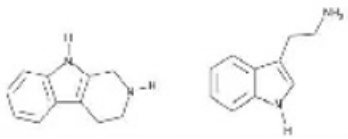
A Novel Biological Control Approach for Cyanobacteria

Lead PI: Dr. Karl J. Indest, ERDC, Karl.J.Indest@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 Harmful algal blooms (HABs) are a worldwide problem and HAB associated cyanotoxins are a priority concern for US inland waterways. USACE District and Division managers lack targeted, effective tools for combatting problematic cyanoHABs in their respective regions. Short-term mitigation strategies for the effective management of HABs and their toxins are needed like target-specific novel cyanocidal chemical products.



Objective To identify a novel cyanoHAB control method utilizing a bacterially-derived compound(s) demonstrating both cyanocidal activity and class-level specificity that will provide USACE Districts, water resource managers, and other interested stakeholders with a proven, effective alternative to less discriminatory cyanoHAB control methods. Biological control through bacterially-derived bioactive compounds remains a relatively untapped research area in cyanoHAB mitigation with the potential for highly specific cyanobacteria control.

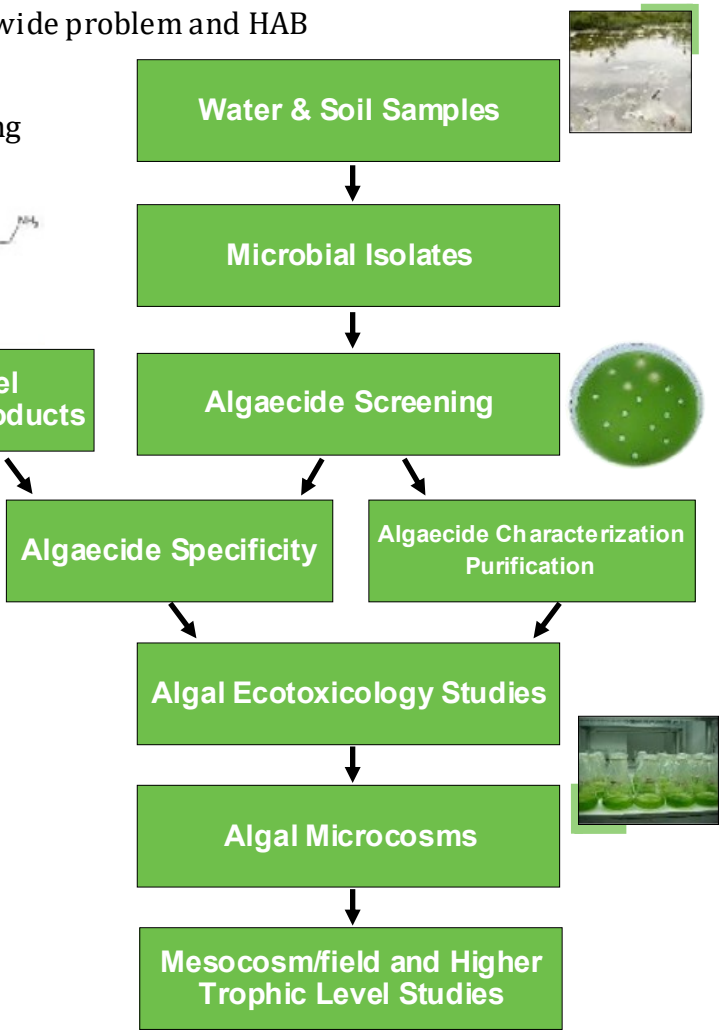


Figure 1: *Project approach to screening and identifying natural cyanocide compounds*

Approach In FY21, identify and evaluate experimental bacterial cyanocide compounds that achieve 30% reduction in biomass in 72 hours in model organism and in standard screening assays on various cyanobacteria monocultures. Screen and identify aquatic/terrestrial bacteria for secondary metabolites able to inhibit algal growth in liquid/semisolid media. In FY22, there were continued algaecide evaluations on broad phytoplankton-based species and efforts to determine potential effects on non-target species via zooplankton toxicity studies. Research efforts included partial purification and characterization of bacterial algaecide compounds. In FY23, microcosm community impact evaluations of bacterial algaecide compounds will be performed.

Value to USACE Mission USACE District and Division managers lack targeted, effective tools in combatting problematic localized cyanoHABs in their respective regions. Target-specific novel cyanocidal chemical products offer short-term mitigation strategies for effective management of HABs and their toxins.

USACE District Liaison: *Eric Glisch, New Orleans District*

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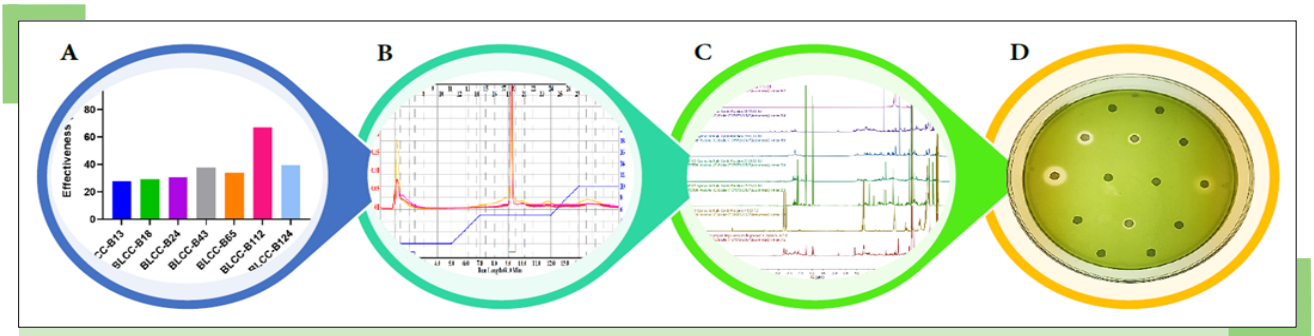

Figure 2: *A flow chart of the methods used to identify new cyanocide compounds. A: bacteria strains were tested on Microcystis sp. and those that reduced the algal biomass by 30% were used for downstream experiments. B: candidate bacterial strains were extracted and extracts analyzed using flash chromatography. C: purified standards were run on a Nuclear Magnetic Resonance (NMR) instrument to help identify unknown compounds. D: bacterial extracts were screened for cyanocide activity represented as zones of clearing on a cyanobacterial lawn plate.*

Major Milestones

Date	Milestone
FY21-Q1-Q4	Evaluate current and novel cyanocide compounds
FY21, Q4	Conference: Society of Industrial Microbiology and Biotechnology (SIMB)
FY22, Q3	Go-No Go: Identification/down select of a least 1 bacterial algaecide
FY22, Q3	Conference: ERDC RD22
FY22, Q3	Conference: 12th International Conference on Toxic Cyanobacteria
FY22-FY23 Q2	Evaluate phytoplankton and zooplankton effects
FY22, Q4-FY23, Q4	Technology Development-Partial purification of ≥1 compound with cyanocidal activity
FY23, Q2	Journal Article – On cyanocide specificity across cyanobacteria and non-target organisms
FY23, Q2	Technical Report– Standardizing bacterial-derived cyanocidal product screening
FY23, Q1-Q4	Microcosm community impacts of candidate compounds
FY23, Q3	Journal Article-On genomic characterization and chemical characterization of bacterial algaecide strains
Costs	**FY21:**$88K **FY22:**$177K **FY23:**$223K **TOTAL:**$488K

Partnership/Leveraging Opportunities

This work will leverage a collaboration with The University of Florida's Fort Lauderdale Research and Education Center (FLREC) via Dr. Dail Laughinghouse. Currently, this project supports a part time ORISE scientist under the direction of Dr. Laughinghouse. In addition, FLEC is a unique laboratory resource that cultures and maintains several environmentally relevant HABs and other algal species needed for successful execution of this work unit.