Research on Algae Flotation Techniques (RAFT)

Lead PI: Clinton Cender, ERDC, Clinton.J.Cender@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 Algae harvesting can be done efficiently at larger scales when algal blooms are concentrated near the water surface. The harvesting approach becomes less efficient and scalable when the algae are dispersed throughout the water column, which is common in some eutrophic water bodies.

Objective Develop a scalable method for inducing cyanobacteria flotation that can be efficiently and safely applied to natural water bodies. Concentrating the algae would allow for huge gains in scalability of HAB mitigation through more efficient physical removal.

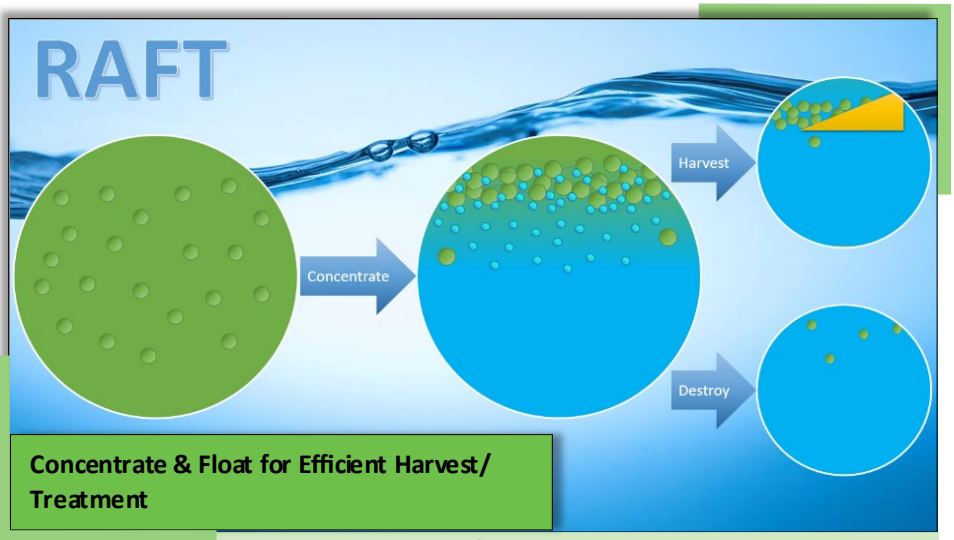

Figure 1: *RAFT algae flotation objective and concept*

Approach Certain cyanobacteria strains produce polymeric substances that help them aggregate while trapping dissolved oxygen, resulting in increased flotation. The Research on Algae Flotation Techniques (RAFT) team is studying environmentally benign chemicals that can enhance these natural aggregation and flotation mechanisms. The algae flotation will be accelerated further by the application of mechanically produced nanobubbles that synergize with the chemical aggregation process.

Iterative benchtop studies on the interaction of microalgae with simulated polymeric substances led to the optimization of a three-stage treatment. First, the polysaccharide xanthan gum was homogenized in algae. A cationic polyacrylamide was then used to destabilize the emulsion charge and adsorb the algae to the polysaccharide. Finally, microbubbles infused beneath the mucus entrapped coagulated algae creating a buoyant, stable layer at the water's surface.

Figure 2: *Image of test ponds*

The benchtop methodologies were translated and scaled for demonstration in four 14,000 gallon test ponds seeded with algae and environmentally grown to bloom conditions. The treated test ponds demonstrated significant and rapid algae biomass surface accumulation measured as phycocyanin. The uniformly dispersed algae were initially measured at 5 relative fluorescence units and after treatment the surface concentrated algae measured 30 relative fluorescence units.

Results The 2022 RAFT field demonstration resulted in significant, and rapid, surface concentration of the present cyanobacteria and Chlorophyta. Microbubble dissolved air flotation after chemical treatment began generating the surface biomass within a thirty minute timeframe.

Research on Algae Flotation Techniques (RAFT)

Lead PI: Clinton Cender, ERDC, Clinton.J.Cender@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

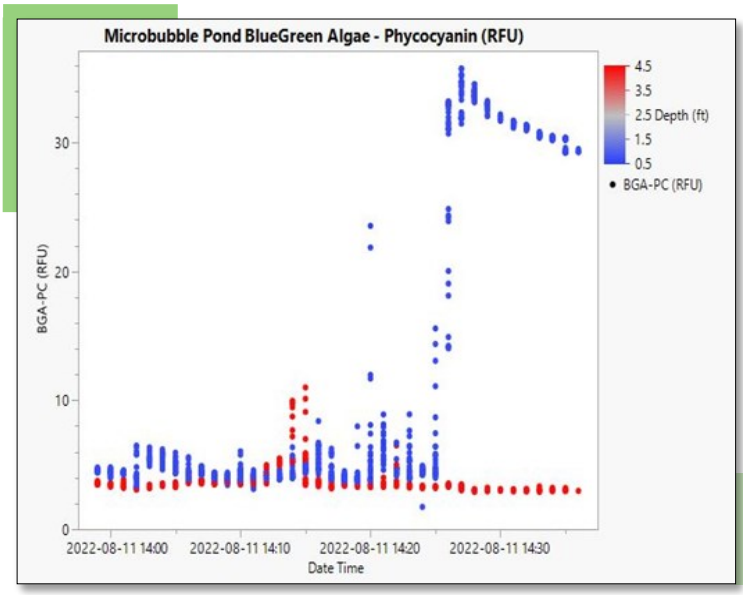

Figure 3 (Left): *The graph displays RAFT phycocyanin data during treatment across depths.*
Figure 4 (Above): *A photo of the observed surface biomass accumulation.*

In-situ flotation similar to that achieved during the demonstration may be achievable with adequate chemical delivery and dispersion throughout the harmful algal bloom.

Major Milestones

Date	Milestone
FY21, Q3	Technical report on cyanobacteria flotation using simulated extracellular polymeric substances
FY22, Q2	Invention disclosure/patent application for novel flotation mechanism
FY22, Q3	Pilot system assembly and test
FY22, Q4	Pilot demonstration at Environmental Laboratory test ponds
FY23, Q1	Journal article on flotation of cyanobacteria combining simulated EPS and nanobubble saturated water (Draft Submitted)
FY23, Q1	Technical report – scalability analysis (Draft Submitted)
Costs	**FY21:**$30k **FY22:**$115K **FY23:**$50k **TOTAL:**$195K

Partnership/Leveraging Opportunities

This work will leverage ongoing field studies within USACE's Aquatic Nuisance Species Research Program, such as HABITATS, which include collaborations with New York State Department of Environmental Conservation and Florida Department of Environmental Protection. In addition to government collaborations, commercial products are being evaluated, modified, and optimized in the RAFT study.

Value to USACE Mission

The impetus driving the RAFT project is the need to more effectively collect and remove harmful algal blooms that have begun to form in greater frequency across national freshwater bodies. Creating a surface concentrated HAB will allow existing and new mitigation techniques to make bold steps in efficiency and scope.

USACE District Liaison: Benjamin Greeling—St. Louis District