

# Research on Algae Flotation Techniques (RAFT)

## USACE Harmful Algal Bloom Research & Development Initiative



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

Lead: Clinton Cender, ERDC, Clinton.J.Cender@usace.army.mil

### 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.

### Approach

Certain cyanobacteria strains produce polymeric substances that help them aggregate while trapping dissolved oxygen, resulting in increased flotation. The RAFT team is studying environmentally benign chemicals that can enhance these natural aggregation and flotation mechanisms.

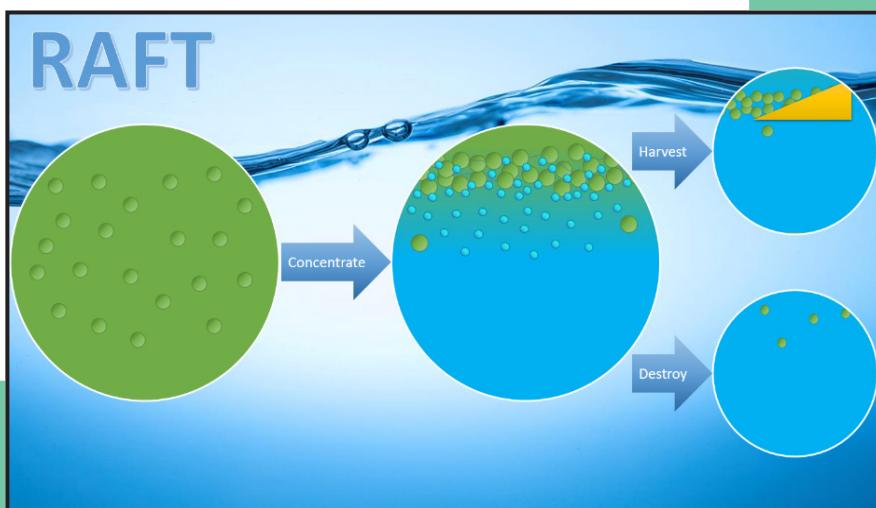


Figure 1. RAFT algae flotation objective and concept.

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. The benchtop methodologies were translated and scaled for demonstration in four 14,000 gal. test ponds seeded with algae and environmentally grown to bloom conditions.



Figure 2. Test ponds.

The treated test ponds demonstrated significant and rapid algae biomass surface accumulation measured as phycocyanin. The uniformly dispersed algae were initially measured at five 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 30 min timeframe. In situ flotation similar to that observed during the demonstration may be achievable with adequate chemical delivery and dispersion throughout the harmful algal bloom.

# Research on Algae Flotation Techniques (RAFT)

## USACE Harmful Algal Bloom Research & Development Initiative



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

Lead: Clinton Cender, ERDC, Clinton.J.Cender@usace.army.mil



Figure 3. Observed surface biomass accumulation.

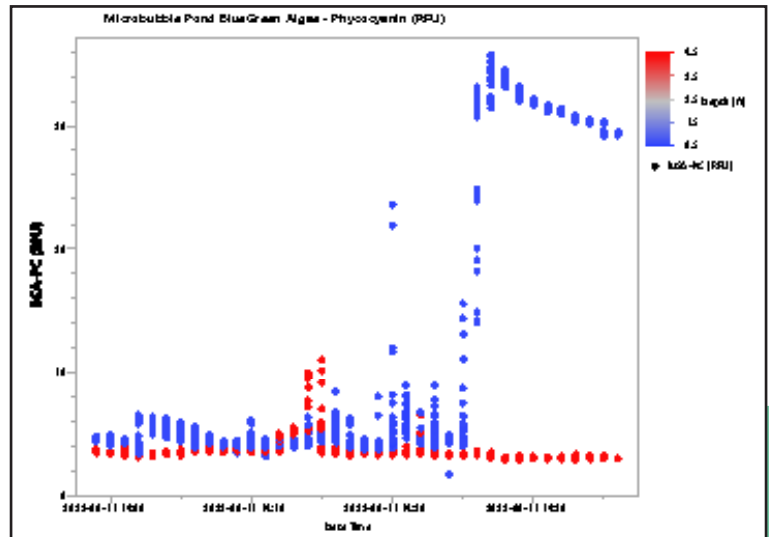


Figure 4. RAFT phycocyanin data during treatment across depths.

## Major Milestones

Deliverable	Description
Publications	<p><b>Tech Report.</b> Cender et al. 2023. <i>Rapid Algae Flotation Techniques</i>. ERDC TR-23-6. Vicksburg, MS: US Army Engineer Research and Development Center.</p> <p><b>Tech Report.</b> Cender et al. In prep. <i>Pilot Scale Optimization: Research on Algae Flotation Techniques (RAFT)</i>. ERDC TR. Vicksburg, MS: US Army Engineer Research and Development Center.</p> <p><b>Journal Article.</b> Cender et al. In prep. "Microalgae Flotation: Manipulating Surface Concentrations with Mucilage Entrapped Air. International Water Association." <i>Water Research</i>.</p>
Products	<p><b>Patent.</b> US Utility Patent Application. "Combination of Cationic Polyacrylamide and Xanthan as Flocculation Agents for Harmful Algal Blooms." USPTO Ser. No.: 18/130,344</p>
Demonstrations	<p>Pilot-scale algae flotation system demonstration and optimization. August 2022. ERDC HQ concrete experimental pond test bed. Vicksburg, MS.</p>

## Partnership/Leveraging Opportunities

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

## Value to USACE Mission

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



Learn about other EL research areas, including  
 Aquatic Nuisance Species  
 Aquatic Plant Control  
 Ecosystem Management and Restoration

Find ERDC on the web at:

