

# A Novel Field-Based Approach to Reducing Harmful Algal Blooms in Freshwater Ecosystems

## Problem & Background

### Harmful Algal Blooms (HABs)

- Excess growth of cyanobacteria in freshwater bodies of water.
- Blooms cause hypoxia and produce toxins which are harmful to all living organisms and communities.
- If toxin levels are above EPA regulations, reservoirs have to be taken offline so they cannot be used to create fresh water as toxins are challenging to be filtered out of the wastewater.

### Hypothesis & Purpose

- Alternative/Research Hypothesis:** If an engineered device that can deploy 3 mL/L of hydrogen peroxide was paired with biochar and deployed into a lake with a harmful algal bloom, it would be effective at destroying and capturing the cyanobacteria cells.
- Purpose:** The purpose of this experiment was to engineer and deploy a self-contained underwater device in a Colorado lake affected by cyanoHABs that would be able to kill cyanobacteria and then collect the debris.

## Methods



Image 1. Student Researcher with HAB: Picture taken by Sarah Muro, mother of student researcher, 2025.



Image 2. Mullein for Biochar: Picture taken by the student researcher during field research, 2025.



Image 3. HAB Device: Picture taken by the student researcher during field research, 2025.



Image 4. Three Section Lake Setup: Picture taken by the student researcher during field research, 2025.

### Hydrogen Peroxide (H2O2):

- 3% H2O2 selectively suppresses cyanobacteria because of its high sensitivity to oxidative stress compared to eukaryotic phytoplankton.
- H2O2 breaks down into H2O and oxygen molecules.
- No toxic byproducts like many other current solutions.
- It was contained in the novel device to be deployed into the lake.

### Biochar

- Biochar was created from Mullein biomass (an invasive species in Colorado).
- Biochar is created by being burned in a low-oxygen/high-heat environment (pyrolysis).
- Creates a web like structure to capture dead cyanobacteria and excess nutrients through being placed in mesh bags in the lake.

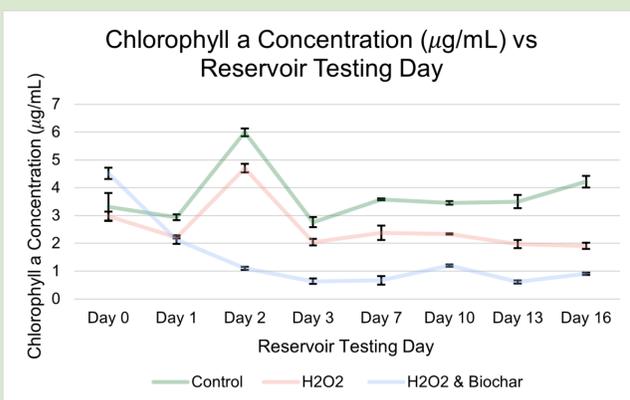
### Wave Motion Device:

- The novel device used the natural wave movement of the lake to deploy hydrogen peroxide in regulated concentrations to kill the cyanobacteria.
- Based on previous modeled designs of wave energy converters.
- Allowed for the targeted suppression of harmful algal blooms.

### Lake Testing

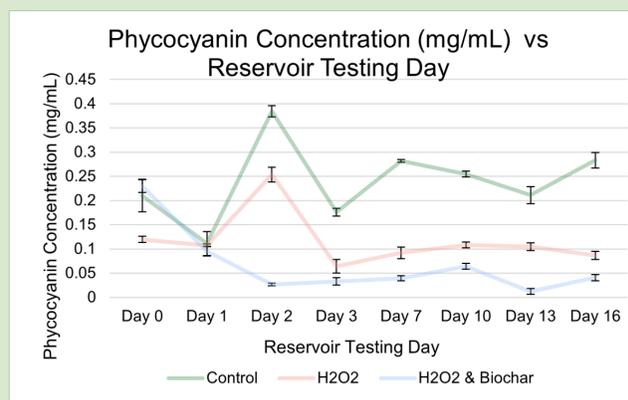
- The HAB lake was divided into three separate sections (control, hydrogen peroxide, and hydrogen peroxide and biochar).
- Water samples were taken on Days 0, 1, 2, 3, 7, 10, 13, and 16 from each section.
- A spectrophotometer measured determine levels of chlorophyll a, phycocyanin, allophycocyanin, and turbidity levels.

## Results



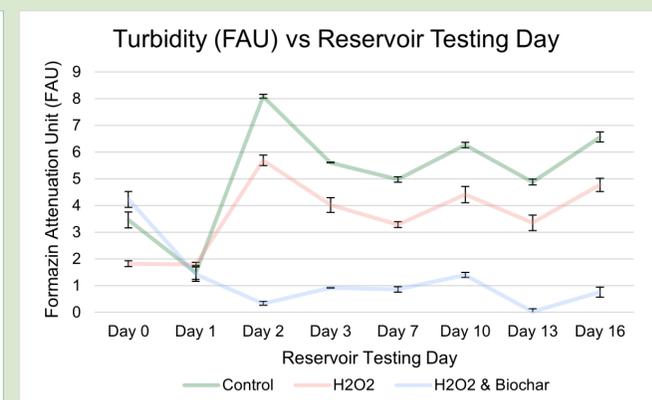
Graph 1. Chlorophyll a Concentration Graph: Graph created by the student researcher using Excel, 2025.

- Between Days 0 and 16, the control increased 27%.
- The hydrogen peroxide group decreased 36%
- The hydrogen peroxide and biochar group decreased by 89%.
- On Day 16, the hydrogen peroxide condition decreased by 45% compared to the control and the hydrogen peroxide and biochar decreased by 78% relative to the control.



Graph 2. Phycocyanin Concentration Graph: Graph created by the student researcher using Excel, 2025.

- Between Days 0 and 16, the control increased 53%.
- The hydrogen peroxide group decreased 27%
- The hydrogen peroxide and biochar group decreased by 82%.
- On Day 16, the hydrogen peroxide condition decreased by 69% compared to the control and the hydrogen peroxide and biochar decreased by 86% relative to the control.



Graph 3. Turbidity Level Graph: Graph created by the student researcher using Excel, 2025.

- Between Days 0 and 16, the control increased 92%.
- The hydrogen peroxide group increased 141%
- The hydrogen peroxide and biochar group decreased by 82%.
- On Day 16, the hydrogen peroxide condition decreased by 32% compared to the control and the hydrogen peroxide and biochar decreased by 88% relative to the control.

## Conclusion and Future Applications

### Conclusion

- The data collected did support the original hypothesis.
- In each category (chlorophyll a, phycocyanin, allophycocyanin (graph not pictured), and turbidity) there was a decrease in the cyanobacteria between Day 0 and Day 16.
- The higher chlorophyll a readings demonstrated how the hydrogen peroxide selectively suppressed the cyanobacteria and did not kill the other phytoplankton.

### Future Applications

- The effectiveness of the engineered device and the HAB mitigation method provided a solution to the worldwide problem.
- This novel approach is low-cost and environmentally friendly, making it applicable for communities to effectively mitigate HABs and increase the potential to preserve water quality and moderate health risks.

### References:

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- Lusty MW, Gobler CJ. The Efficacy of Hydrogen Peroxide in Mitigating Cyanobacterial Blooms and Altering Microbial Communities across Four Lakes in NY, USA. *Toxins (Basel)*. 2020 Jun 29;12(7):428. doi: 10.3390/toxins12070428. PMID: 32610617; PMCID: PMC7405413.
- Piel T, Sandrini G, White E, Xu T, Schuurmans JM, Huisman J, Visser PM. Suppressing Cyanobacteria with Hydrogen Peroxide Is More Effective at High Light Intensities. *Toxins (Basel)*. 2019 Dec 31;12(1):18. doi: 10.3390/toxins12010018. PMID: 31906135; PMCID: PMC7020451.