Operational Strategies for HAB Management in Inland Reservoirs

USACE Harmful Algal Bloom Research & Development Initiative

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

Lead: Dr. Jodi L. Ryder, ERDC, Jodi.L.Ryder@usace.army.mil

Problem

Given the dynamic interplay between flow, water quality, and harmful algal blooms (HABs) it is difficult to anticipate the impacts of operational decisions on water quality at inland reservoirs.

Objective

To develop a model that leverages existing and ongoing routine water quality monitoring for nutrient water quality, chlorophyll-a, and other indicators of algae activity in a process-informed modeling framework to make short-term predictions of water quality responses to operational and flow perturbations.

Approach

Historically, water quality monitoring focused on geochemical parameters, nutrients, and known contaminants and was routinely performed at intervals to evaluate if water quality was declining over the long term. Water quality models were also structured toward answering questions about how small changes would affect a reservoir system in the long term. The hydrodynamic and water quality information used for these models tended to focus on average values or specific periods of intense study. However, HABs are typically short-lived periods of rapid water quality change. There can be many causes (both chemical and physical) so there is no singular best action to mitigate a bloom. The first component of this project, completed in 2020–2022, was to examine which water quality and hydrodynamic parameters were most indicative of blooms at several lakes where high-frequency monitoring of water temperature, chlorophyll-a, and phycocyanin, proxies for algae and cyano-HABs, were recorded. The second component is to develop models for short-term prediction of bloom likelihood that incorporate hydrodynamic conditions so that the models can be used to evaluate the potential effects of operational flow changes at reservoirs.

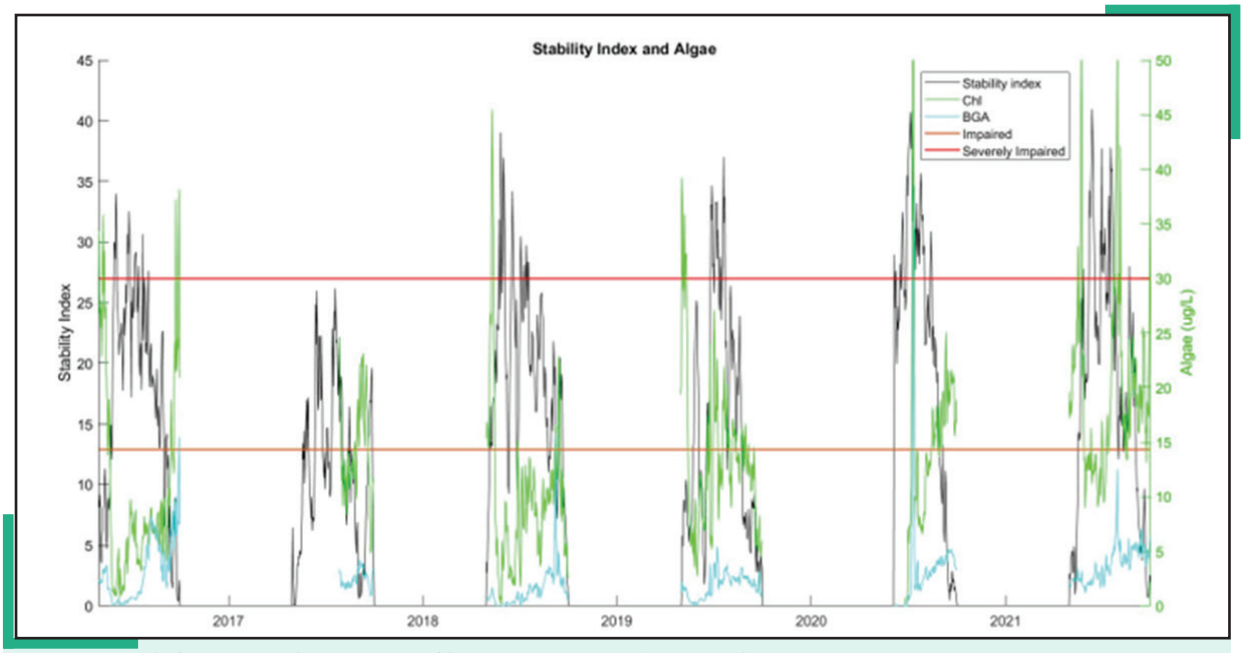

Figure 1. *High frequency observations of key parameters indicating algae presence.*

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Approach (cont.)

	Hypolimnetic Withdrawals	Horizontal Flushing	Pulsed Inflow	Mixing
Management Strategy	Removal of hypolimnetic layer	Removal of surface layer	Upstream water used to break up downstream blooms	Use of artificial mixing to entrain cyanobacteria
Works By	Reducing nutrients	Direct biomass removal	Dilution of cells and altering environmental conditions	Light limitation
Stratification	Retains stability	Retains stability	Breaks up	Breaks up
Nutrients	Decreases legacy nutrients released from sediments	Decreases surface nutrients	Alters nutrient distribution	Alters nutrient distribution
Temperature	Temperature increase in hypolimnetic layer	Hypolimnetic temperature retained, surface temperature reduced	Decrease surface temperature, more uniform profile	More uniform temperature profile
Outflow	Cold, oxygen depleted, nutrient rich	Warm, oxygen rich, eutrophic	N/A	N/A

Major Milestones

Date	Milestone
FY21, Q4	Development of literature-based HAB-specific processes and parameters (complete)
FY22, Q4	**Journal Article:** "The Manipulation of Limnological Parameters to Impact HAB Events" (in review)
FY23, Q3	**Technical Report:** "Water Quality Trends and Observed Impacts of Reservoir Operations" (in progress)
FY23, Q2	**Technical Note:** Model Design report (in progress)
FY23, Q3	**Technical Report:** Model Dem/Val report (in progress)
FY23, Q3	Model release (in progress)
FY23, Q3	**Technical Report:** "Use of the USACE Enterprise Water Quality Database to Visualize HAB Vulnerability" (in progress)

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Partnership/Leveraging Opportunities

This work will leverage ongoing field studies within USACE's Aquatic Nuisance Species Research Program, such as HABITATS, which includes 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

This product enables the predictive use of modeling tools to test reservoir operational strategies to maintain regulatory and stakeholder requirements with respect to multiple water quality and hydrodynamic parameters. The capability to change reservoir conditions to prevent or reduce bloom impact would represent a cost effective mitigation strategy. However, because hydrodynamic conditions can both positively and negatively impact water quality, it is important to be able to test changes before enacting them.