Profiling Microbial Community Composition and Functions in the Lake Okeechobee Watershed

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USACE Harmful Algal Bloom Research & Development Initiative

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

Problem

Lake Okeechobee (Lake O) is a model ecosystem to study the patterns and processes of phytoplankton assembly in large, shallow subtropical lakes with coastal connectivity. Novel anthropogenic environmental gradients created by surrounding land use types, natural and managed hydrologic processes, and climate change create spatial and temporal heterogeneity that are likely driving phytoplankton assemblage structure and HAB dynamics within the Lake O system.

Objective

(1) Describe spatial and temporal patterns and drivers of phytoplankton community structure, HAB events, and toxin-production in the Lake O system, and (2) experimentally test the effects of NO_3, NH_4 and PO_4 enrichment on short term phytoplankton dynamics and toxin production.

Approach

Monthly water samples were collected at 21 locations for quantitative phytoplankton taxonomic analysis and measurement of cyanotoxins and cyanotoxin biosynthesis gene concentrations from March 2019 to October 2021 (32 months). During this period, six independent in situ nutrient amendment mesocosm experiments were conducted at different times of the year at the Franklin Lock and Dam on the Caloosahatchee River, which drains Lake O to the west into the Gulf of Mexico.

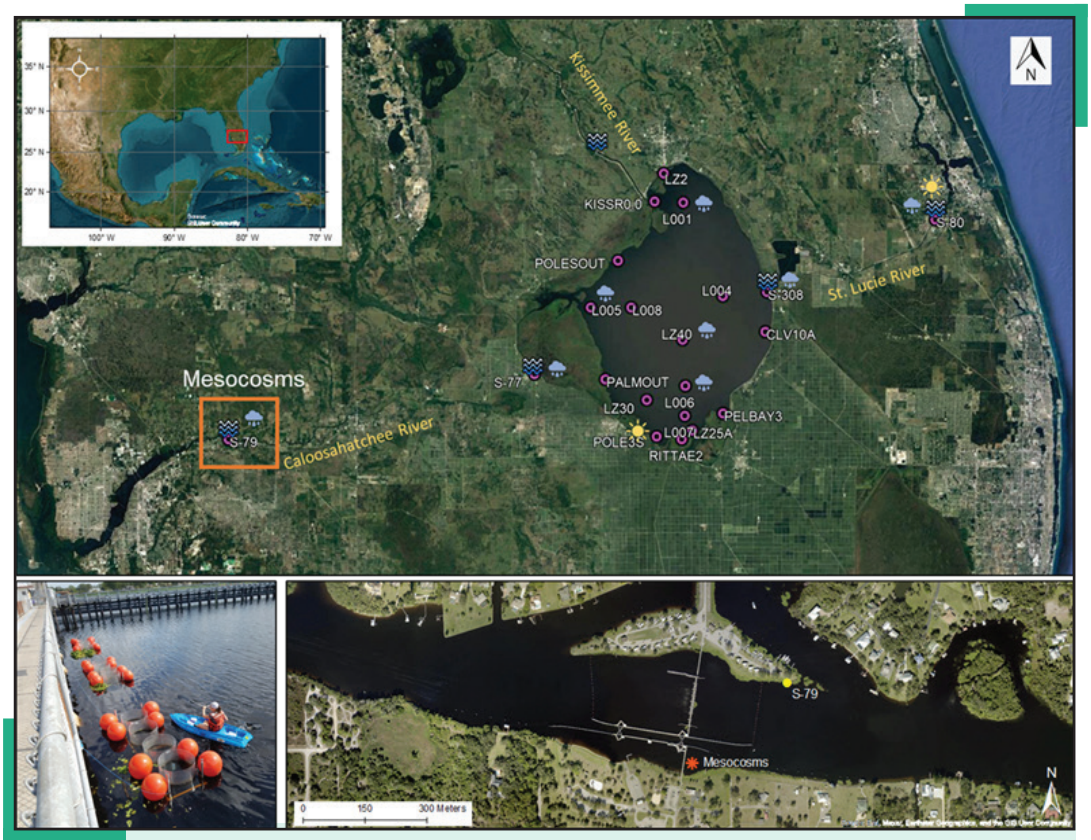

Figure 1. *Location of the 21 sampling locations. Stacked wavy lines indicate locations of lock and dam structures controlling lake inflows and outflows. Cloud icons indicate sites where precipitation data are routinely collected. Sun icons indicate where total solar radiation data were collected. The location of the mesocosm experiments relative to the other sampling stations is marked by the box. The bottom panel shows a close up of the Franklin Lock and Dam site of the mesocosm experiments and a photo of the experimental structure and design.*

EL ENVIRONMENTAL LABORATORY

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Major Milestones

Deliverable	Description
ScienceBase Data Release	**Mazzei, V.,** and K. Sullivan. 2022. *Caloosahatchee River Nutrient Enrichment Mesocosms: Phytoplankton Taxonomic Quantification September 2019, June 2020, September 2020, February 2021.* US Geological Survey data release. https://doi.org/10.5066/P99ELCEC. **Mazzei, V.,** and K. Sullivan. 2023. *Caloosahatchee River Nutrient Enrichment Mesocosms: USGS Phytoplankton Taxonomic Quantification February 2021, May 2021, July 2021*. US Geological Survey data release. https://doi.org/10.5066/P96LONDP. **Mazzei, V.,** and K. Sullivan. 2022. *Monthly Phytoplankton Taxonomic Quantification in Lake Okeechobee and the Okeechobee Waterway, Florida, USA, 2019–2021.* US Geological Survey data release. https://doi.org/10.5066/P9QOJ4JZ. Karwacki, E. E., and **V. Mazzei**. 2022. *Quantitative Polymerase Chain Reaction (qPCR) Cyanotoxin Data for Eight Mesocosm Experiments in the Caloosahatchee River, Florida from May 2019 through August 2021.* US Geological Survey data release. https://doi.org/10.5066/P9D52SZ1. Karwacki, E. E., and **V. Mazzei**. 2022. *Quantitative Polymerase Chain Reaction (qPCR) Cyanotoxin Data for 21 Sites on Lake Okeechobee and the Okeechobee Waterway, Florida, USA Collected Monthly from March 2019 through October 2021.* US Geological Survey data release. https://doi.org/10.5066/P9CFALMR.
Journal Article	**Mazzei, V.,** E. E. Karwacki, K. A. Loftin, J. V. Lopez, L. E. Krausfedlt, B. H. Rosen, and H. Urakawa. In review. "Phytoplankton Responses to Experimental Nitrogen and Phosphorus Loading in a Eutrophic and Turbid Subtropical River." *Ecological Applications*. **Mazzei, V.**, K. Sullivan, and K. A. Loftin. In review. "Phytoplankton Assemblage Structure, Drivers, and Thresholds in the Lake Okeechobee System, Florida, USA with an Emphasis on Cyanobacterial HAB Taxa." *Limnology & Oceanography*.

Partnership/Leveraging Opportunities

The USGS Environmental Health Toxic Substance Hydrology Program provided additional funding support for this project. The South Florida Water Management District collected the monthly field samples in tandem with their routine water quality monitoring samples, allowing their water quality data to be leveraged for this project.

Value to USACE Mission

Understanding cyanobacteria community composition and how it varies as a function of nutrient concentrations and over time in Lake Okeechobee provides new insight into the cyanoHABs that plague Lake Okeechobee. This fundamental knowledge has the potential to inform novel prevention and management strategies in Lake Okeechobee and cyanoHAB research in freshwaters across the nation.