The Jefferson Project at Chautauqua Lake

Chautauqua Lake Symposium
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Strategy

Rensselaer Integrated Science Engineering and the Arts

Chautauqua Institution

NEW YORK STATE Environmental Facilities Corporation

NEW YORK STATE Department of Environmental Conservation

FREDONIA STATE UNIVERSITY OF NEW YORK

Chautauqua Lake

End Goal

Develop a holistic understanding of water quality dynamics in the lake, accounting for both spatial and temporal (seasonal) heterogeneity, with an overall emphasis on trying to better understand the causes of Harmful Algal Blooms (HABs). Findings will be used to help guide management and remediation of Chautauqua Lake.

Efforts began in 2020, but 2025 marks the beginning of significant funding from New York State for the Jefferson Project.

Sensor platforms and surveys have only been deployed/performed for partial seasons thus far. 2025 will be the first year of complete open-water data collection and research.

Chautauqua Lake Association

Tributary monitoring stations were established in 2024, with improvements and full functionality coming in 2025.

Two new weather stations will be built to support research and model validation.

Expanding partnerships will allow for greater research collaboration and insights.

Chautauqua Lake

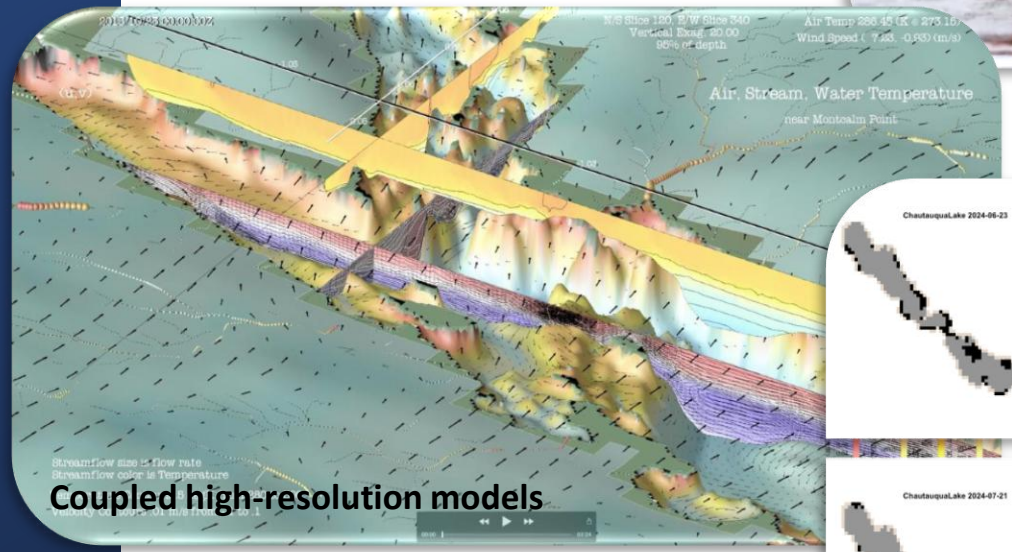
Top Management Challenges

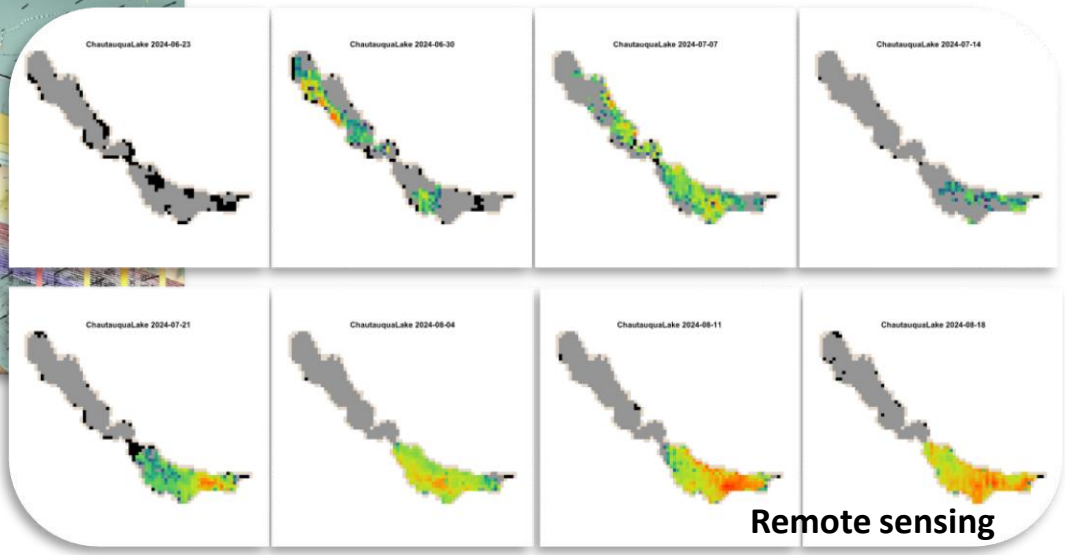
- Eutrophic conditions: frequent toxin-producing harmful algal blooms
- Invasive macrophytes: harvesting and herbicide applications to control plants
- Lake is a drinking water source & major recreational site

2025 Priorities and Goals

- Developing a high-resolution nutrient budget
- Identify areas of high nutrient loading throughout the watershed
- Tributary station improvements
- Weather station builds
- High-resolution model spin up
- Beginning to develop HABs forecasting

Our Approach





2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- Modeling

- **Frequency:** Every two weeks
- **Spatial coverage:** 15 sites
- **Depth resolved:** From the surface to the bottom
- **Important parameters:**
  - Nutrients
  - Algae
    - Toxins
    - Genetics
  - Light extinction
- **Complements the vertical profilers and tributary stations**

2025

- Lake Surveys
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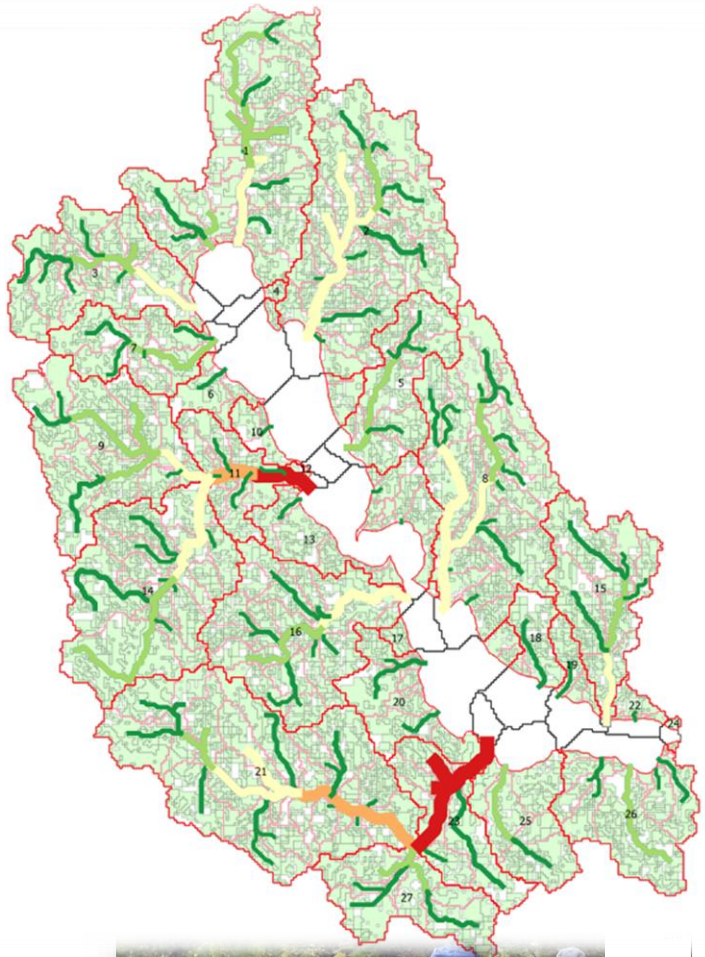
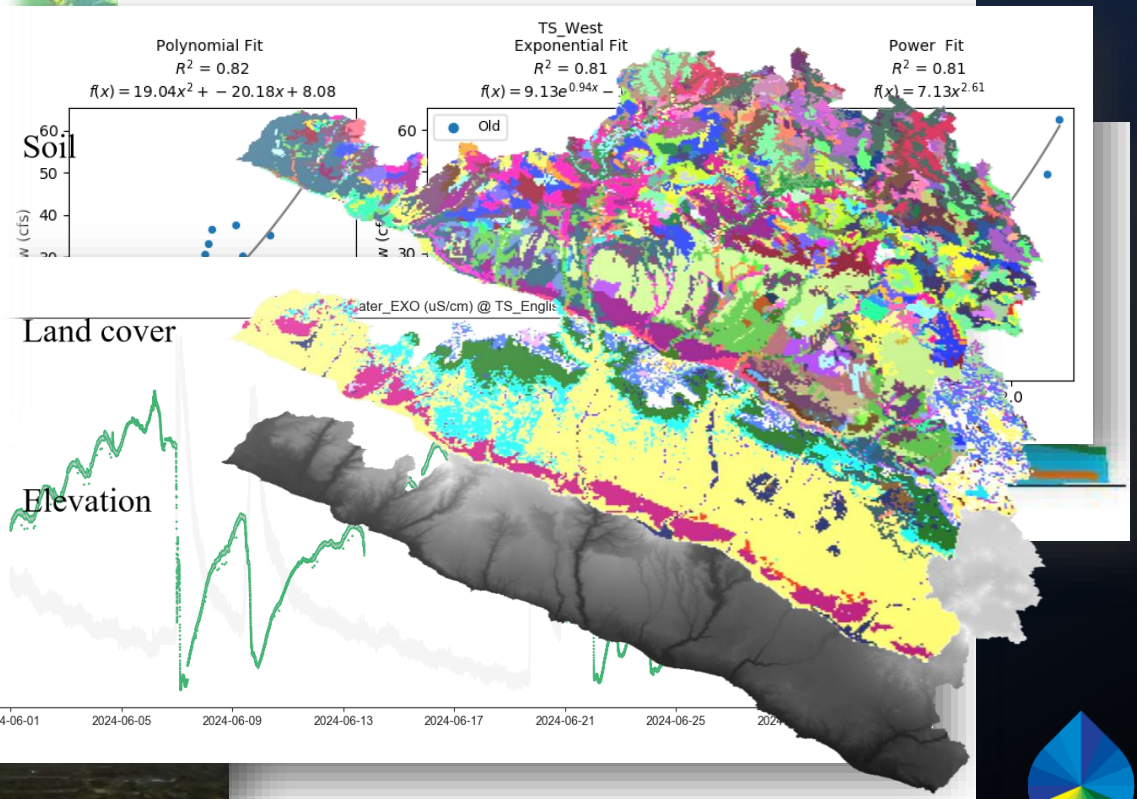
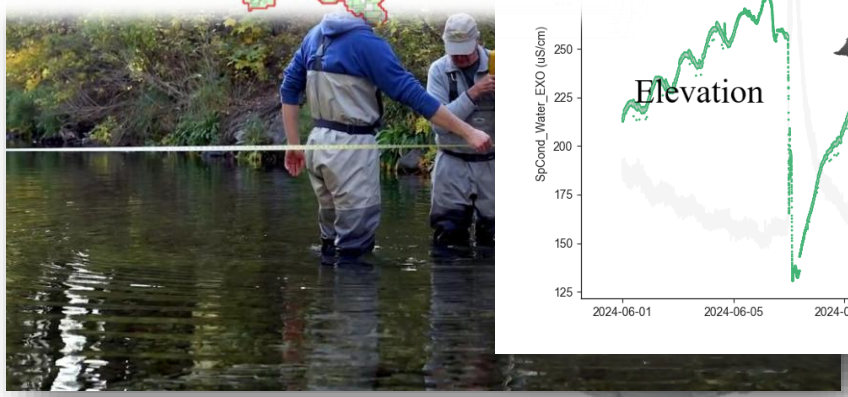


- Six tributaries to be surveyed + Chadakoin
- Baseflow sampling
- Storm event sampling
- Stream gaging
- Paired with high-frequency sensor data
- Model validation





Purdue University, 2020

2025

- Lake Surveys
- Stream Surveys
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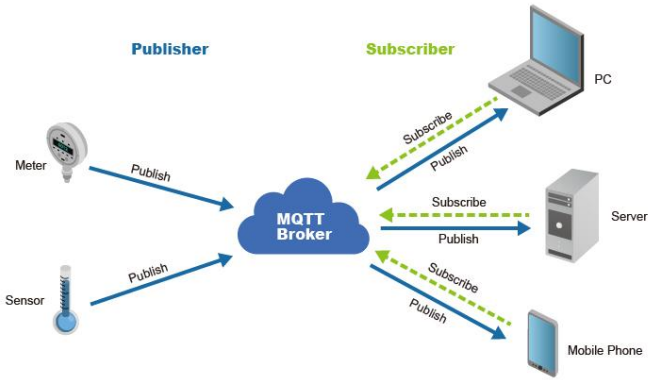
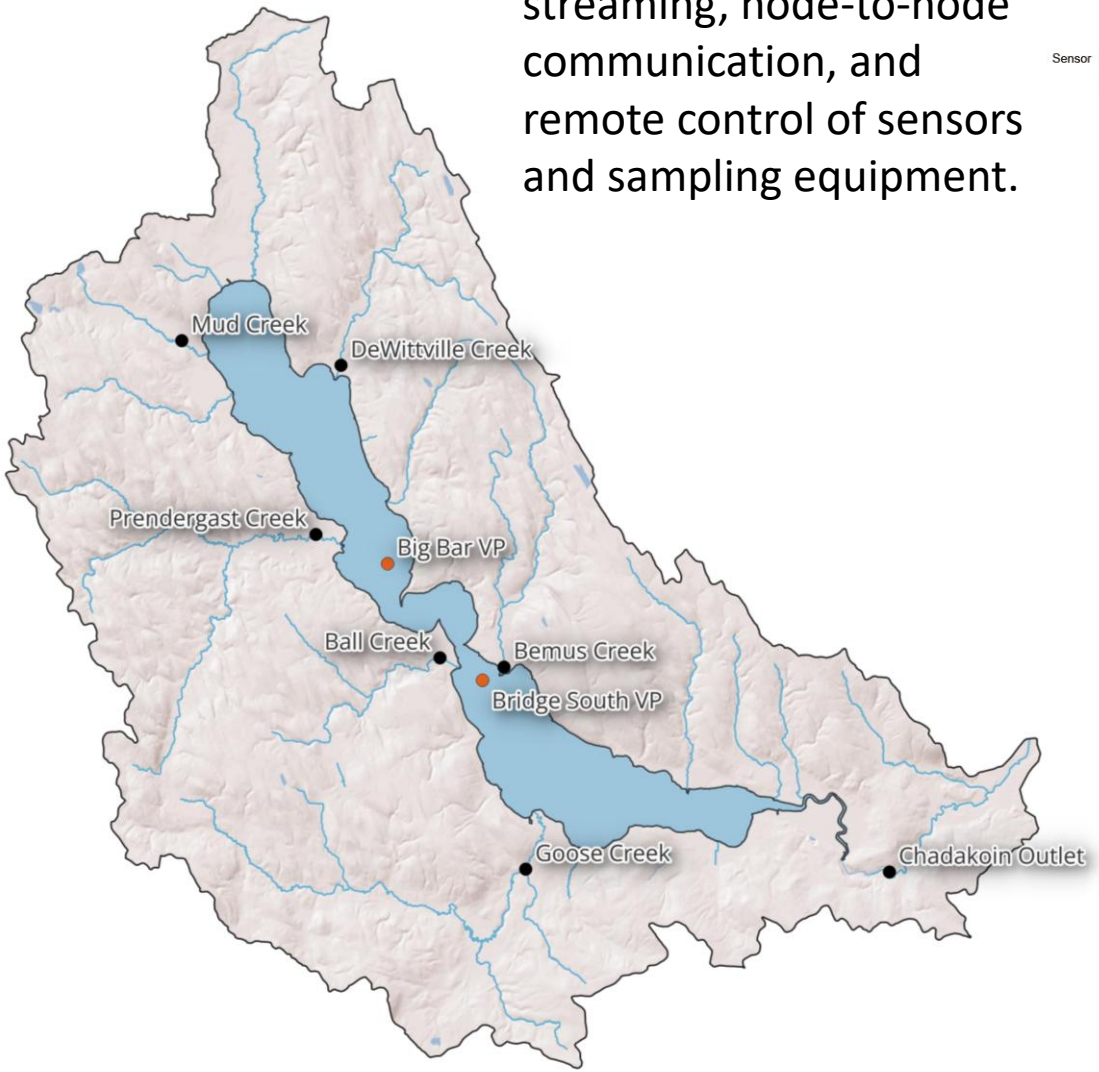
- Modeling

Internet-of-things (IoT) smart sensor network allows for real-time data streaming, node-to-node communication, and remote control of sensors and sampling equipment.





2025

- Lake Surveys
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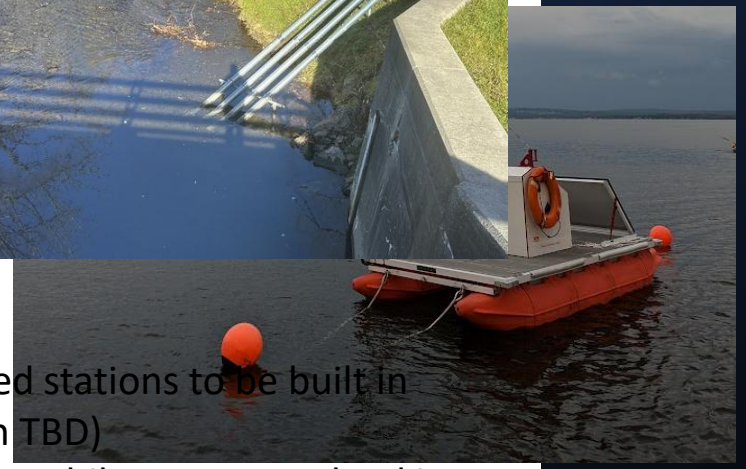
Vertical Profilers

- Custom built for high-frequency data collection
- Profile water column top to bottom
- Water velocity
- Weather station
- Surface fluorescence

Tributary Stations



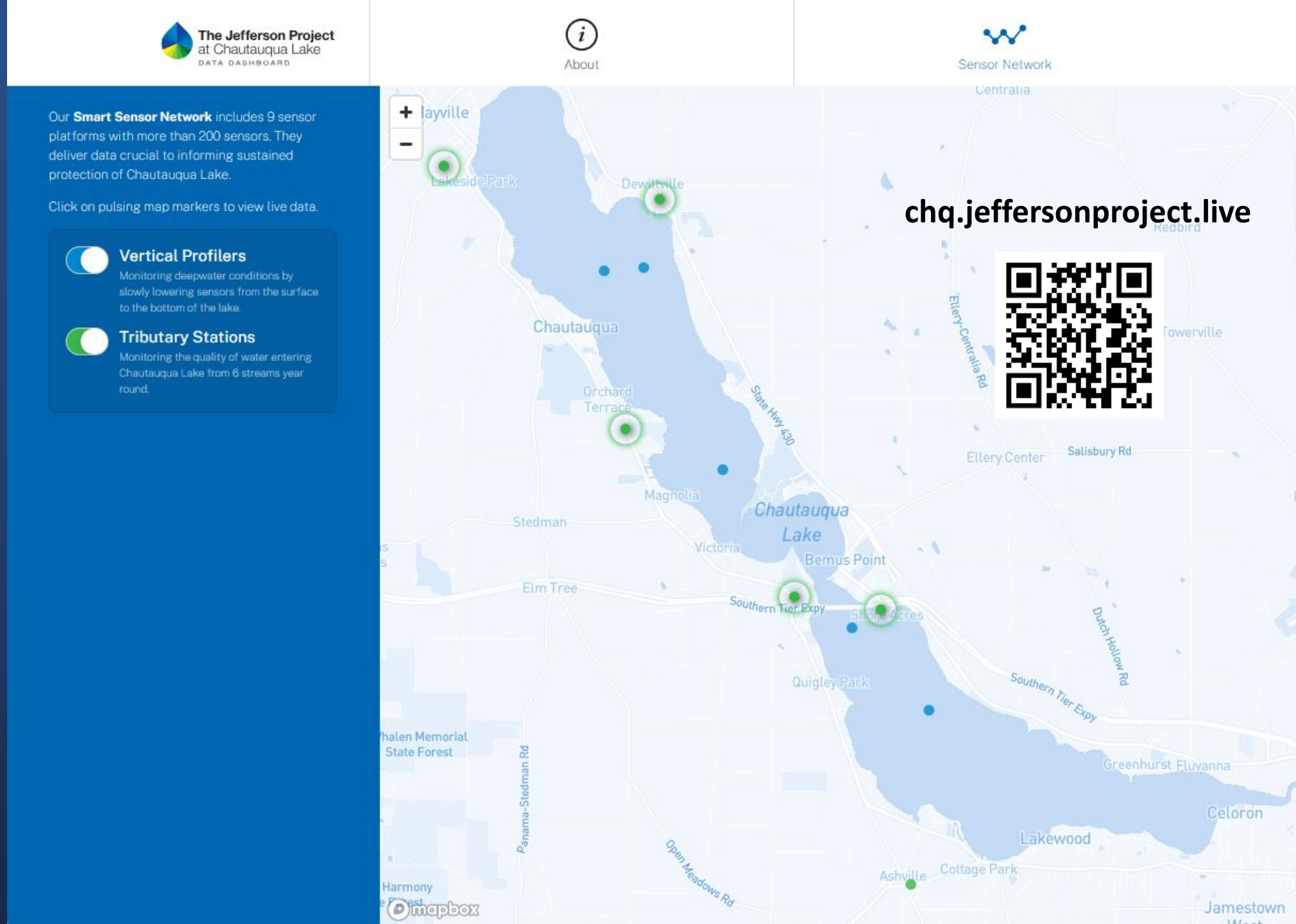
- Two land-based stations to be built in 2025 (location TBD)
- Fill gaps in data while VPs are on land in the winter
- Validate weather models and forecasting
- Tipping bucket rain gauges ideal for snow

- Custom built for high-frequency data collection
- Water quality and quantity
- Automated samplers
- Winter flow-cell systems
- Expandable

Weather stations

2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- Modeling



2025

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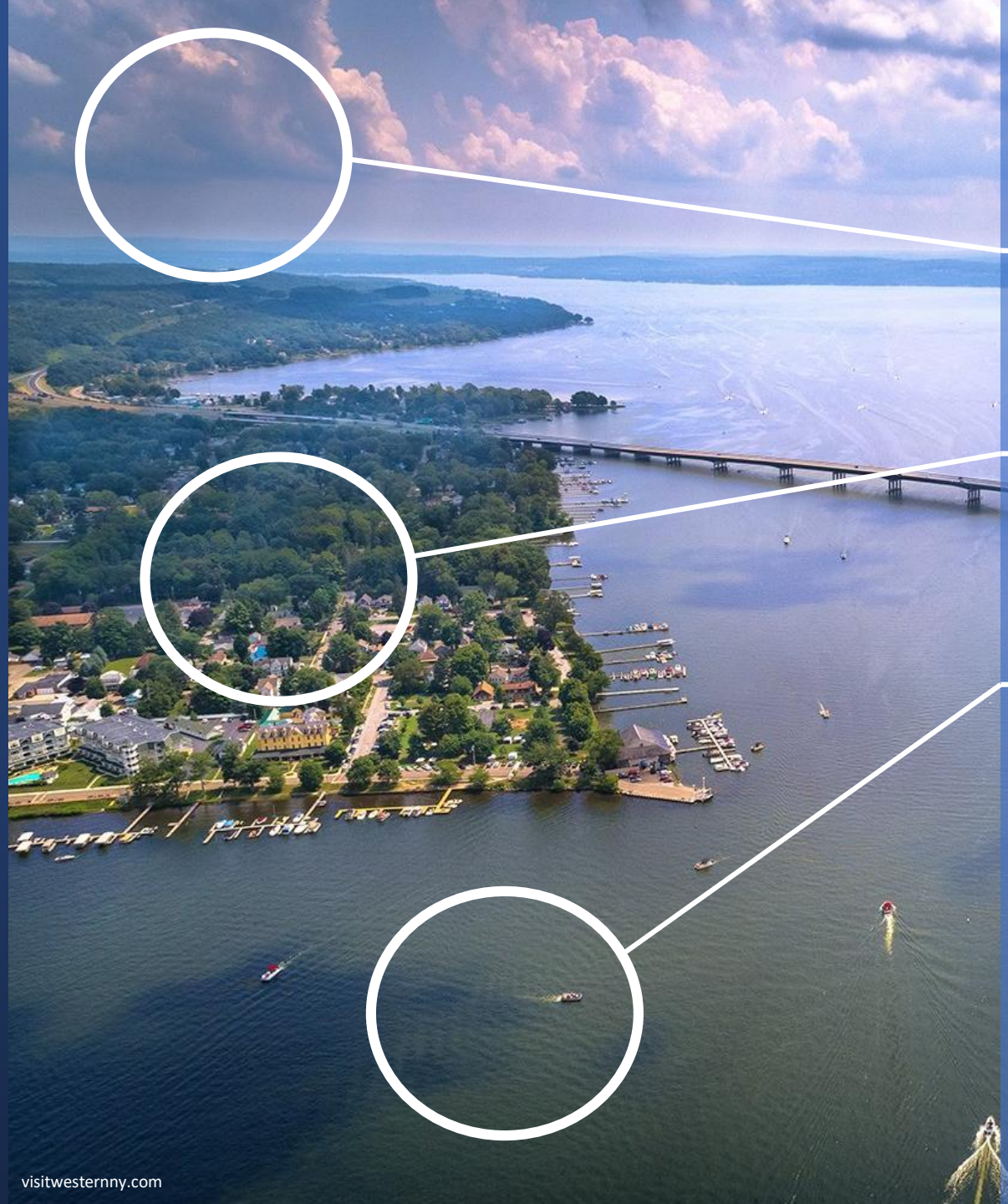


Modeling brings everything together

Weather

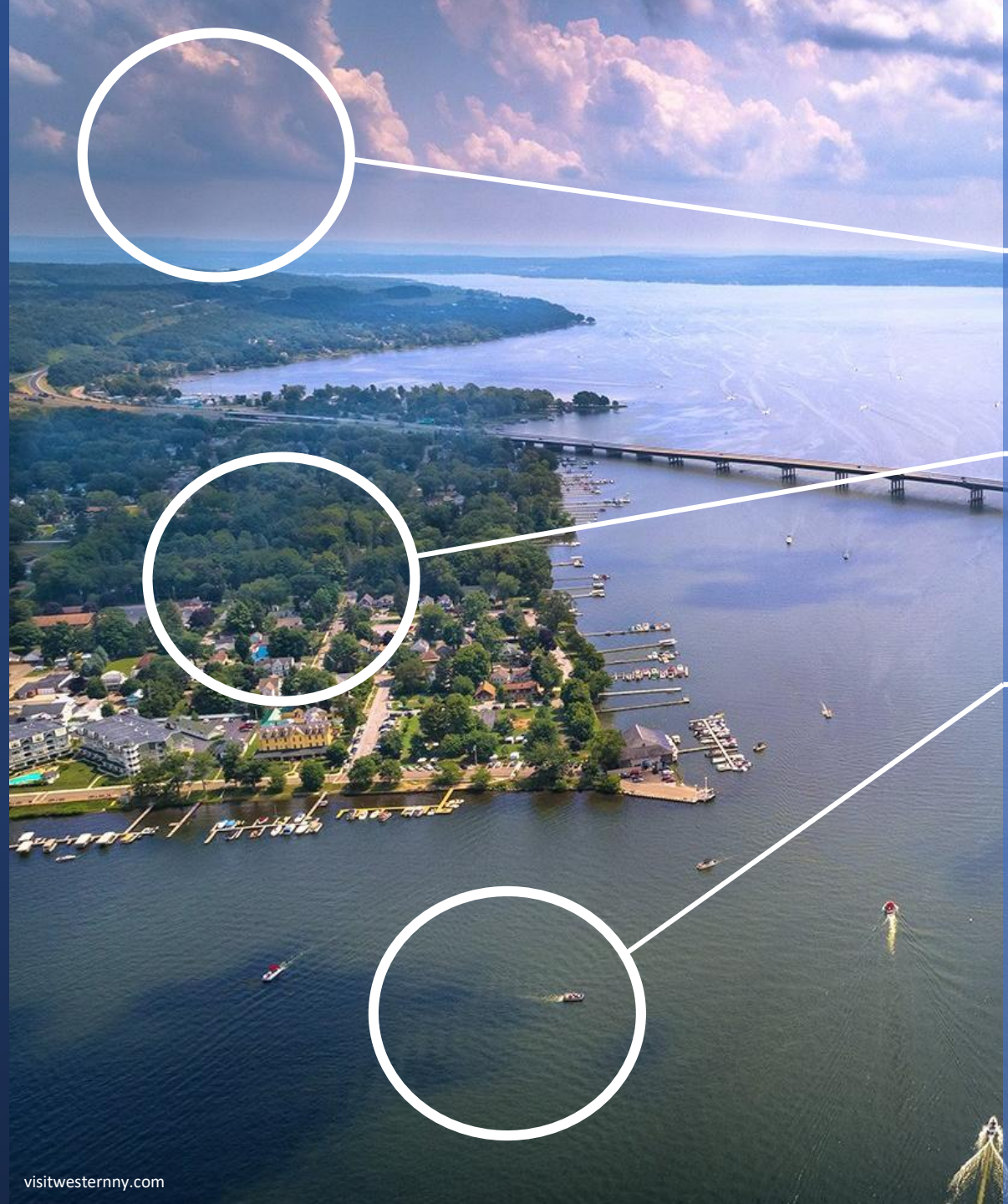
Watershed

Hydrodynamics

Model outputs are used to build a more complete picture of lake processes and health. They can also be used to forecast change over time.

2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- Modeling



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2025

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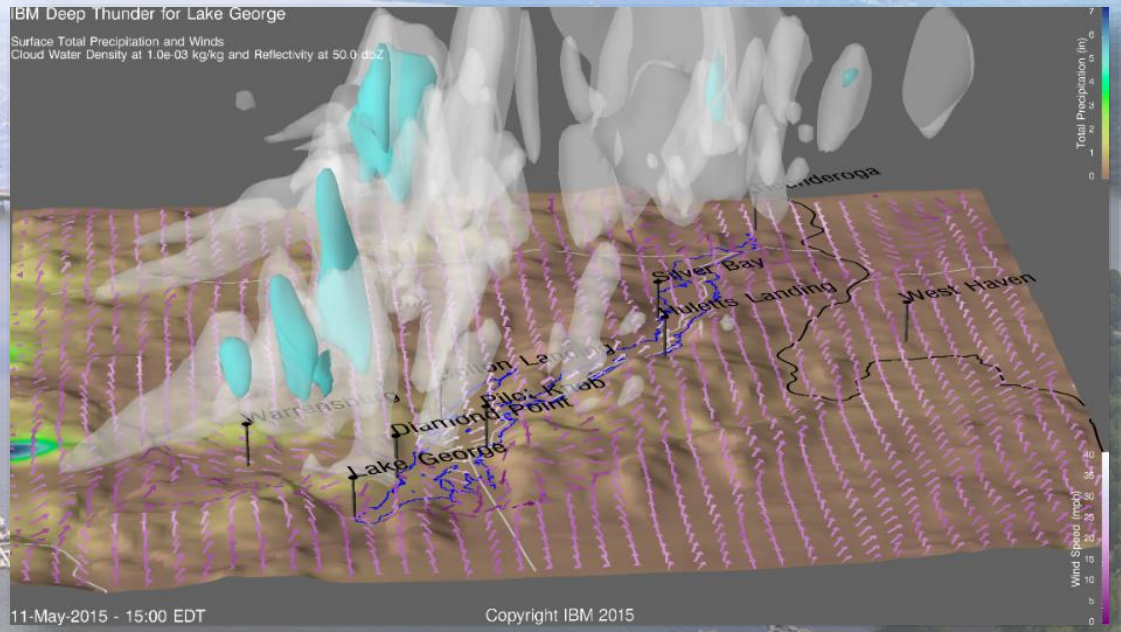
IBM DeepThunder high-resolution weather models

- 1 km grid resolution
- Rainfall and other forecast outputs drive watershed models
- Wind and temperature forecasts drive 3D lake circulation and hydrodynamics models



2025

- Lake Surveys
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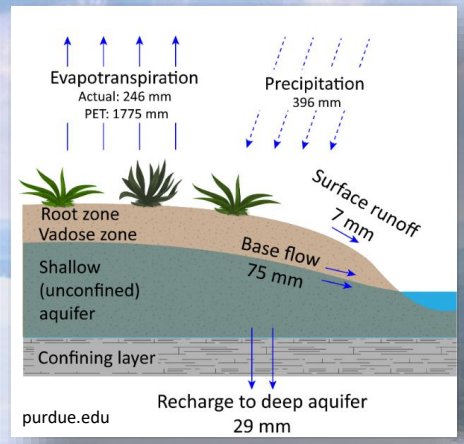
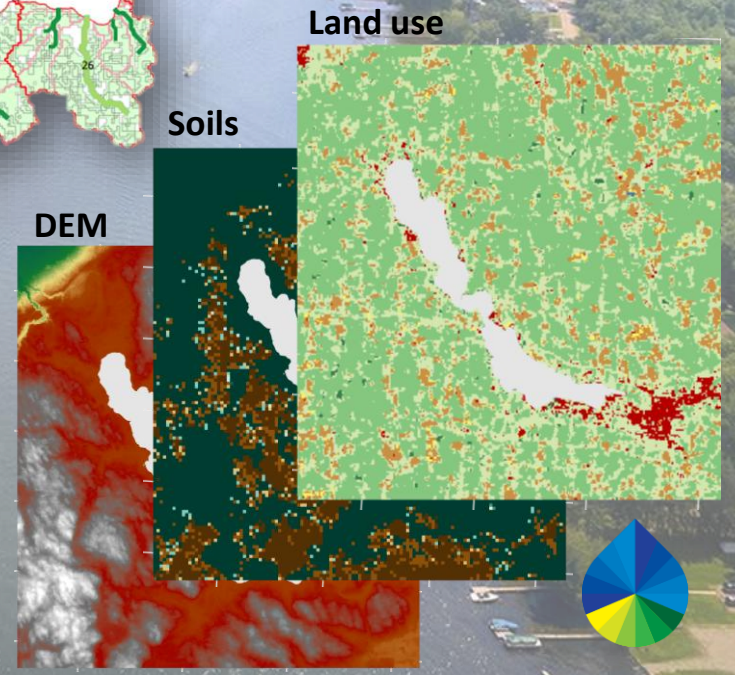
SWAT model for runoff and nutrient loading

- Simulation tool for modeling basin scale hydrologic processes
- Soil, land use, and digital elevation data combined with weather drivers
- Useful for exposing problem areas in a watershed
- Useful for developing time-resolved nutrient budgets and loading estimates





3D Lake Hydrodynamics

2025

- Lake Surveys
- Stream Surveys
- Sensor Network
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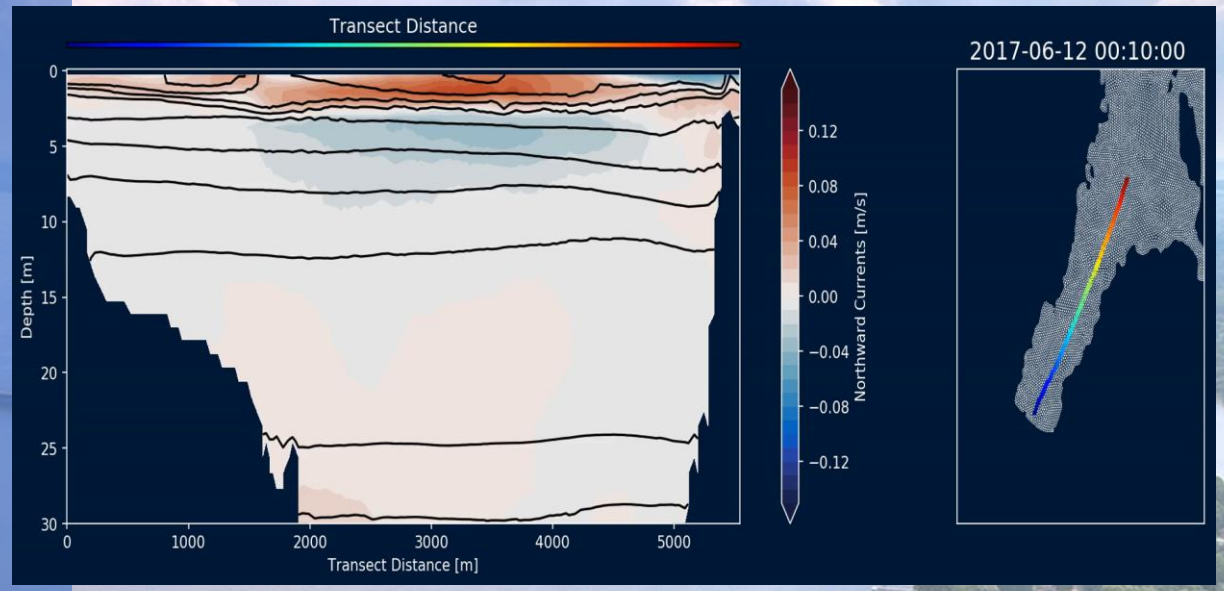
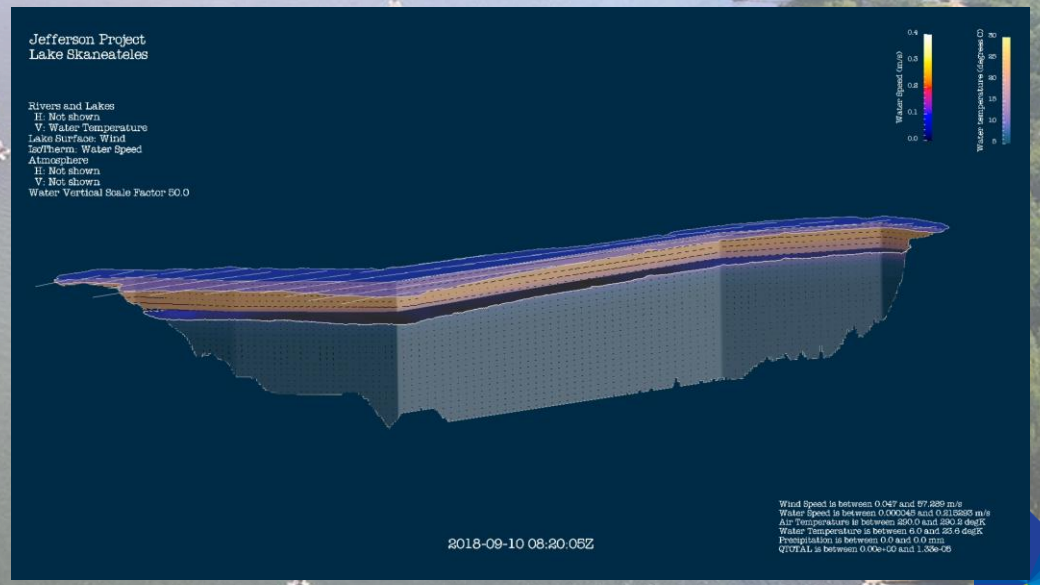
- 3D forecasts of lake circulation, stratification, and more
- Critical for modeling and calculating internal nutrient loading (chemical AND mechanical)
- Inter-basin exchange
  - Internal waves
  - Stream intrusion





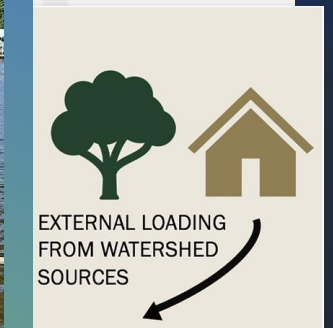
Nutrient Budget

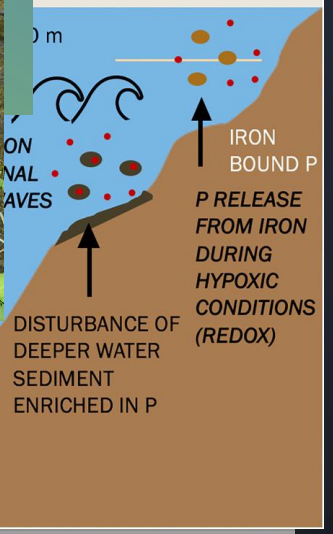
- Focus on Phosphorus
- Water balance is critical
  - Groundwater
- Understanding external nutrient inputs
- Internal nutrient dynamics are extremely complex
- The role of macrophytes

Gw-project.org

How do macrophytes influence the nutrient budget?

- How much N and P are removed during harvesting?
- How does the presence of macrophytes influence bottom shear stress and sediment resuspension?

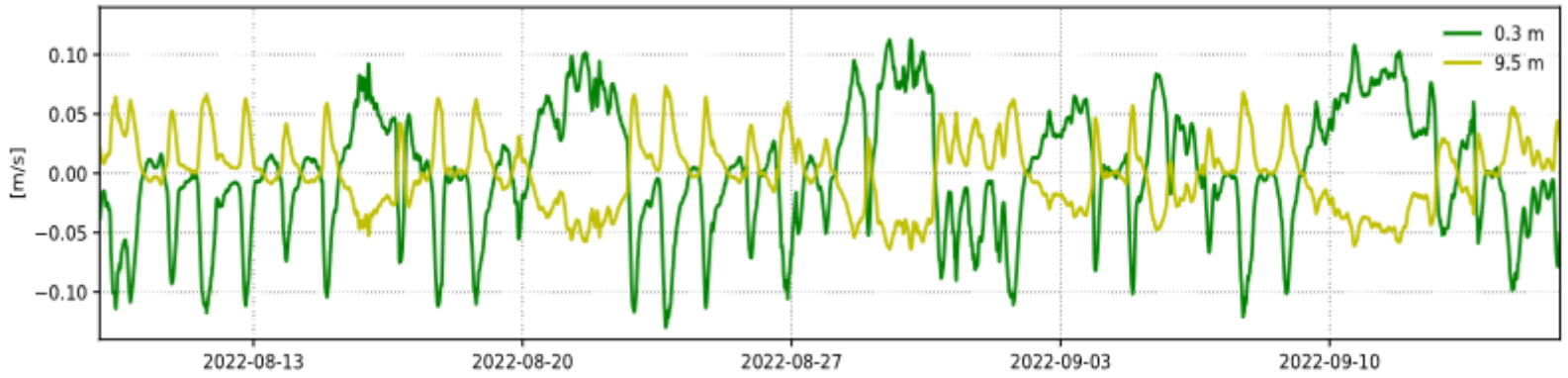


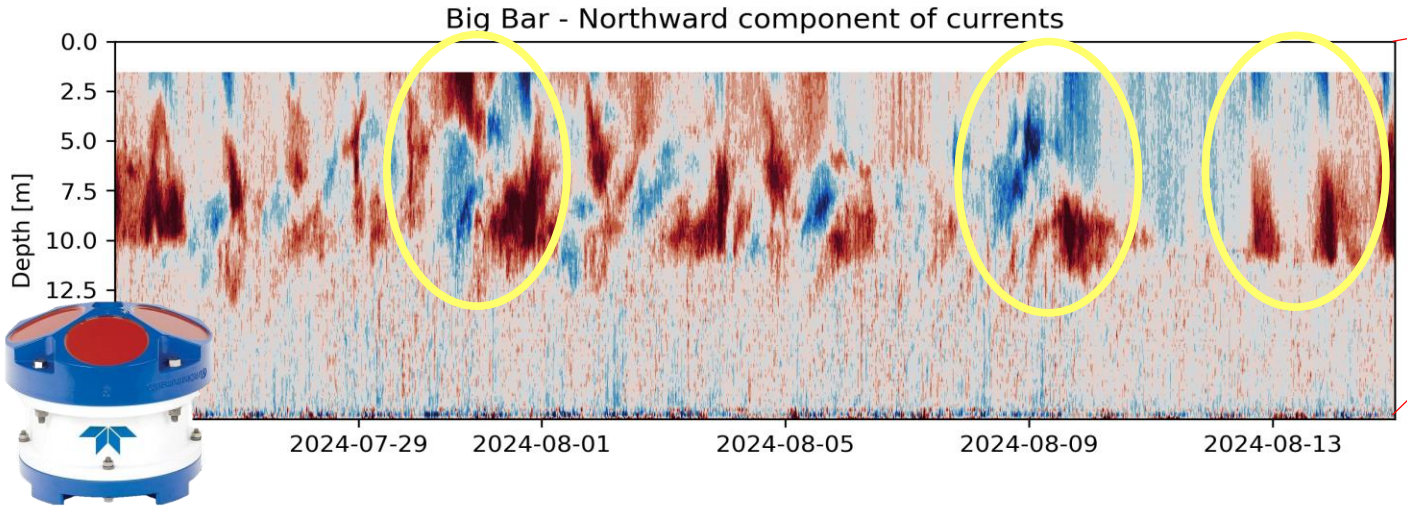


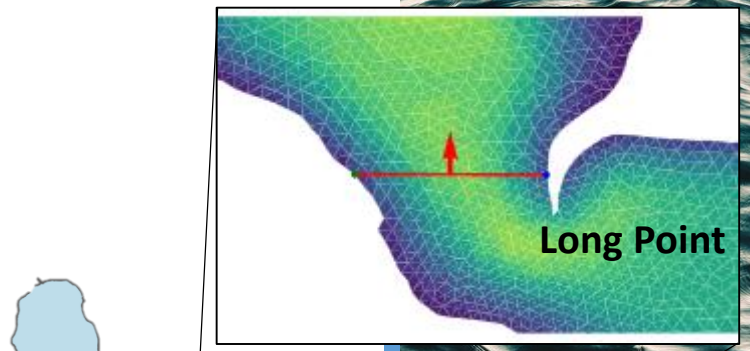
Active Research

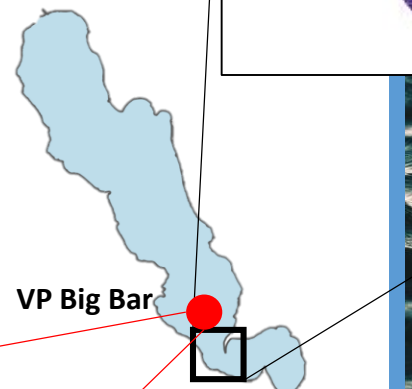
Inter-basin exchange

Can the south basin be supplying the north basin with nutrient pulses or algae?





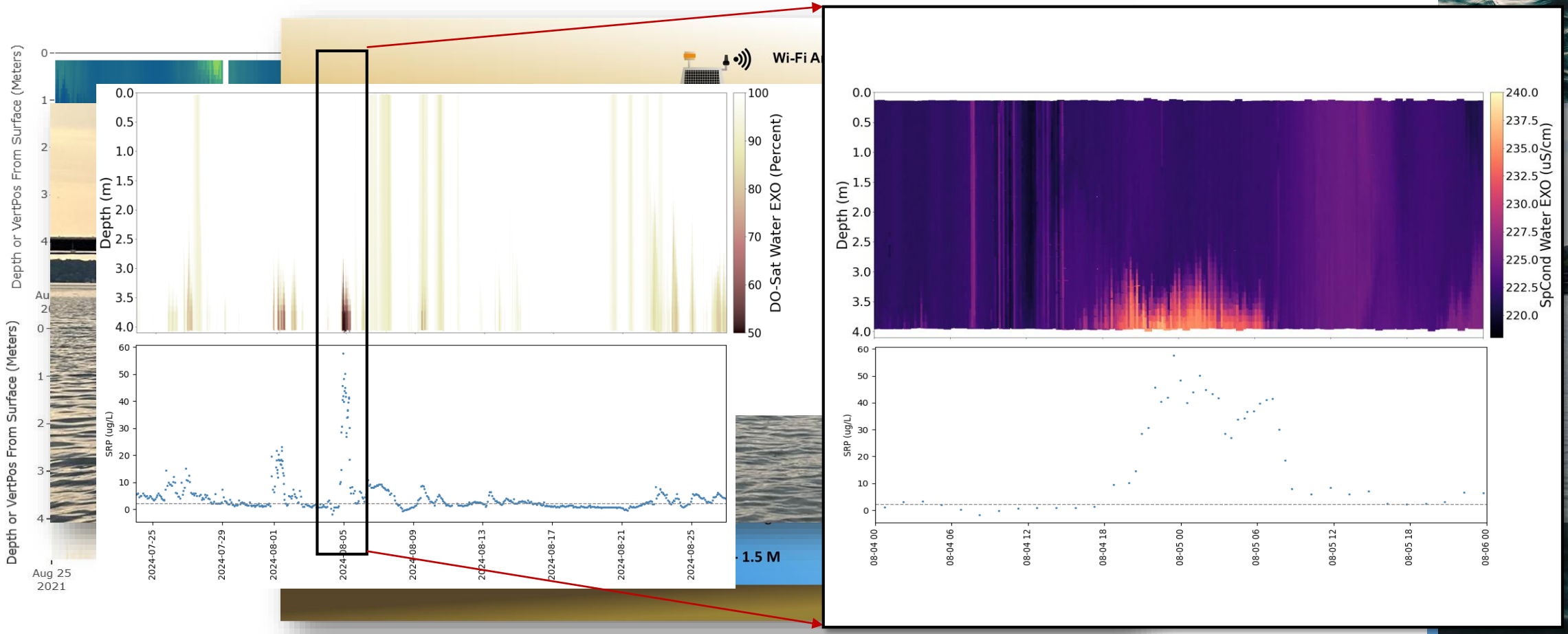




Active Research

South Basin ephemeral stratification

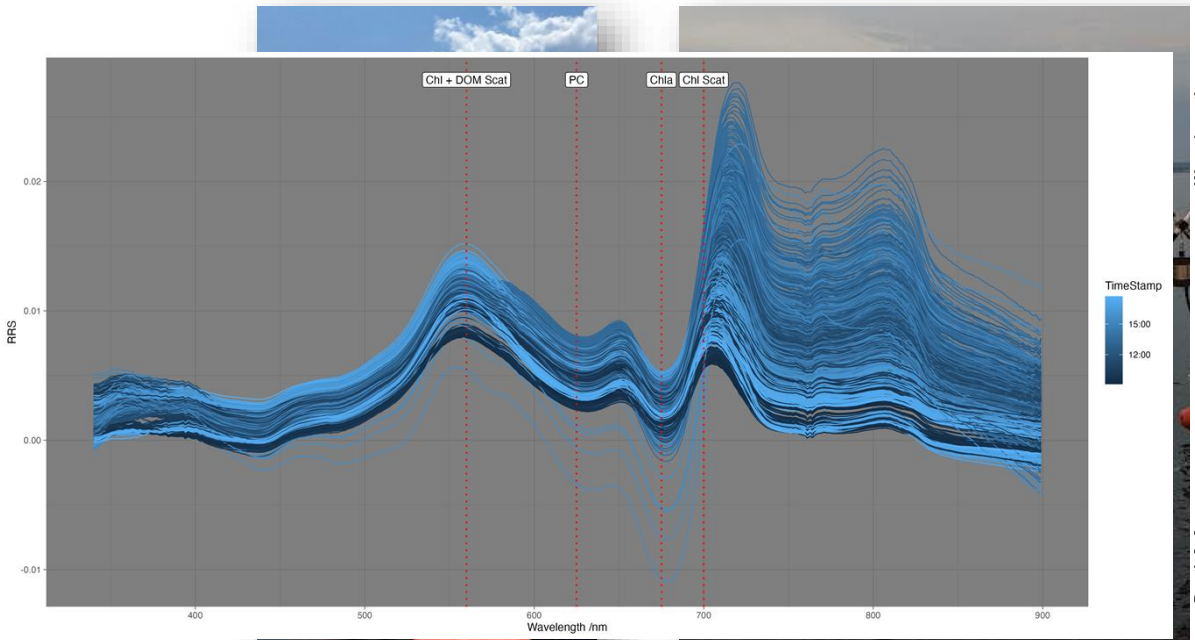
Is ephemeral stratification in the south basin a significant source of phosphorus?

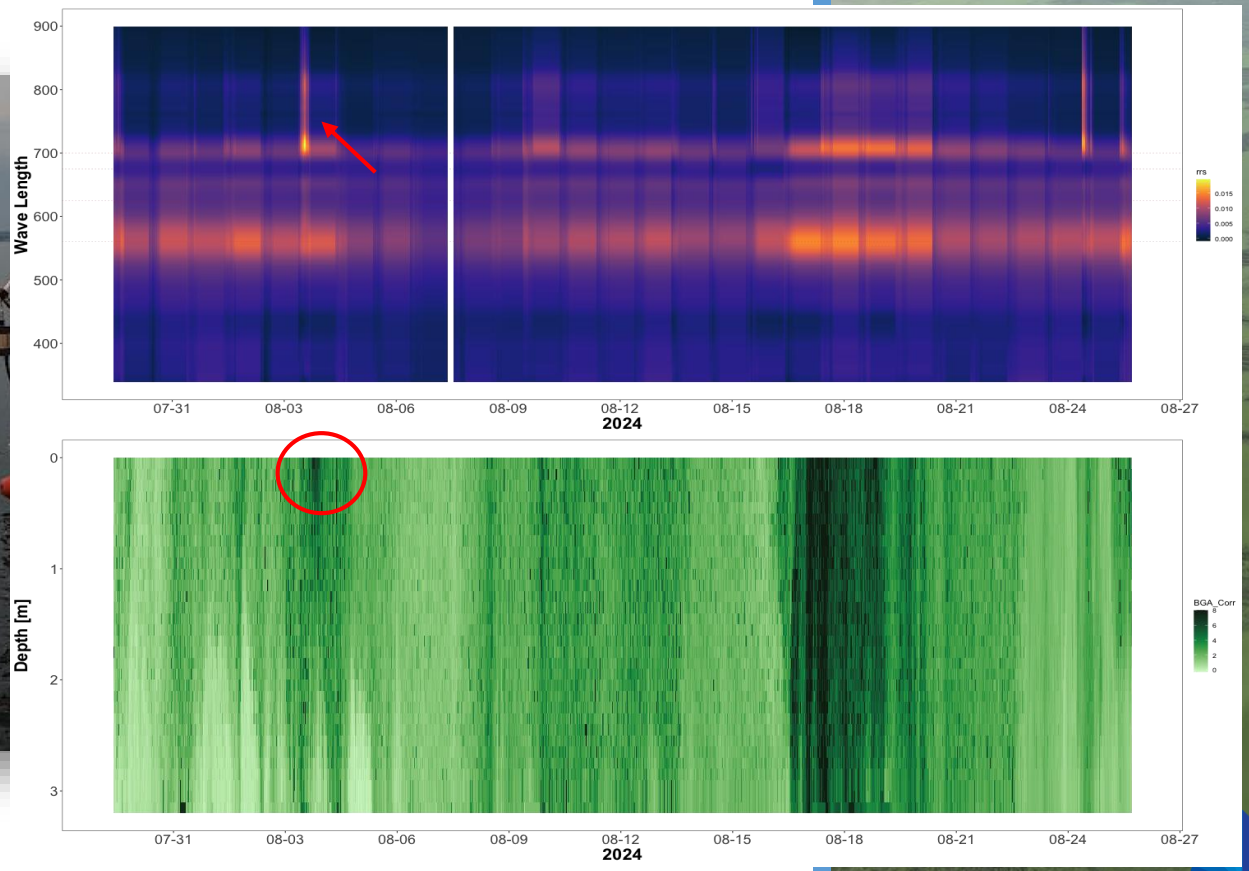


Active Research

Hyper-spectral monitoring of harmful algal blooms

Can we identify hyper-spectral fingerprints in surface reflectance data that serve as leading indicators of Harmful Algal Blooms in the South Basin?

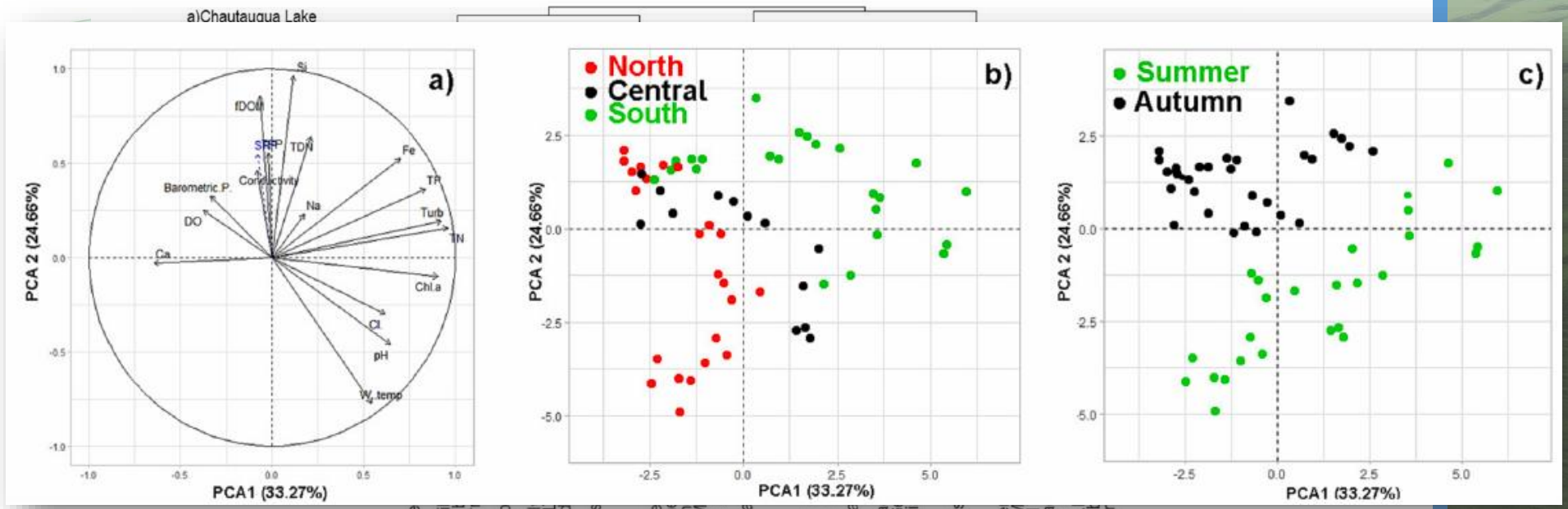




Active Research

Cyanobacteria genomics

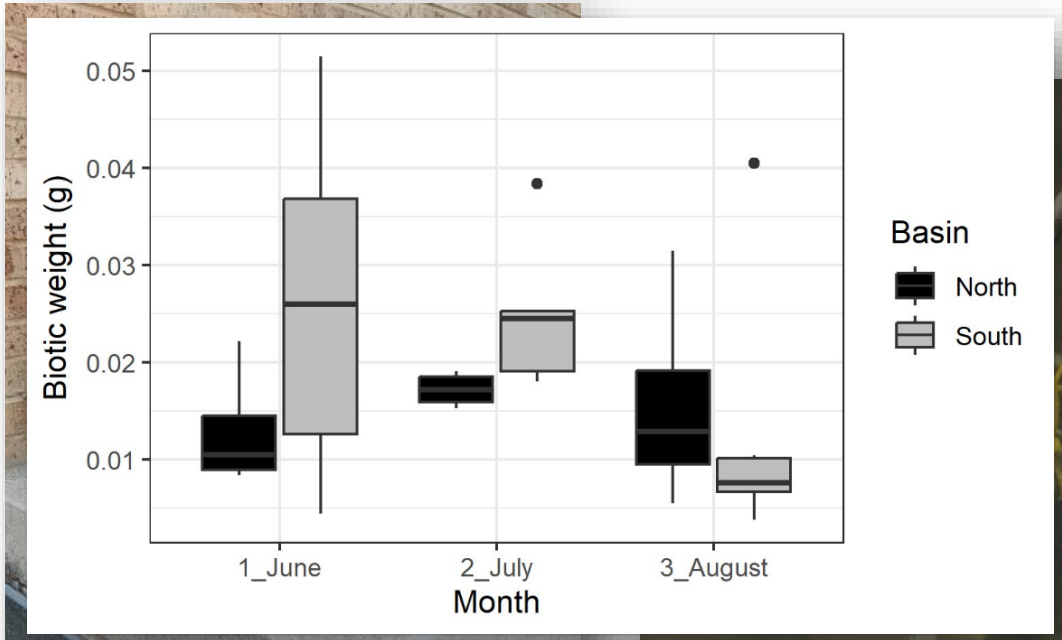
Can we use genetic markers to understand algal dynamics and why cyanobacteria produce toxins?

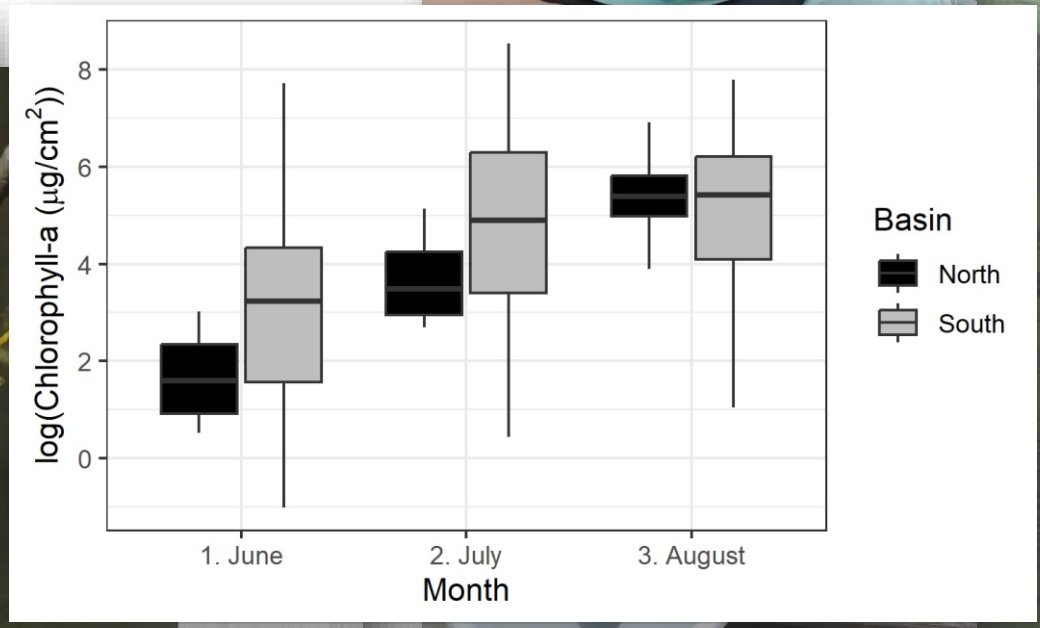


Active Research

Algal Tiles

Do surface water algal blooms influence sediment algal growth patterns?





Conclusion

The Jefferson Project is at the forefront of research efforts at Chautauqua Lake. By the end of the project, our research and monitoring will enable us to identify areas contributing high nutrient inputs to Chautauqua Lake that can to help inform action.

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Acknowledgements

We acknowledge the support of the State of New York to conduct this project.

Funders

NEW YORK STATE Environmental Facilities Corporation

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Ralph C. Sheldon Foundation, Inc.

Collaborators

BGSU

Chautauqua Lake Partnership

Fredonia State University of New York

Chautauqua Lake & Watershed Management Alliance

US Army Corps of Engineers®

Chautauqua Lake Association

Chautauqua County State of New York

SMU

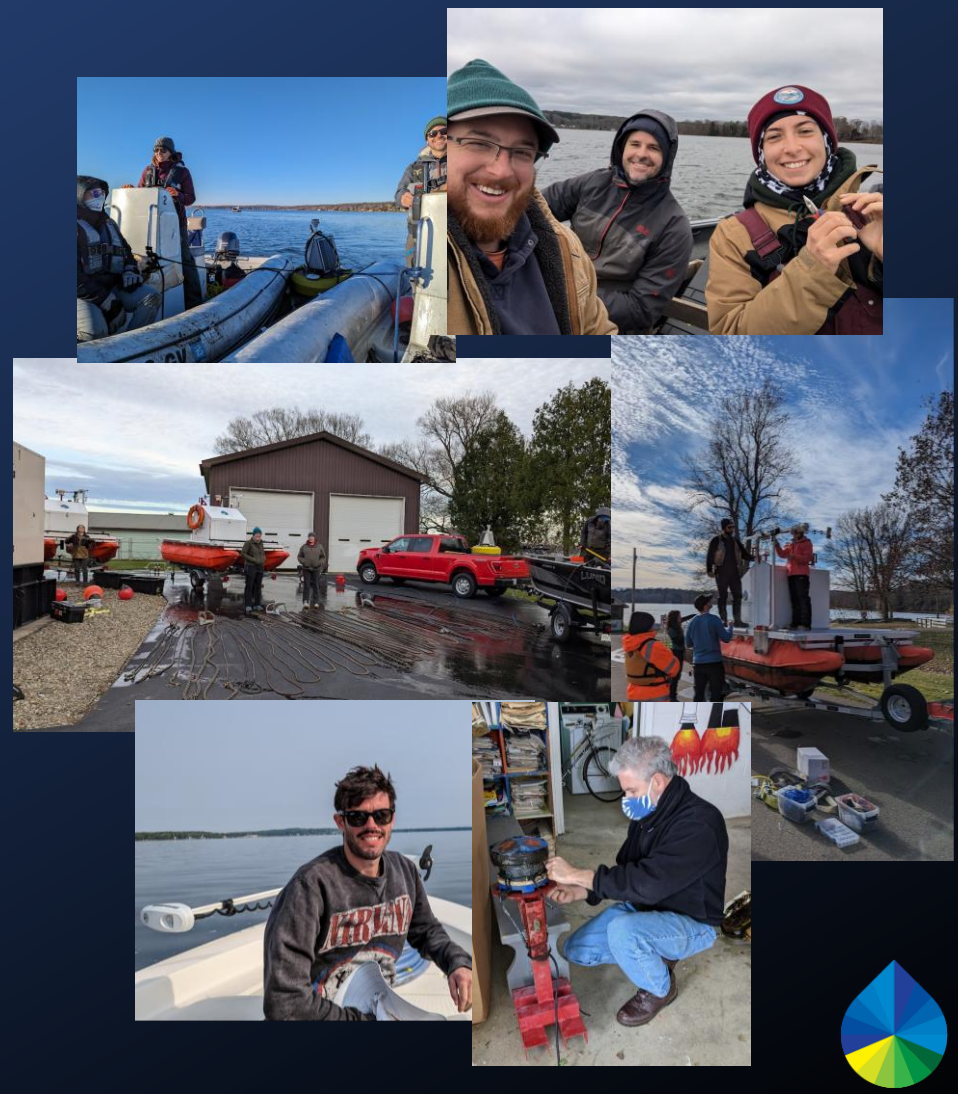
PML Plymouth Marine Laboratory

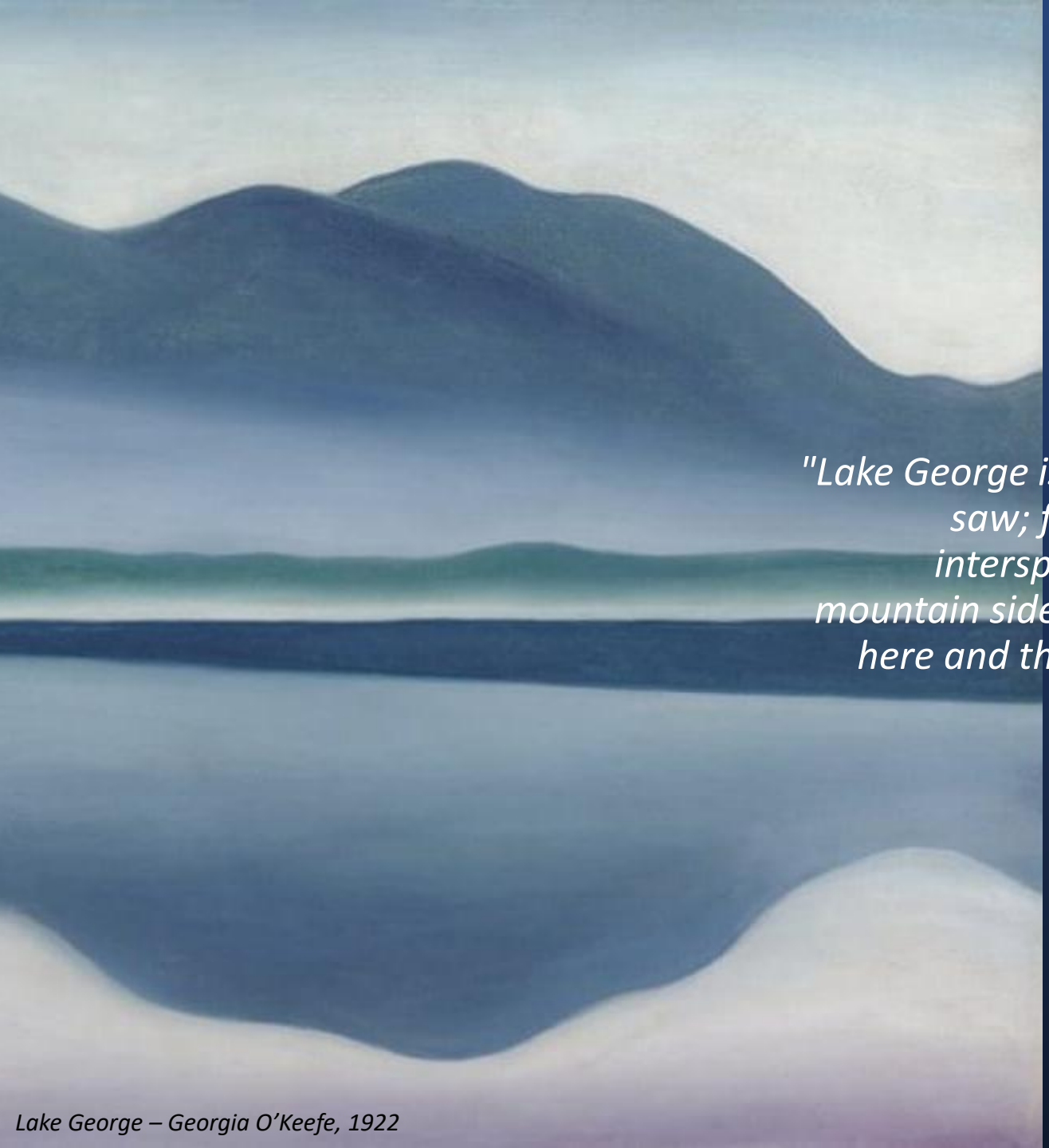
UAlbany

Duquesne University

Chautauqua Watershed Conservancy

Questions?





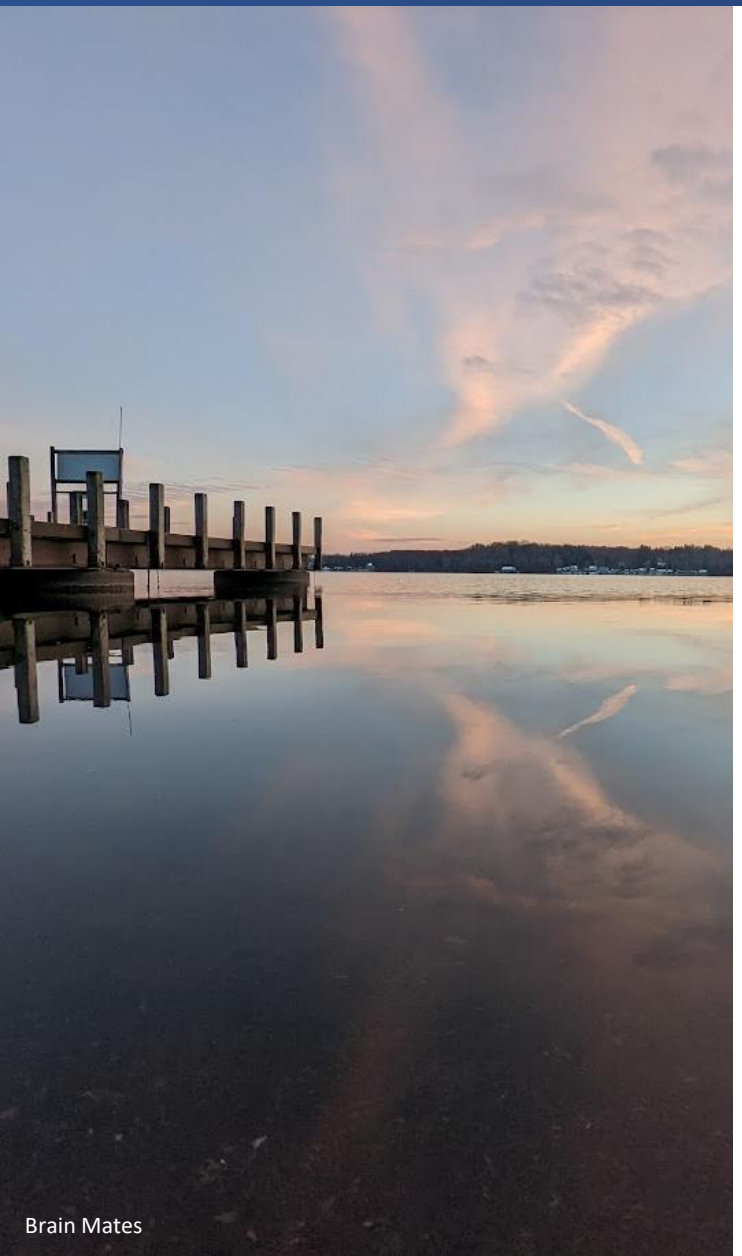
Lake George – Georgia O'Keefe, 1922

The Jefferson Project

"Lake George is without comparison, the most beautiful water I ever saw; formed by a contour of mountains into a basin... finely interspersed with islands, its water limpid as crystal, and the mountain sides covered with rich groves... down to the water-edge: here and there precipices of rock to checker the scene and save it from monotony."

-- Thomas Jefferson, May 31, 1791

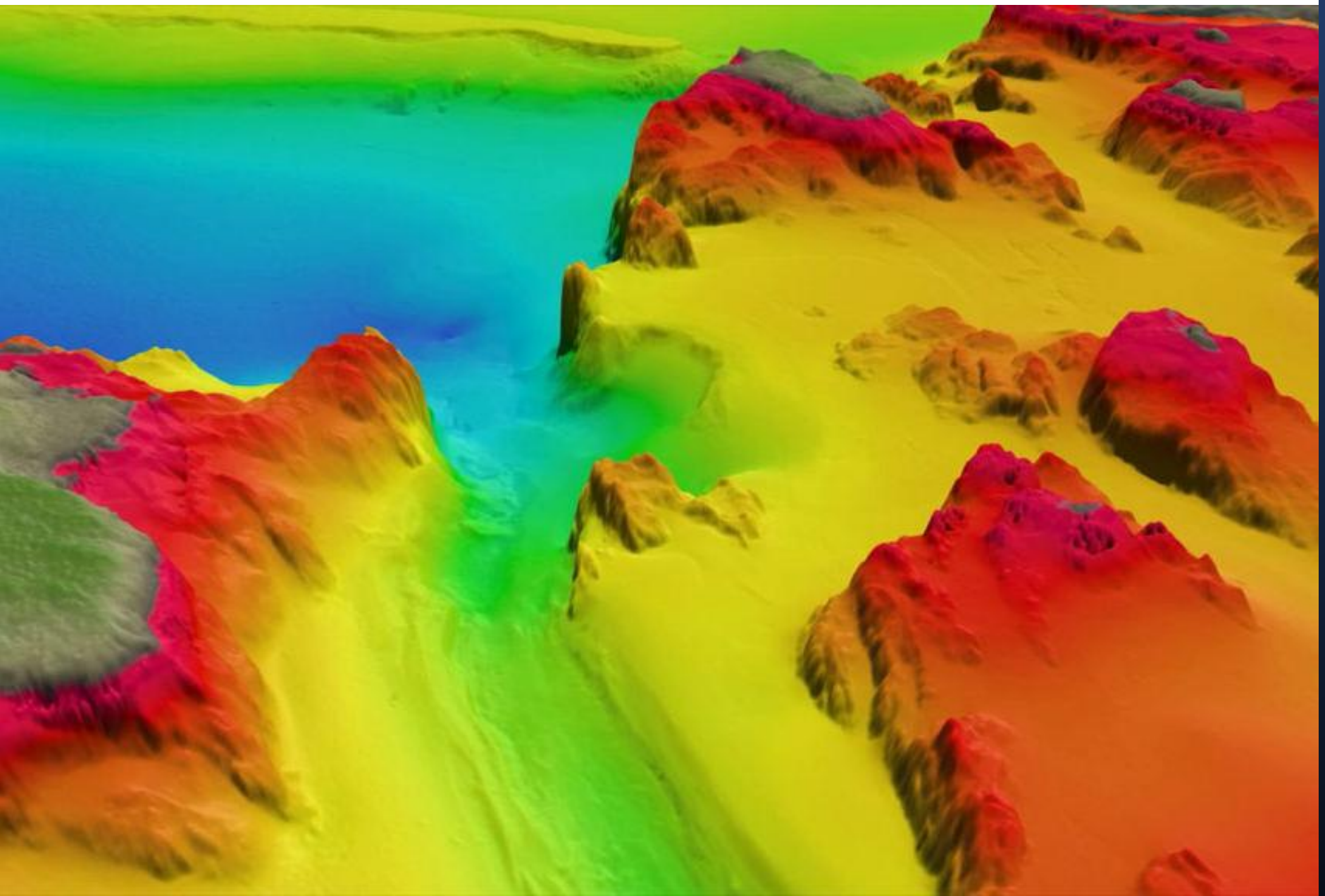
2025 Goals



Brain Mates

- Develop a high-resolution nutrient budget for Chautauqua Lake
- Identify areas for remediation and potential pilot projects
- Tributary station improvements
- Weather station builds
- Model spin up

Collecting higher resolution bathymetric data



Supporting activities

- Improved hypsographic curves
- Improved hydrodynamic model outputs

High-frequency nutrient sensors

Supporting activities

- Targeted research + model validation + nutrient budgeting efforts
- High-frequency nutrient data impossible to get with traditional field sampling