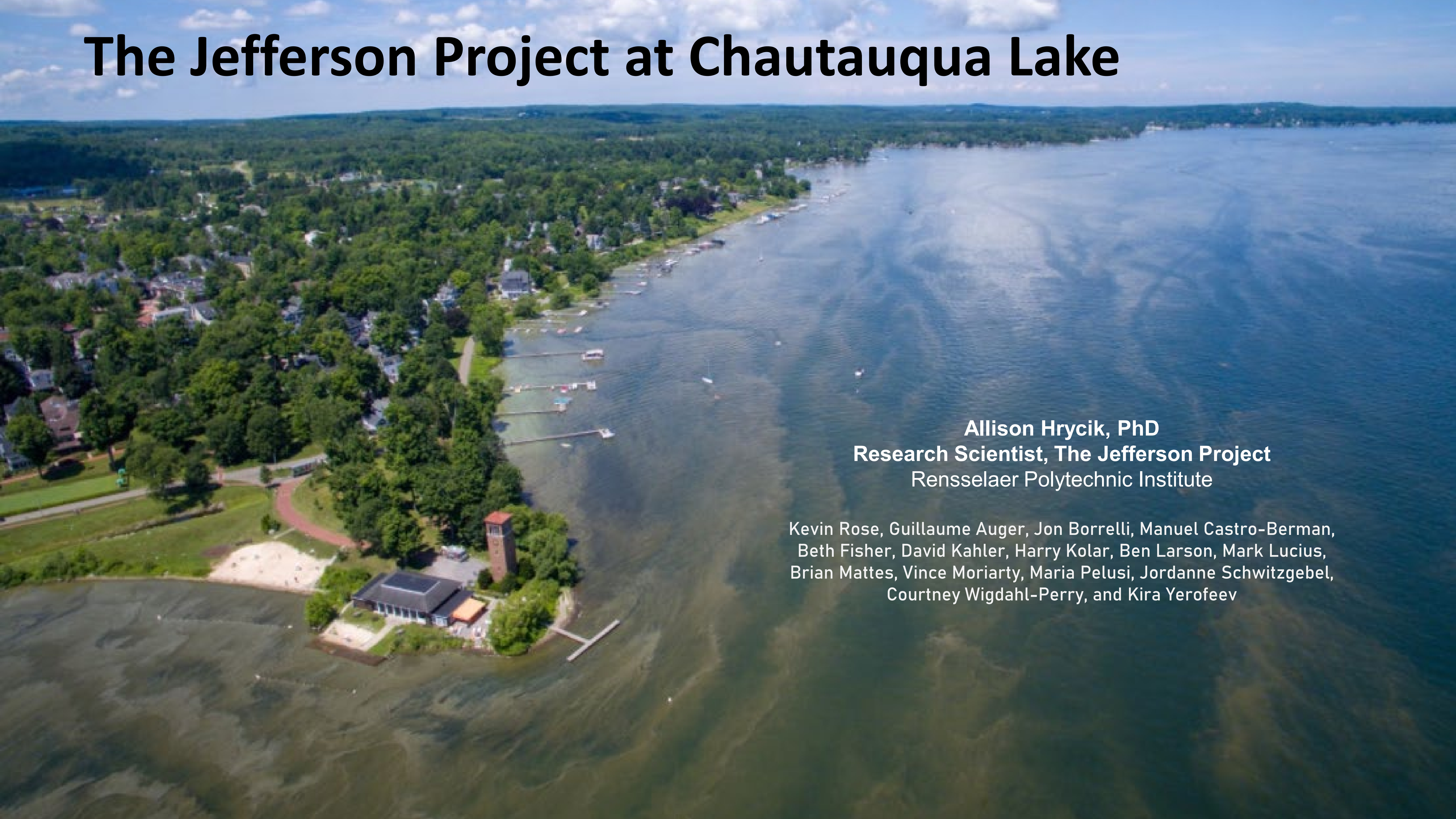
The Jefferson Project at Chautauqua Lake



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The Jefferson Project at Chautauqua Lake

Collaboration between Rensselaer Polytechnic Institute and IBM Research

- Launched in 2013 on Lake George with the Lake George Association
- Started on Chautauqua Lake in 2020 with Chautauqua Institution
- Team of scientists with diverse specialties

A central goal of the Project is to understand the impact of human activity on fresh water and how to mitigate those effects

Chautauqua Lake

Pilot research 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 is the first year of complete open-water data collection and research.

Tributary monitoring stations were established in 2024, with improvements in 2025.

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

Expanding partnerships will allow for greater research collaboration, insights and forecasting to support optimized management efforts.

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) and mitigate excess nutrients. Findings will be used to help guide management and remediation of Chautauqua Lake.

Chautauqua Lake

Top Management Challenges

- Eutrophic conditions: frequent harmful algal blooms with the potential to produce toxins
- Invasive macrophytes: harvesting and herbicide applications to control plants
- Lake is a drinking water source & major recreational site

2025-2026 Priorities and Goals

- Developing a high-resolution nutrient budget
- Identify areas of high nutrient loading throughout the watershed
- Tributary station improvements
- Weather station deployments
- High-resolution modeling
- Conduct HABs forecasting

Where do we stand & what do we need?

- **Some management methods are not effective.** Pilot nutrient mitigation projects need to be researched, developed, tested, and scaled.
- **Many mitigation efforts have been poorly monitored**. Time spent to refine the monitoring program can be vital, allowing identification of state and trends from mitigation actions.
- **Resource optimization is essential.** Where do we get the biggest bang for the buck?
- **Often, mitigation decisions are based on legacy data;** AI, modelling and forward projections based on climate change are required: we need to develop resilience - maintenance will not get us there.
- **Collaboration & coordination** among stakeholders, policymakers is essential.

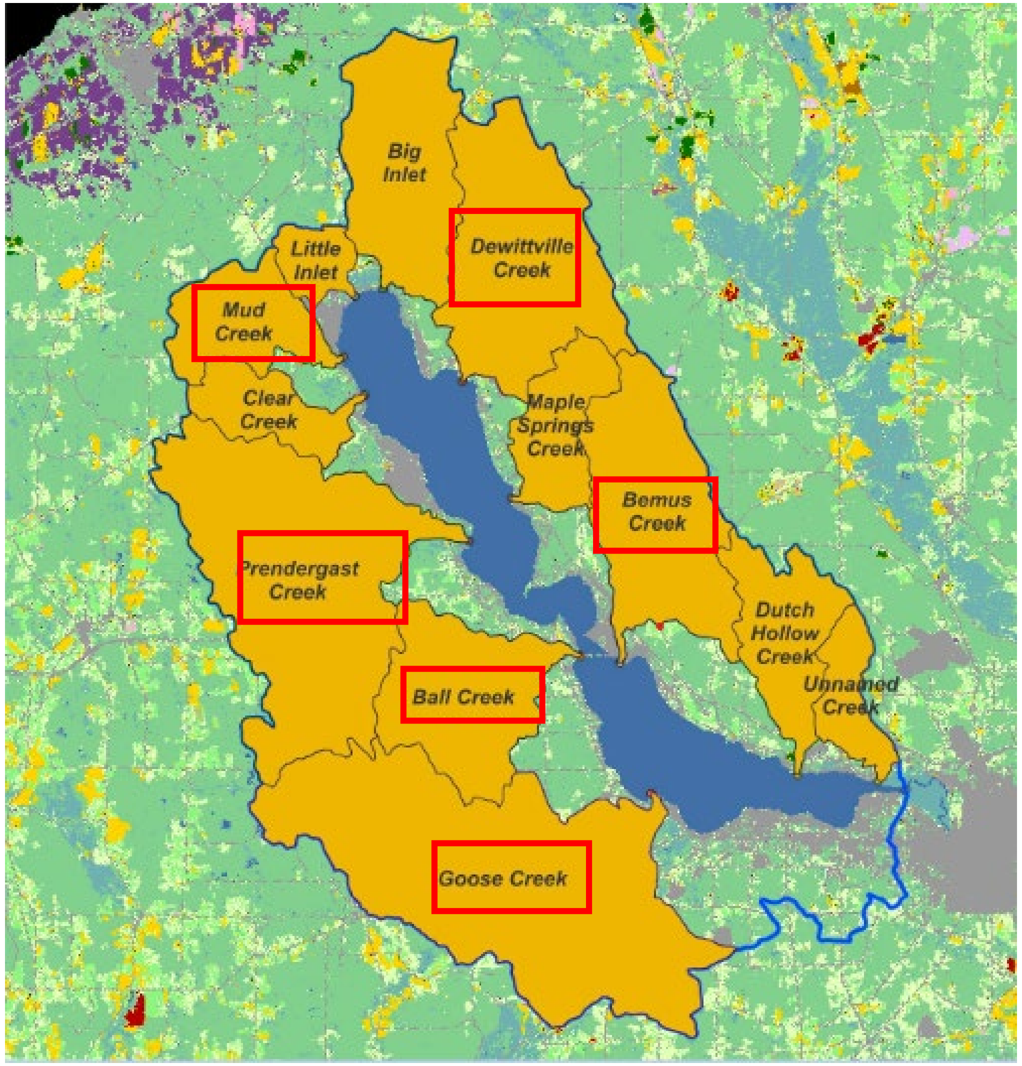
2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- Modeling

- **Frequency:** Every two weeks
- **Spatial coverage:** 14 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
- Stream Surveys
- Sensor Network
- Modeling



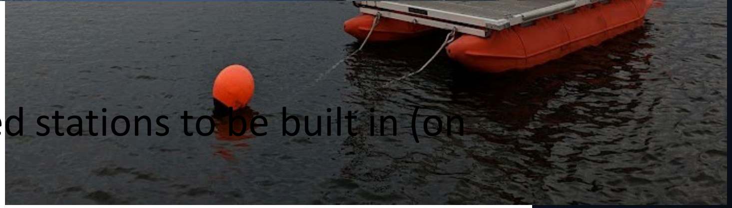
- Six tributaries to be surveyed + Chadakoin
- Baseflow sampling
- Storm event sampling
- Stream gaging
- Paired with high-frequency sensor data
- Model validation

2025

- Lake Surveys
- Stream Surveys
- **Sensor Network**
- Modeling

Vertical Profilers

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



Tributary Stations

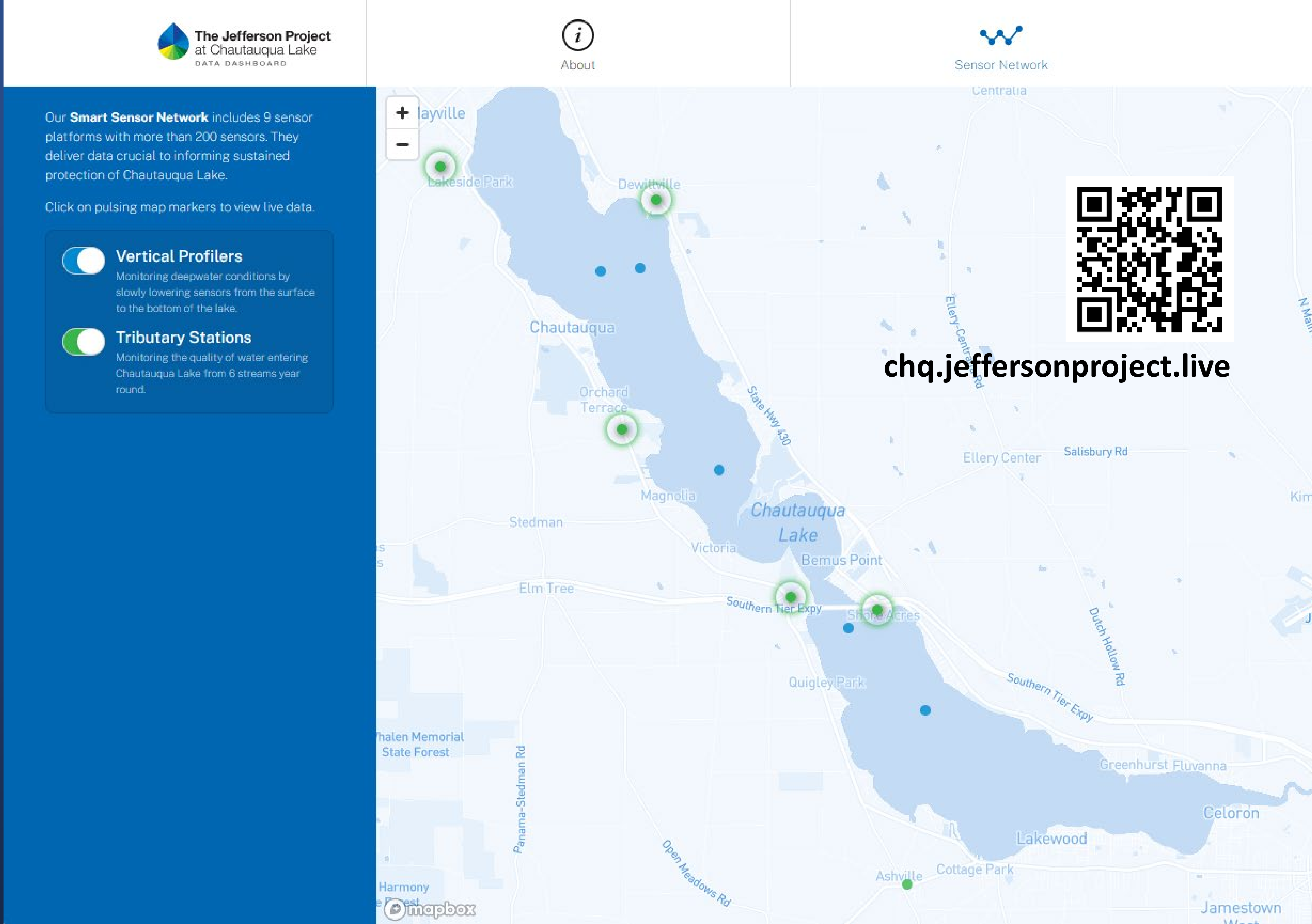
- Custom built for high-frequency data collection
- Water quality and quantity
- Automated samplers
- Winter flow-cell systems
- Expandable

Weather stations

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

2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- Modeling



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2025

- Lake Surveys
- Stream Surveys
- Sensor Network
- **Modeling**

Modeling brings everything together

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

Modeling brings everything together

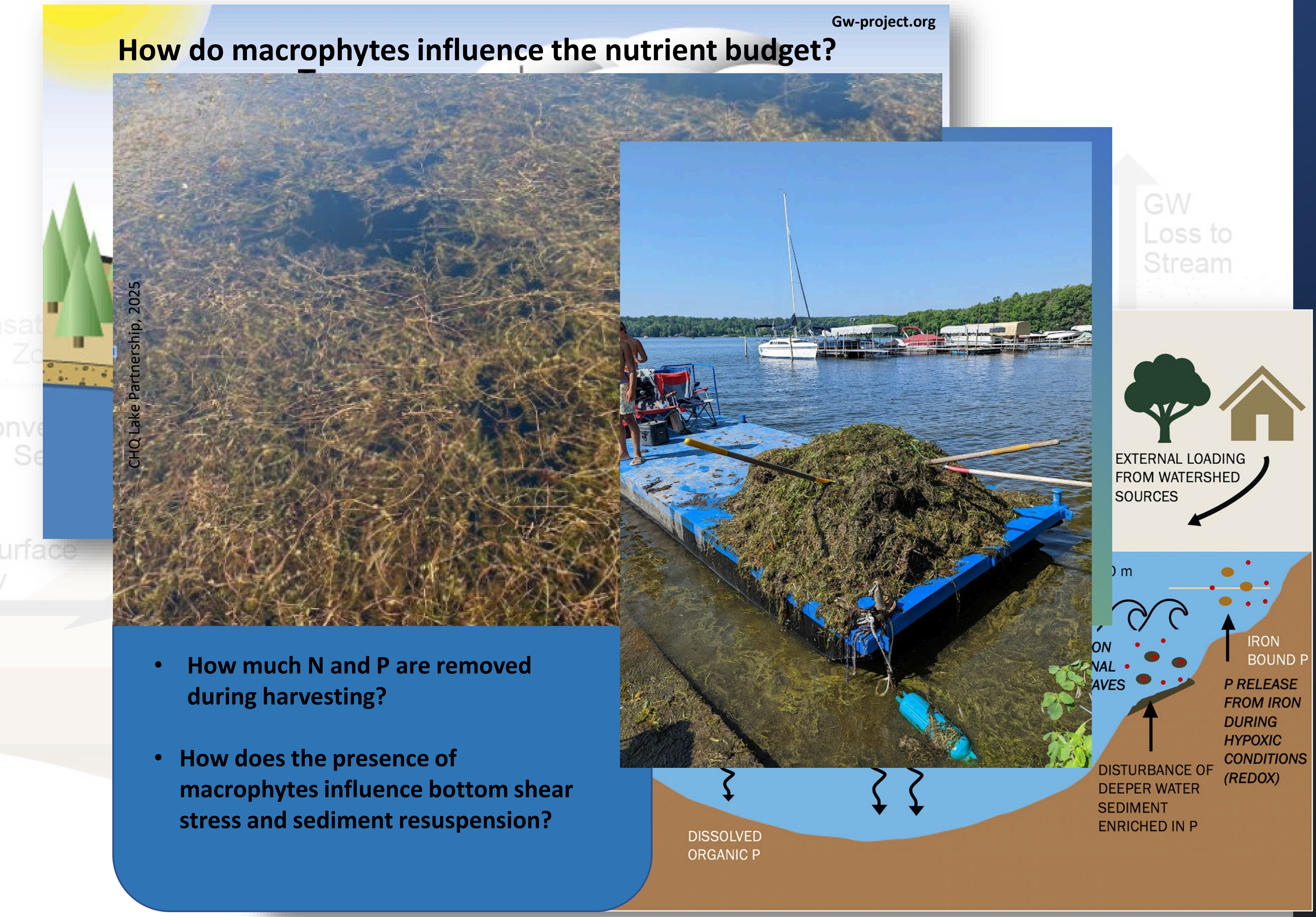
Weather

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.

Active research and preliminary results



Nutrient Budget

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

ENVIRONMENT

Chautauqua Lake weeds tangling relations th

CHAUTAUQUA COUNTY

'Absolute nightmare': Chautauqua Lake homeowners voice concerns over weeds

Weed Growth In Chautauqua Lake Southern Basin Increasing Concern

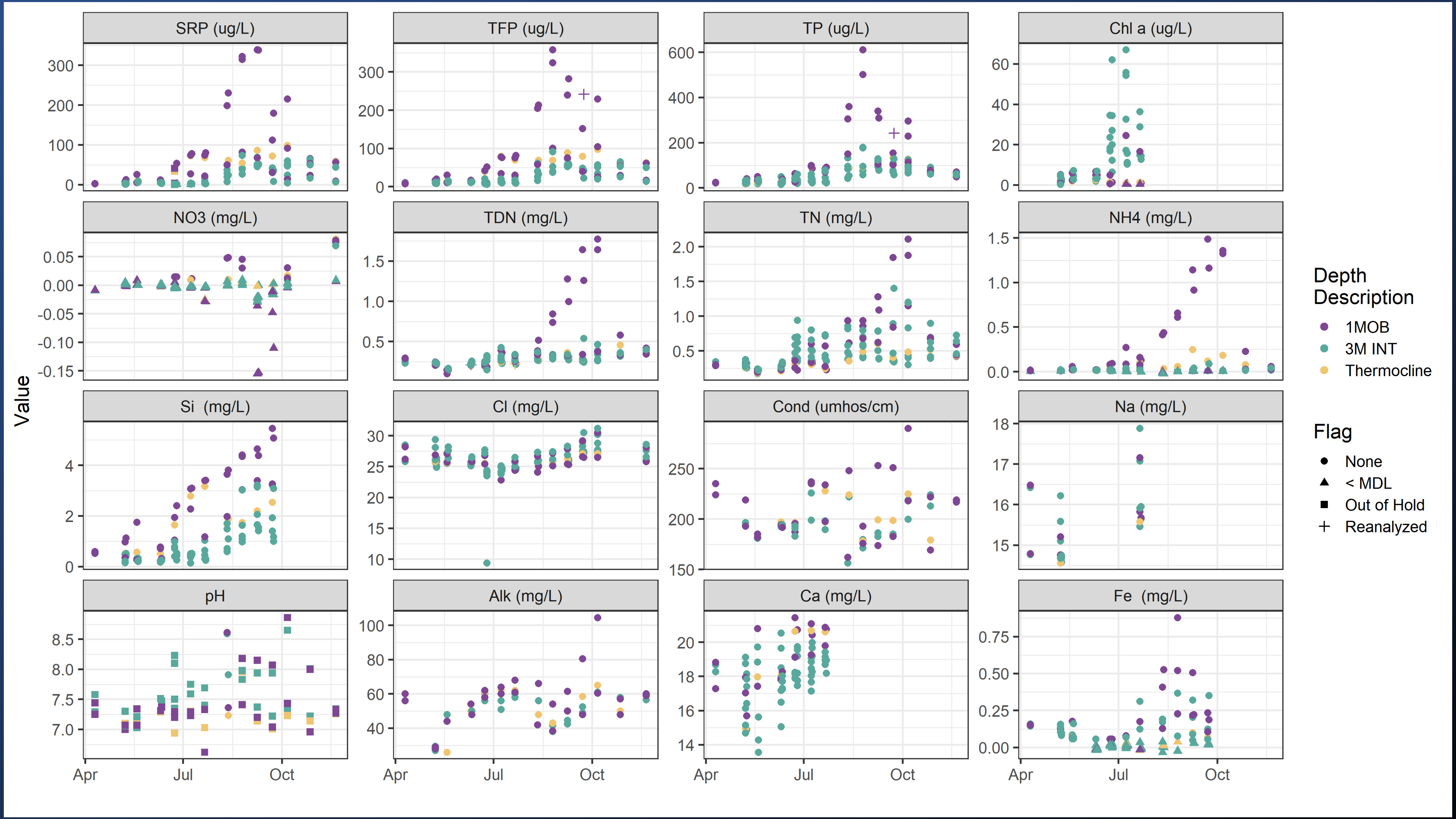
LOCAL/REGION

AUG 2, 2025

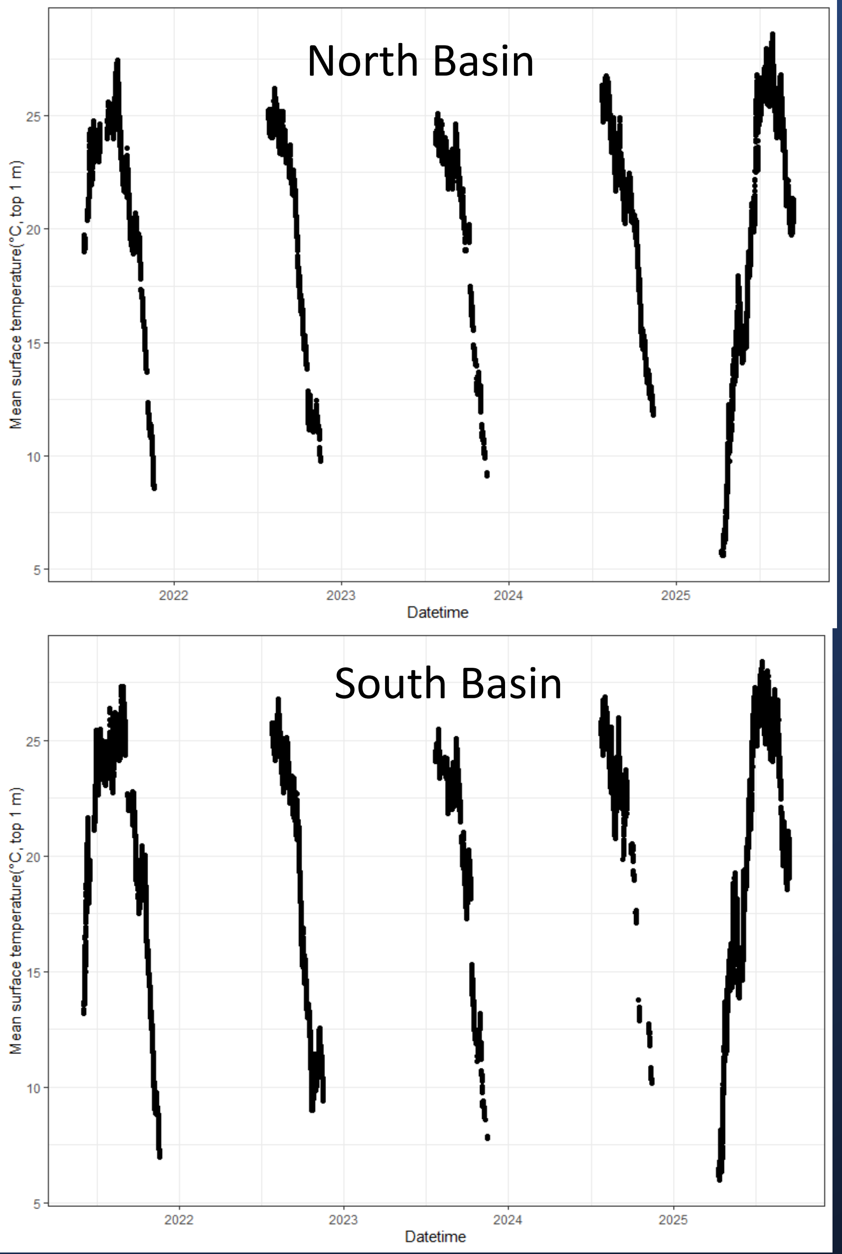
Possible explanations for excessive macrophytes

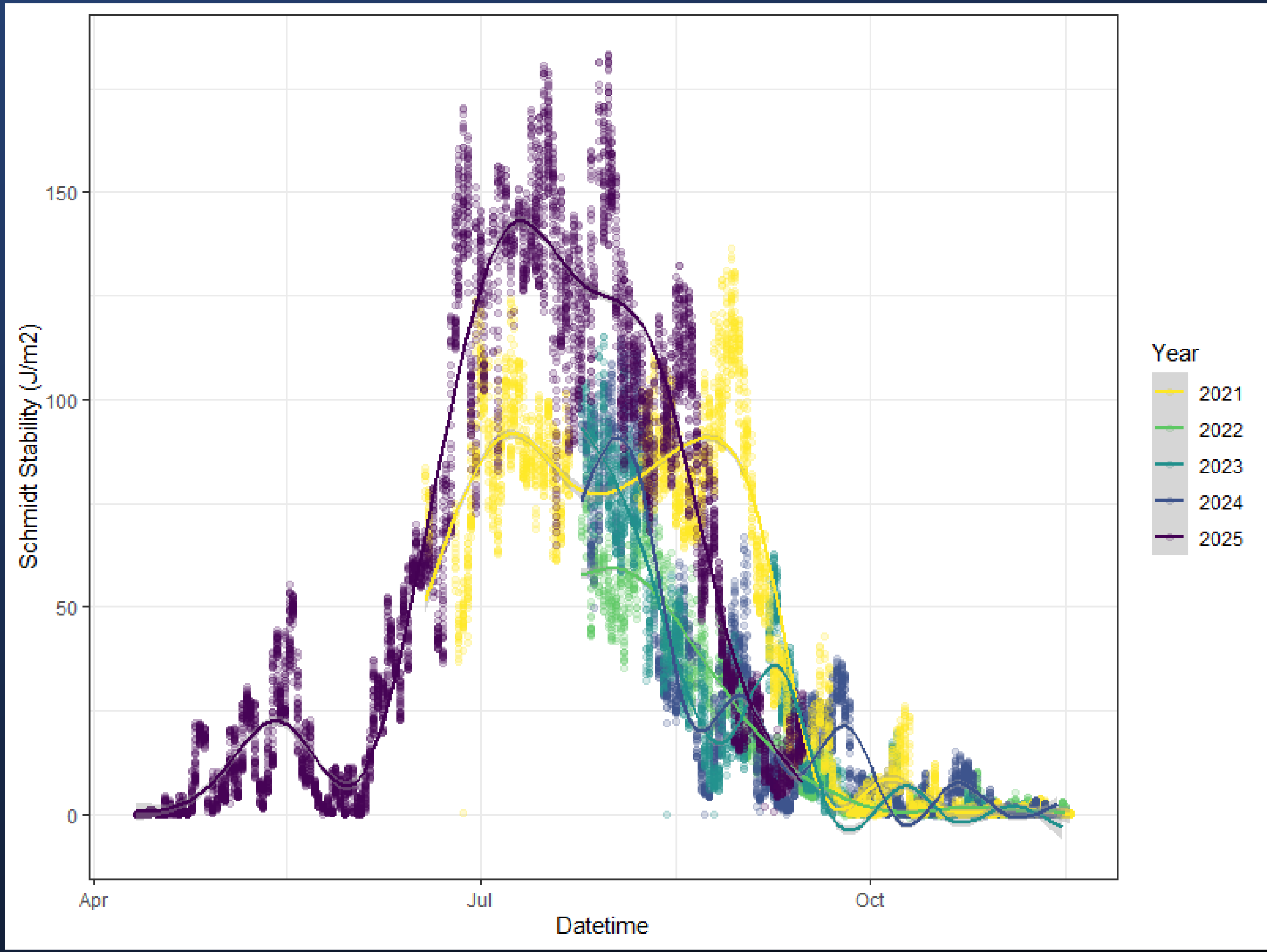
- Biocontrols
- Management
- Water temperature
- Nutrients

In-lake nutrients are in similar ranges to previous years

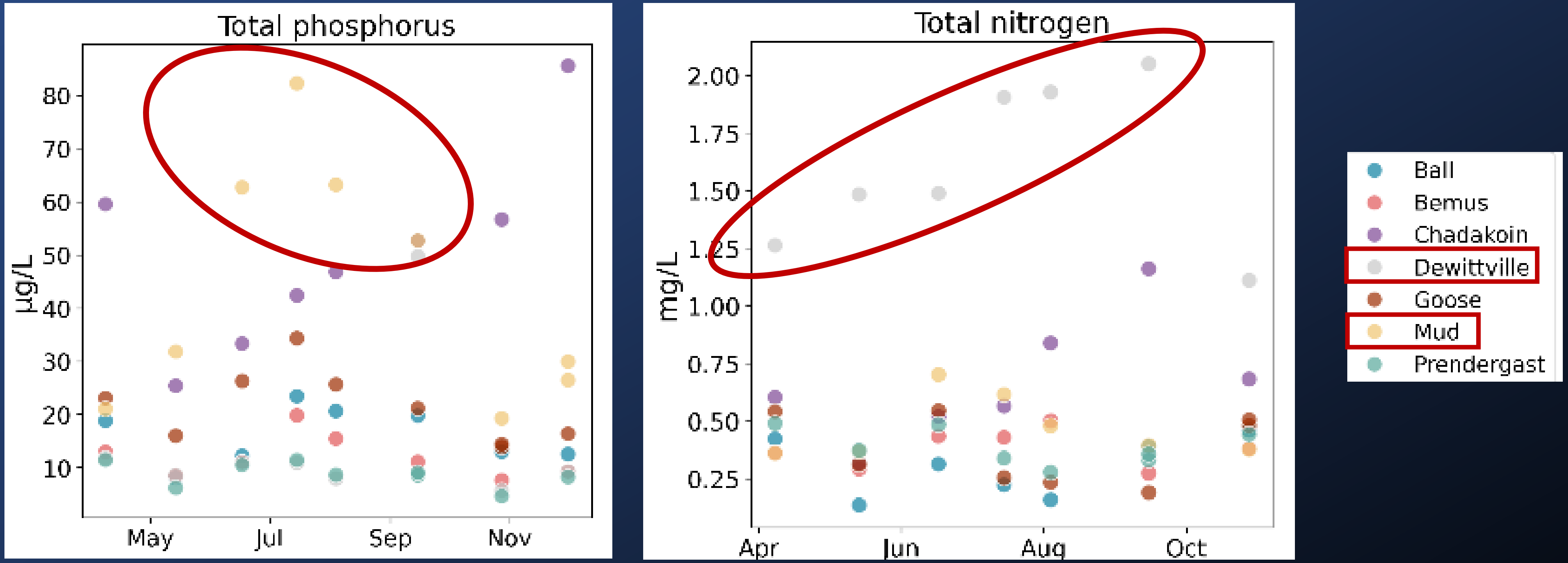


Water was warmer and more strongly stratified this year than in previous years

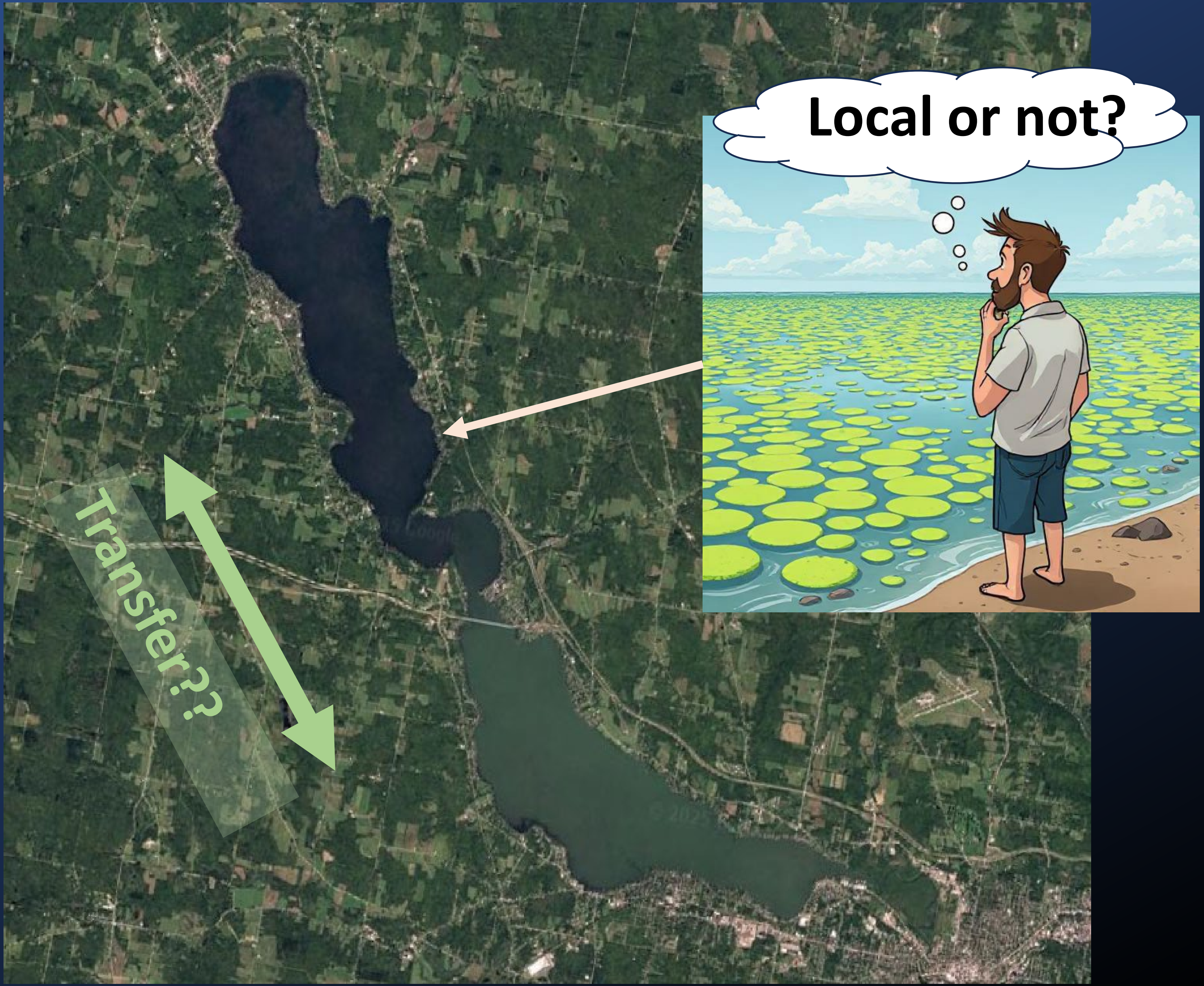




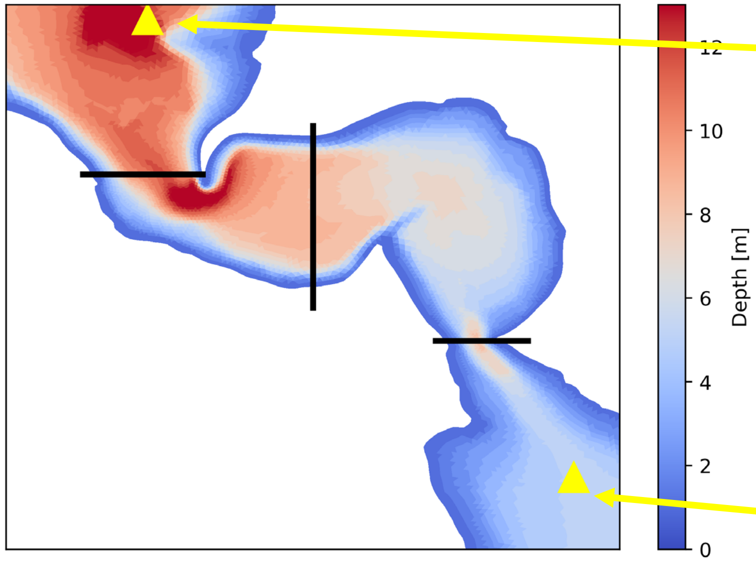
Targeted nutrient management in tributaries may be most impactful in Mud, Dewittville, and Goose Creeks

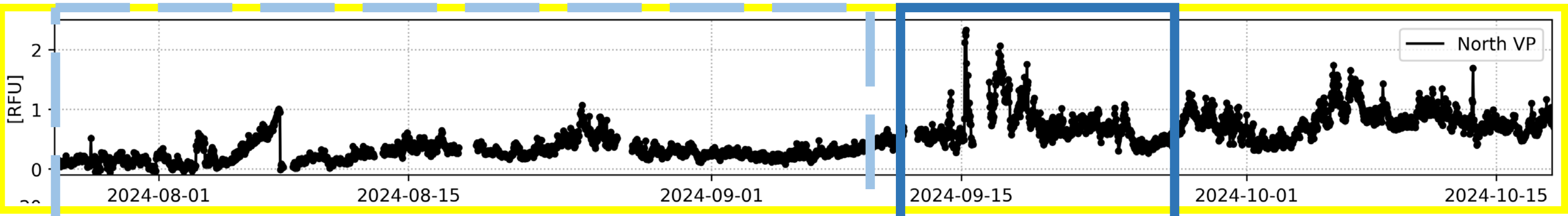


Can the south basin be supplying the north basin with nutrient pulses or algae?

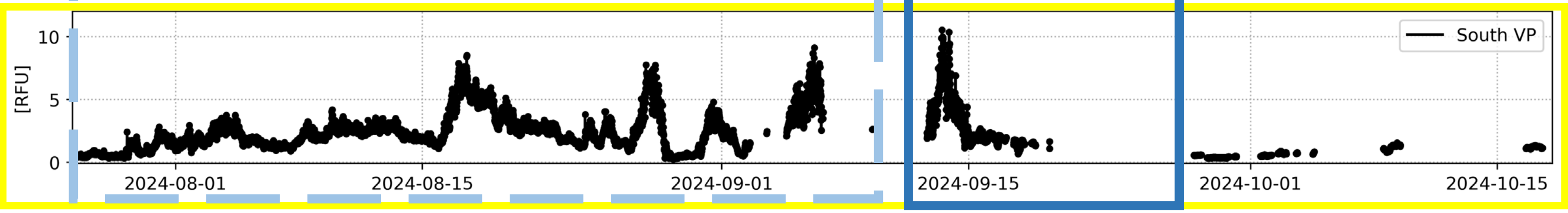


Cyanobacteria originates in the South Basin in some cases





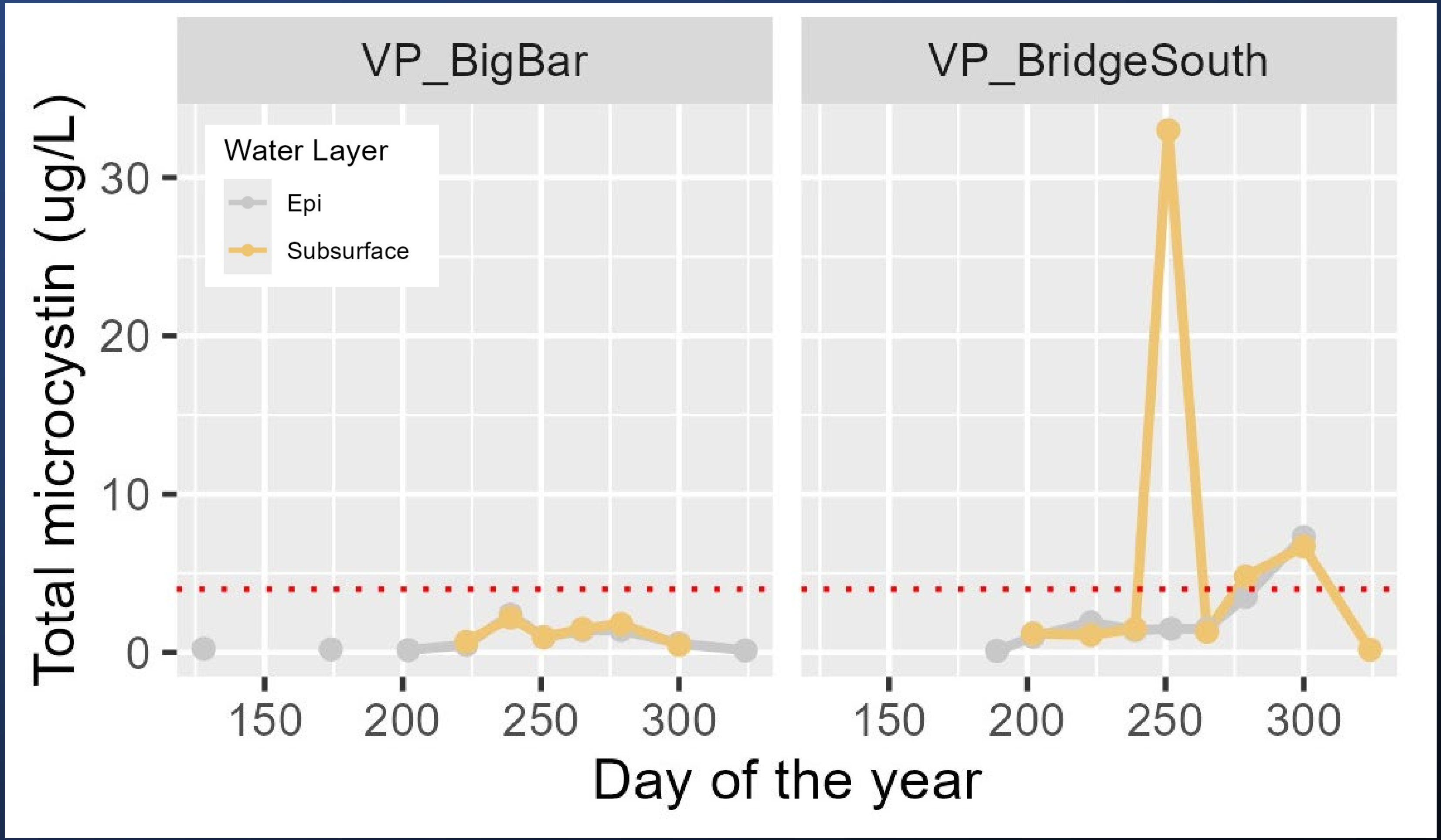
Measurements from Vertical Profiler



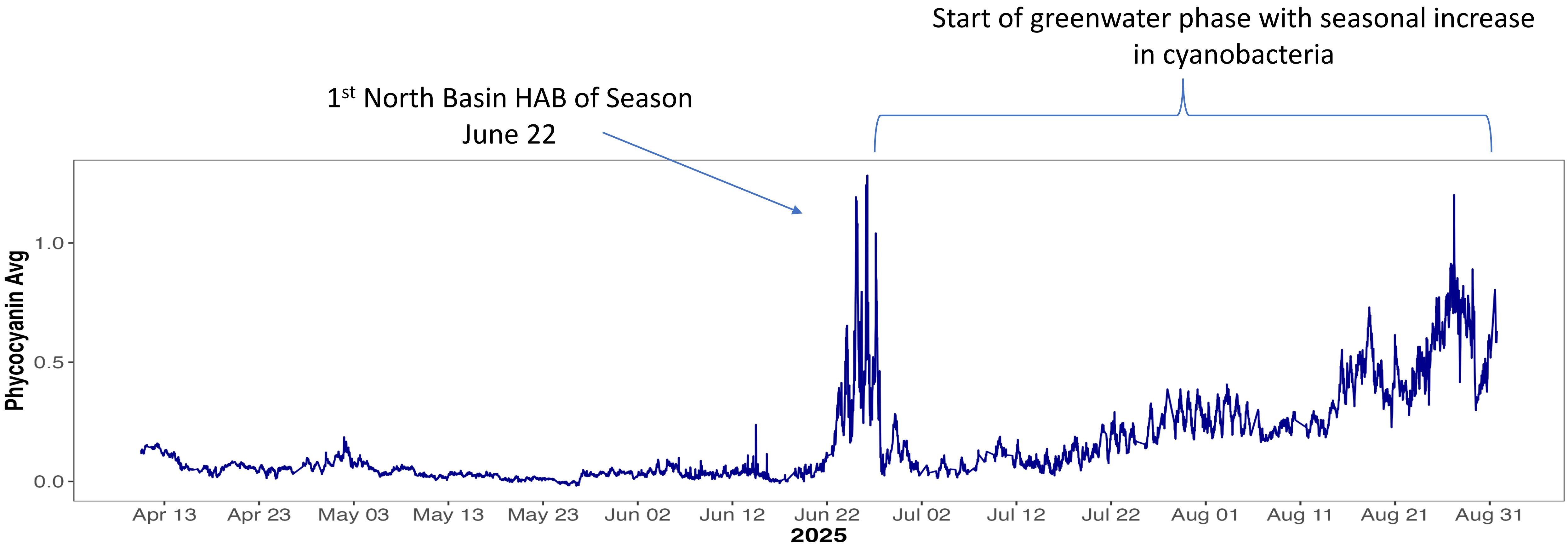
Increase in Phycocyanin measured in South Vertical Profiler without increases in North Vertical Profiler

One day delay between increases in South and North Vertical Profilers

- Cyanotoxins were present at low concentrations, dominated by microcystins
- 4 HABs exceeded the recreational safety threshold of the NY DOH (4 µg/L) Cylindrospermopsin was recorded in one HAB at a low level
- *Microcystis* is the main toxin-producing cyanobacteria in Chautauqua Lake



Chautauqua Lake has a distinct greenwater phase

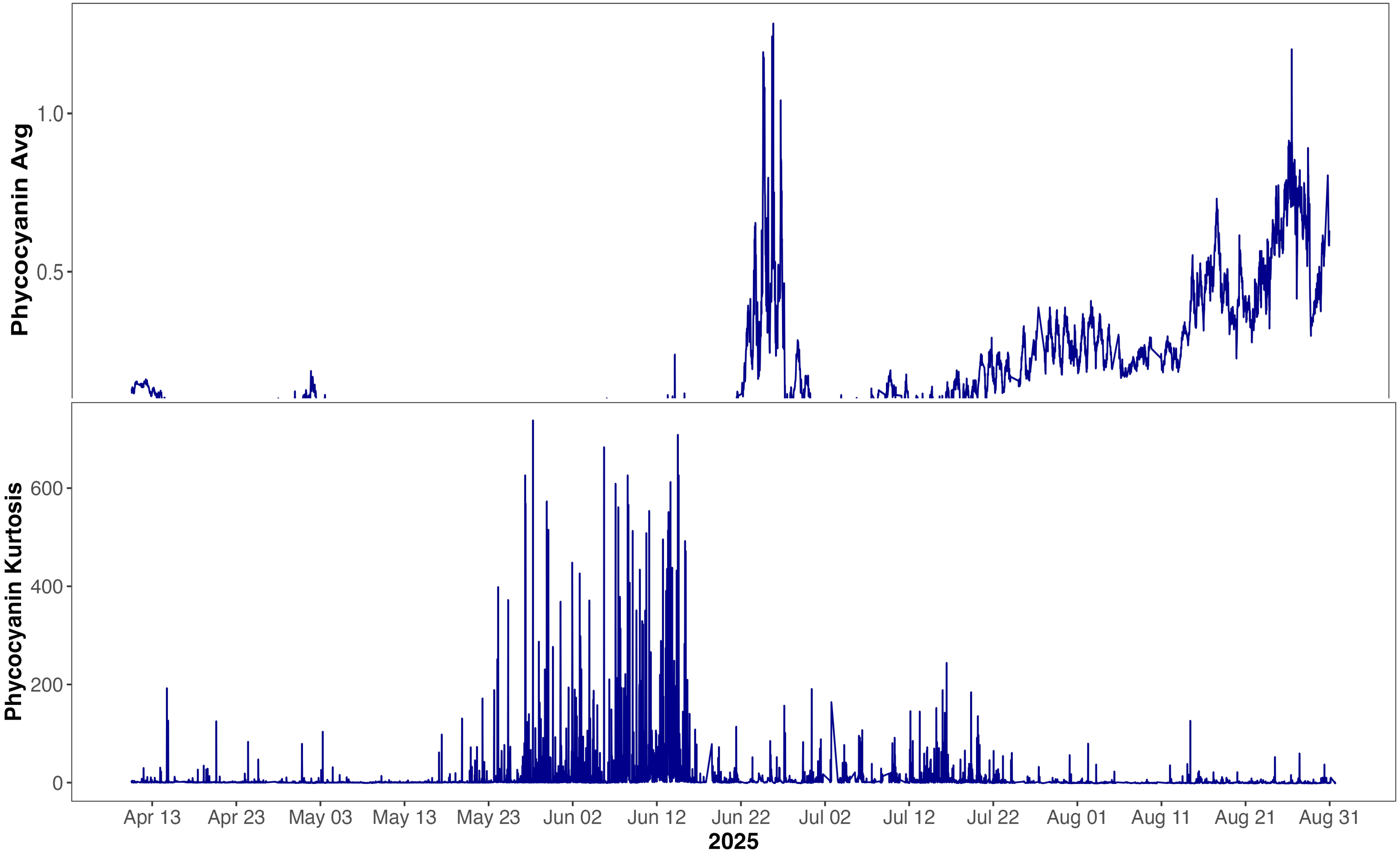


- *No* leading indicators of:
  - Initial HAB
  - Critical transition to phytoplankton dominated system

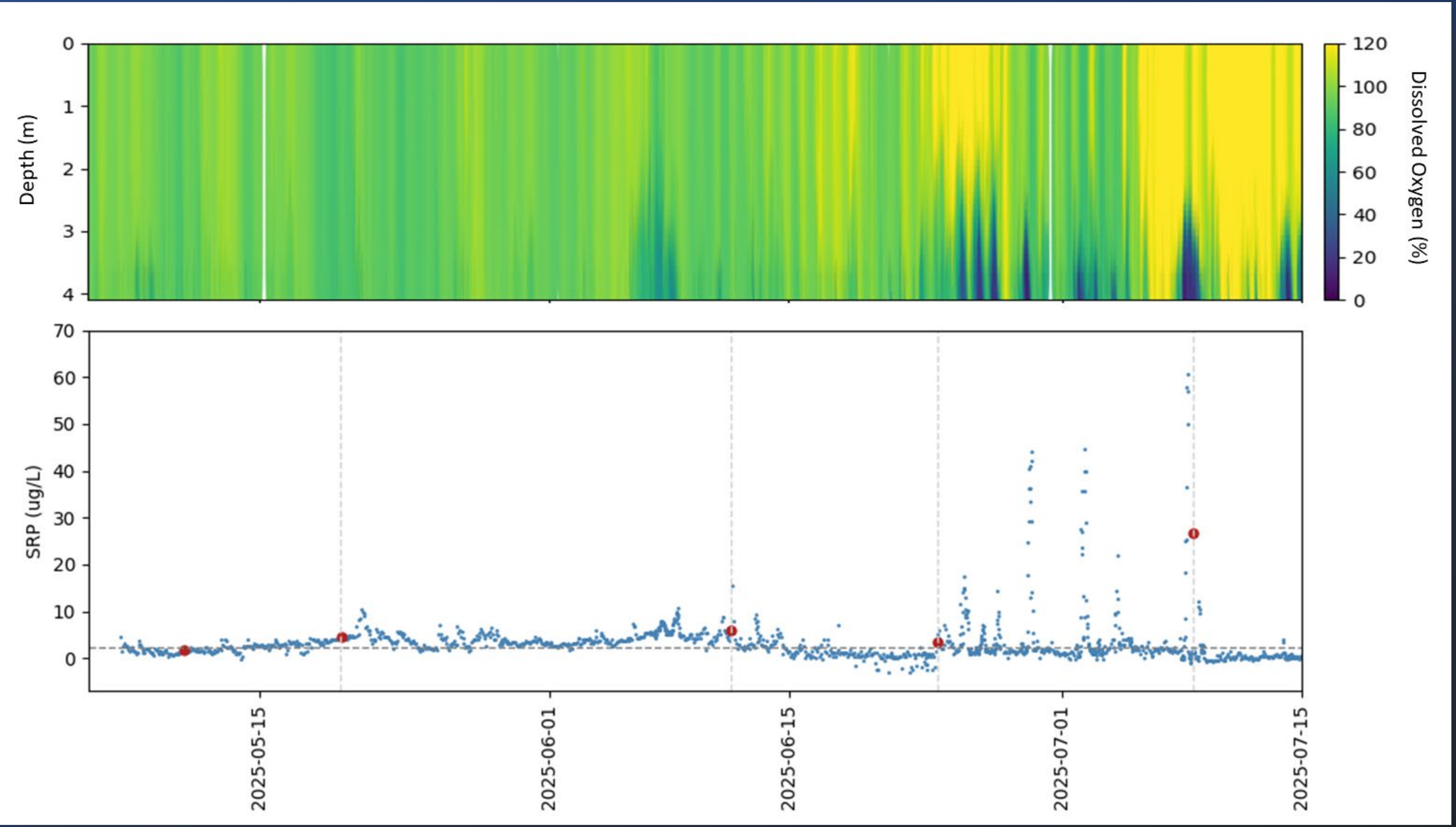
The onset of the HAB season may be predicted with statistical analysis of ultra-high frequency data

Using ultra-high frequency sensor data from JP platform, higher statistical moments provide 1-month *leading indicator* of critical transition.

Useful for HABs *prediction*, and may be used to inform management decisions such as *beach closures* and decisions concerning when and where to draw *drinking water* from.



South Basin short-term stratification contributes to internal P loading

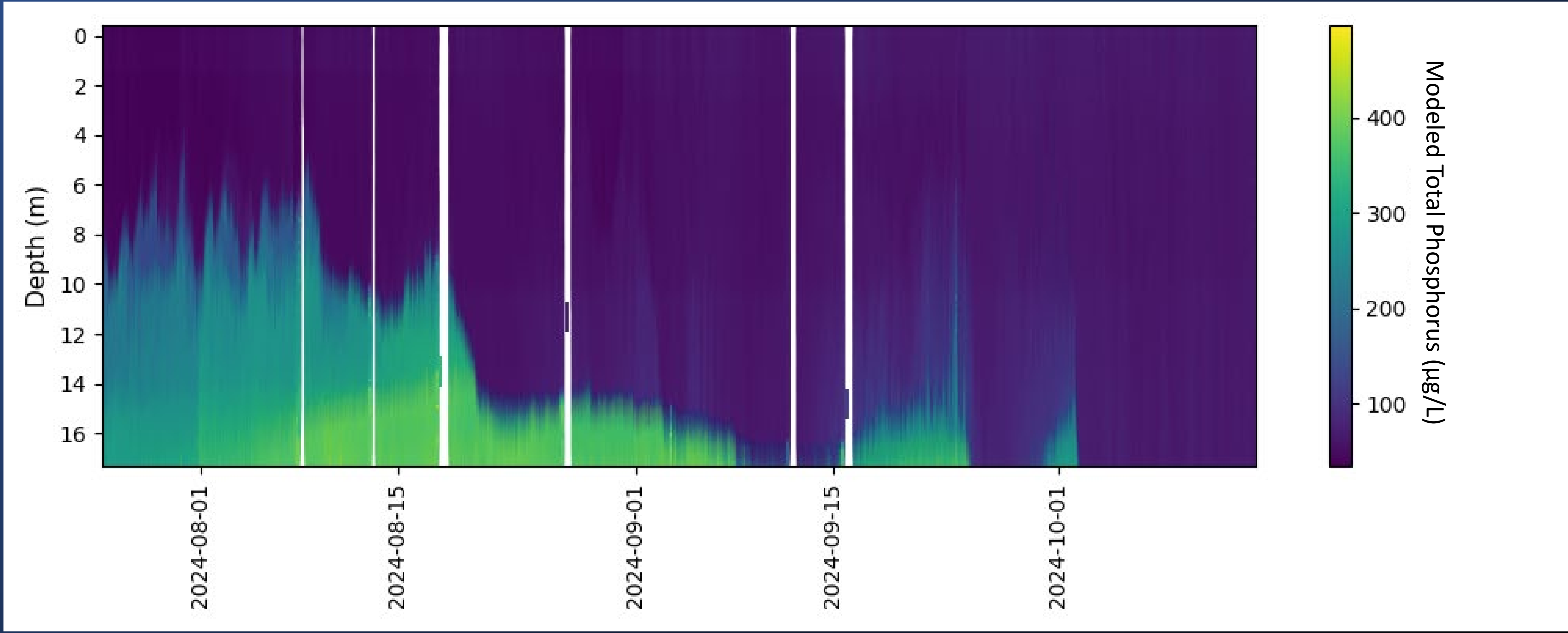


Earliest deployment yet (May 6th).

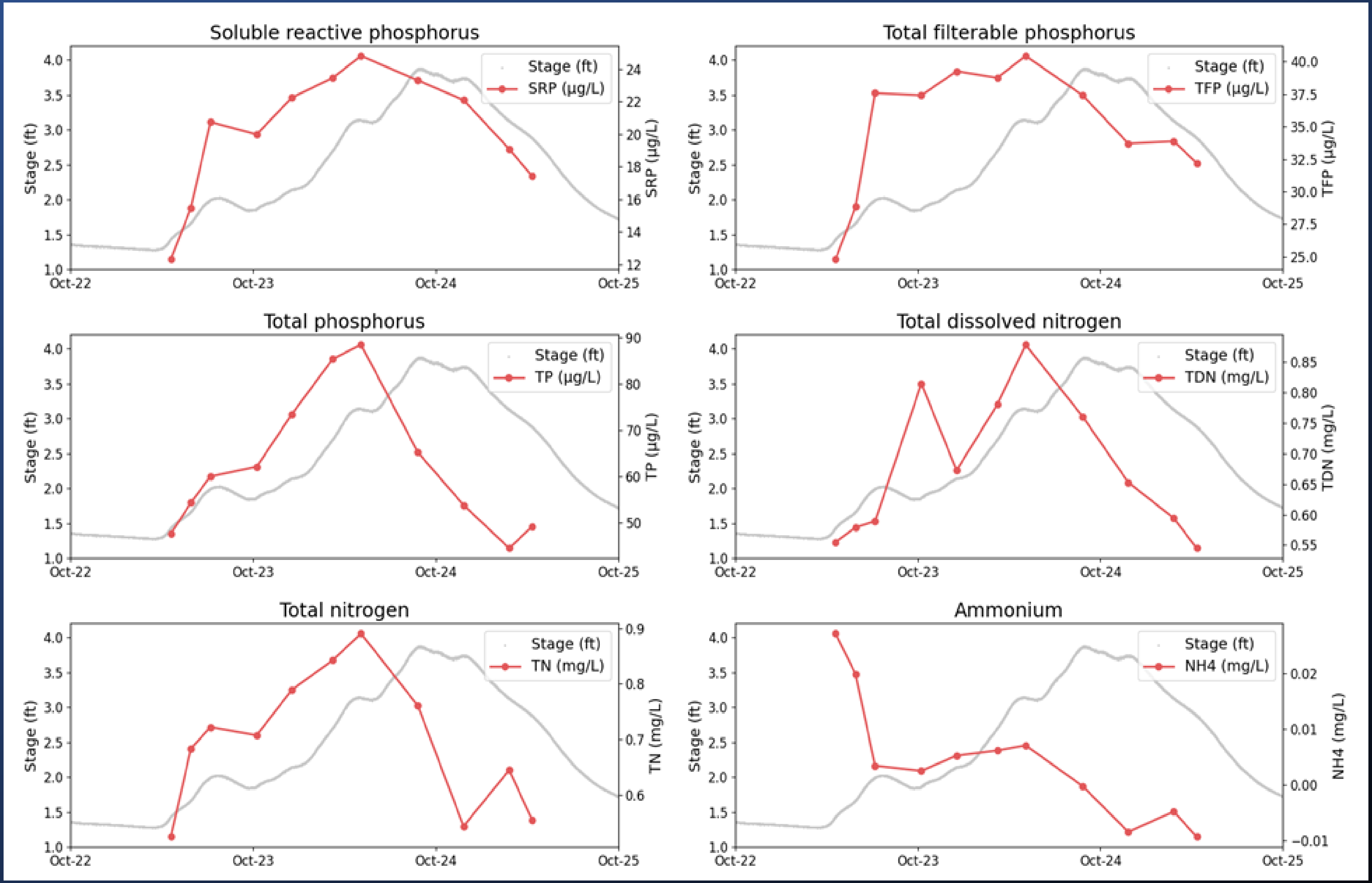
Some small pulses in spring, but main pulses begin to occur in late June.

Three years of data will be used to estimate internal P loading and how it contributes to HABs.

Surrogate regression model "SINC" uses machine learning to predict critical nutrient concentrations from sensor data



Nutrient concentrations peak before highest flows during storms



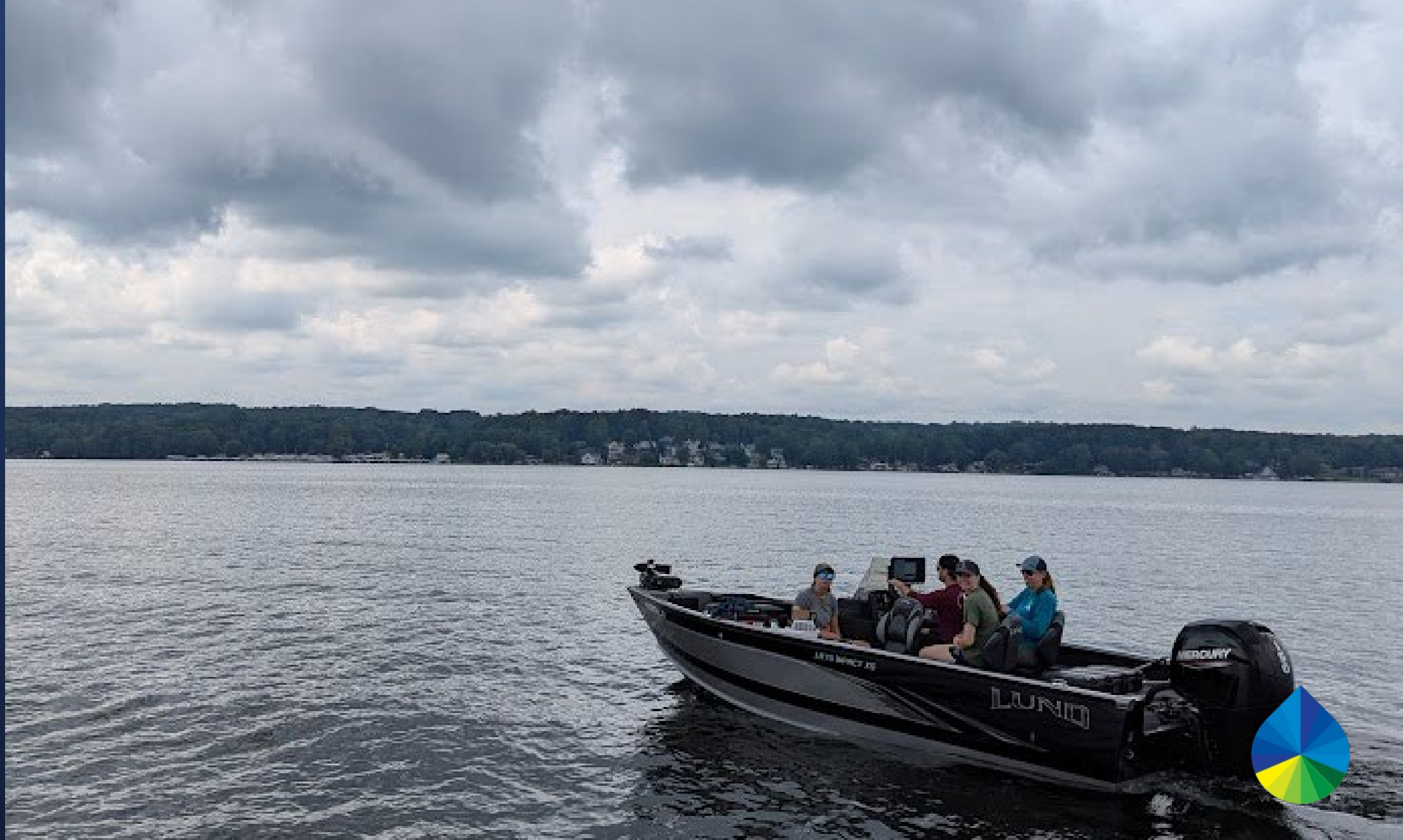
Summary of results

- 2025 was warmer than usual. This may have contributed to excess macrophyte growth.
- Data indicate that HABs can move south to north
- Some cyanotoxins observed, mostly microcystins at low concentrations
- Nutrient measurements in tributaries provide data to support informed management decisions
- Ultra high-frequency data helps us predict blooms
- Evidence of internal P loading in South Basin

- All data and 2025 report will be made public.
- 2026 work will include pilot nutrient mitigation projects.

Conclusions

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



Acknowledgements

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Collaborators

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US Army Corps of Engineers

Chautauqua Lake Association

Chautauqua County State of New York

SMU

PML Plymouth Marine Laboratory

UAlbany

Duquesne University

Questions?