SUNY Fredonia - Water Quality Research Update and 2023 Plans

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Fredonia Aquatic Research Program

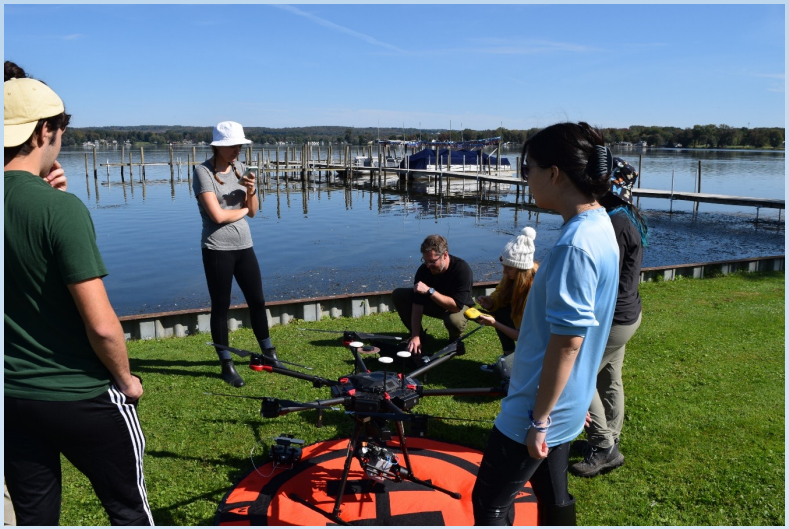
- ***How do lakes respond to different types of environmental change?***
  - Understanding algae blooms at Chautauqua Lake (and others!) in space and time

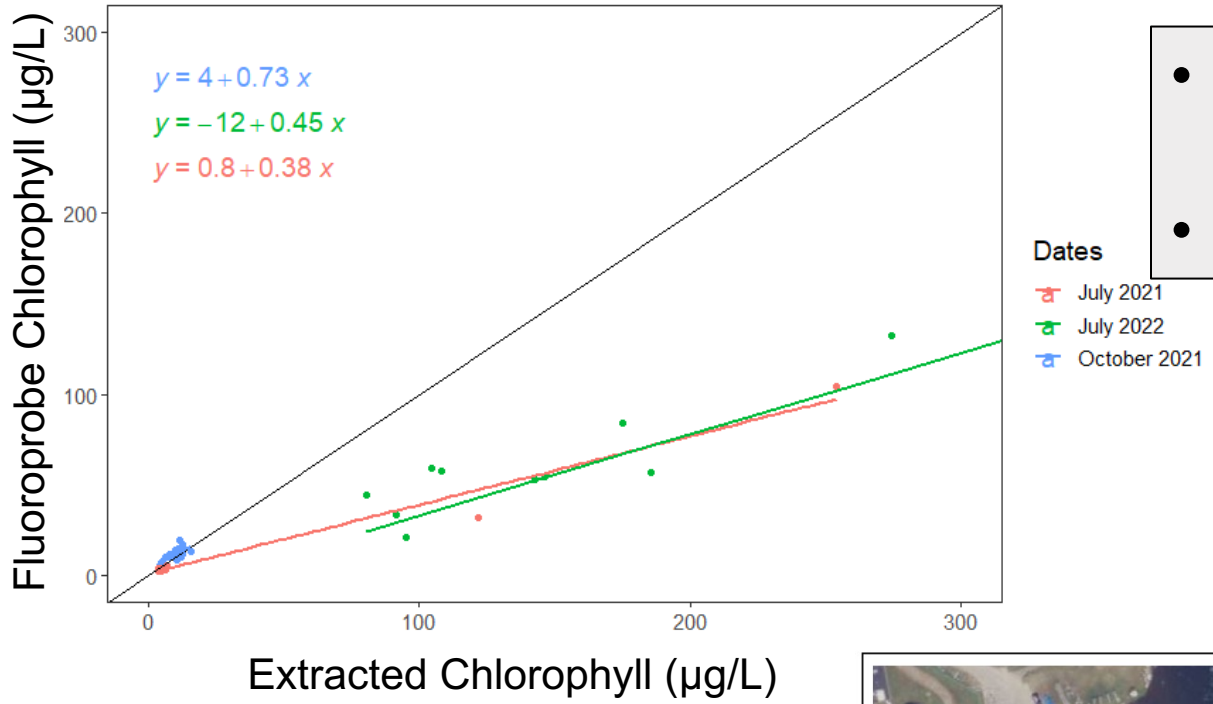
Sarah Yenesel, Chautauquan Daily

Drone Surveillance of Blooms

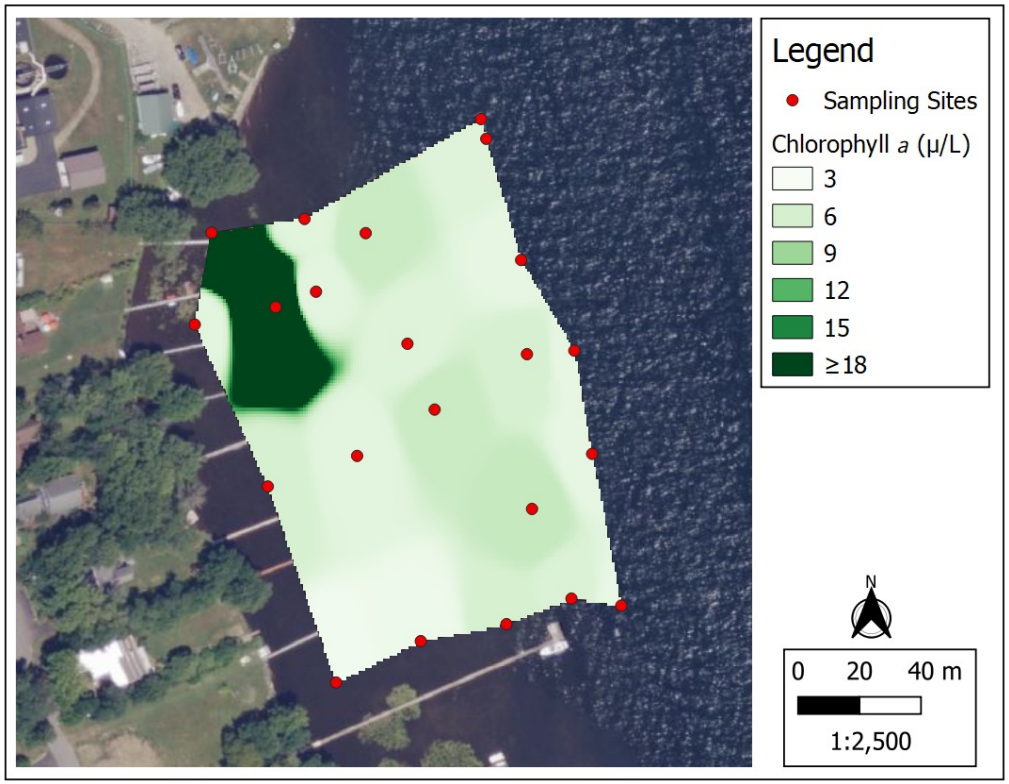
- **How do blooms originate, move, and disperse in lakes?**
  - Spatial patterns of blooms

- Paired drone flights and algae samples for ground truthing
  - Drone flights
    - Hyperspectral Imaging (HSI)
    - microHSI 410 Shark – Corning, Inc.
  - Gridded water sampling
    - Surface grab samples, up to 20 locations within flight path
    - Processed in lab for different algae metrics





- Strong correlation across algae metrics
- Not always 1:1

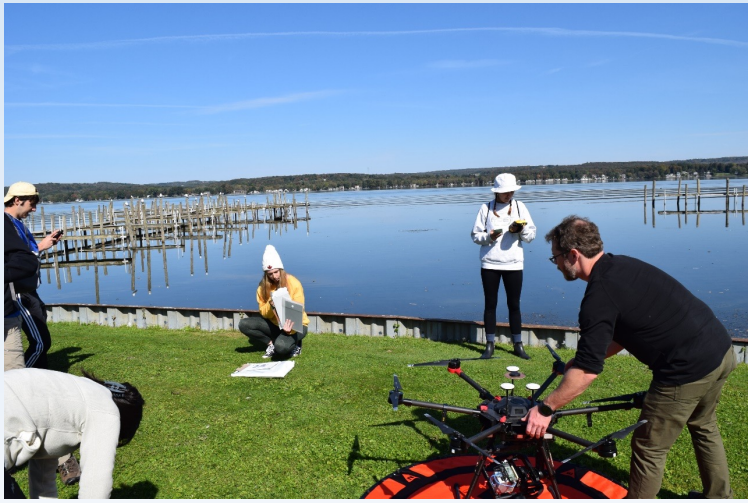


- High spatial variation
- Not always highest at shore

Drone Surveillance of Blooms

- Next steps:
  - New colleague: Dr. Jayson Boubin (SUNY Binghamton)
  - Air Force Research Lab Grant

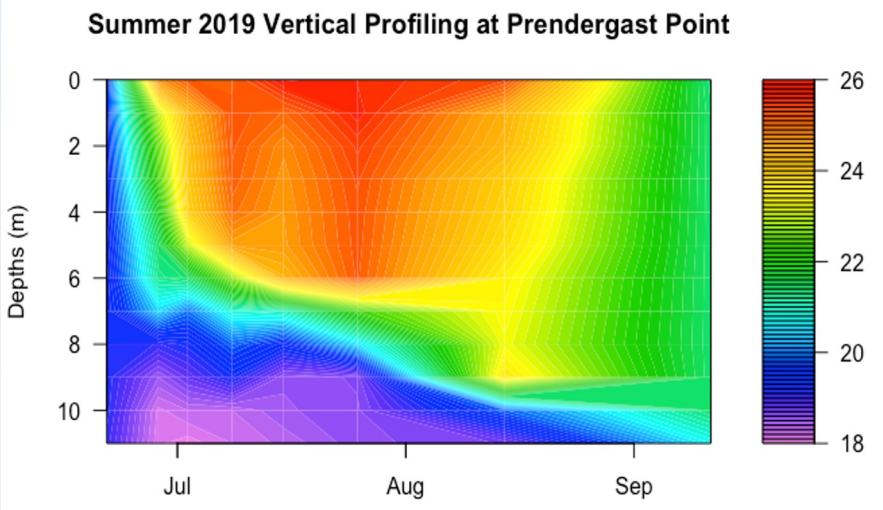
- 2023
  - Ongoing data analysis: connect water quality to imaging
  - Additional flights
  - Refining approaches – machine learning to automate and optimize flight data collection



Vertical temperature patterns

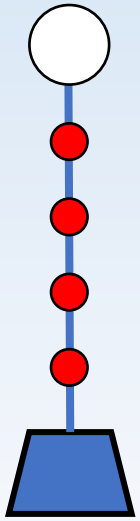
Mason 2020

- **What temperature patterns occur in different parts of Chautauqua Lake?**



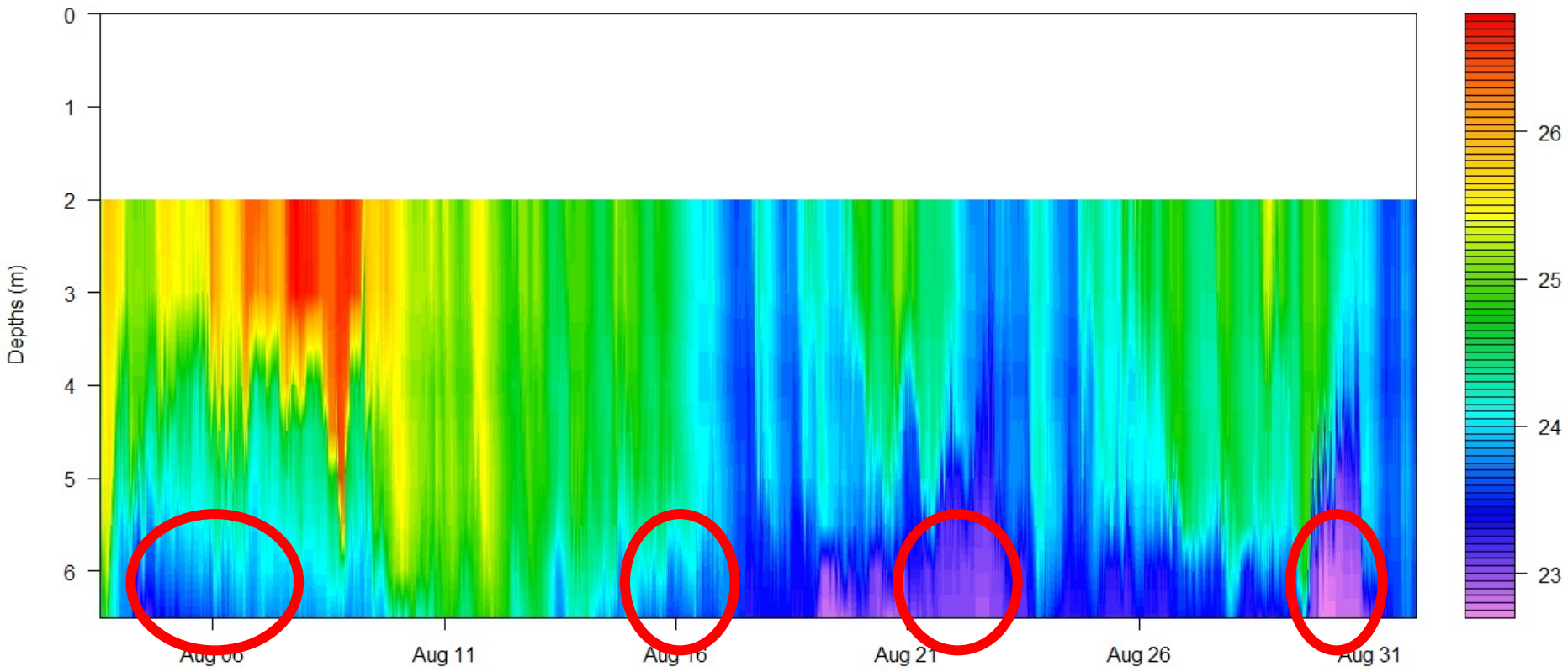
- Stratification
  - Warm surface layer; cool deep layer
  - Nutrients, chemistry, oxygen, physics, etc.

- Temperature loggers
  - Subsurface sensor line
  - 0.5 - 1 m vertical resolution
  - 5 min intervals



- 2019 – North Basin
- 2021 – South Basin
- 2022 – Bemus Bay/ Interface

2022: Bemus Bay

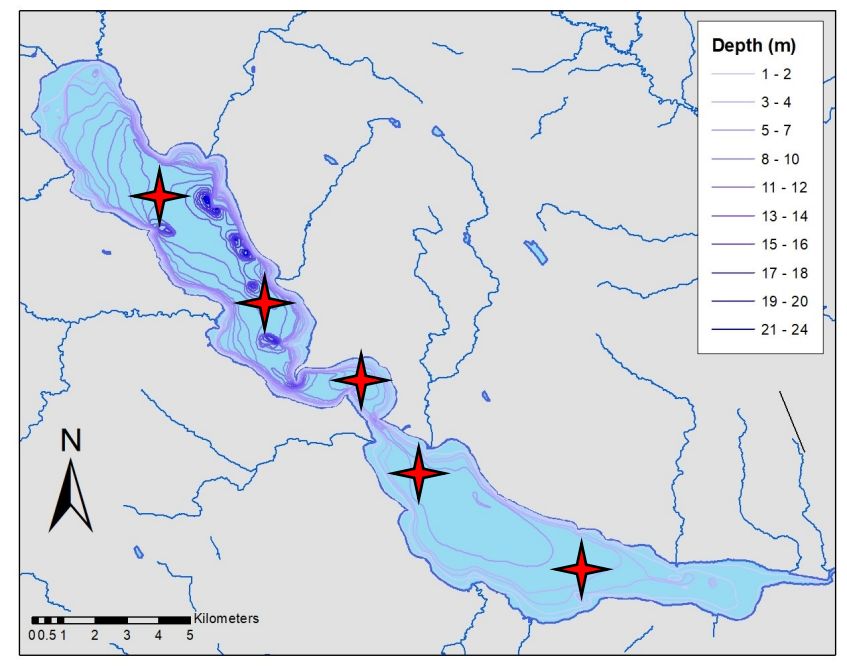


- Stratification occurs, but not stable
- Periods of low oxygen (hypoxia/anoxia)
- Rapid swings in temperature and oxygen

2023: Whole lake investigation

- **How are temperature patterns connected across the entire lake?**
  - 5 sensor lines
  - 3 with dissolved oxygen sensors

- Simultaneous temperature data
  - Within versus across basins
  - Basin interactions
  - Role of wind/storm events



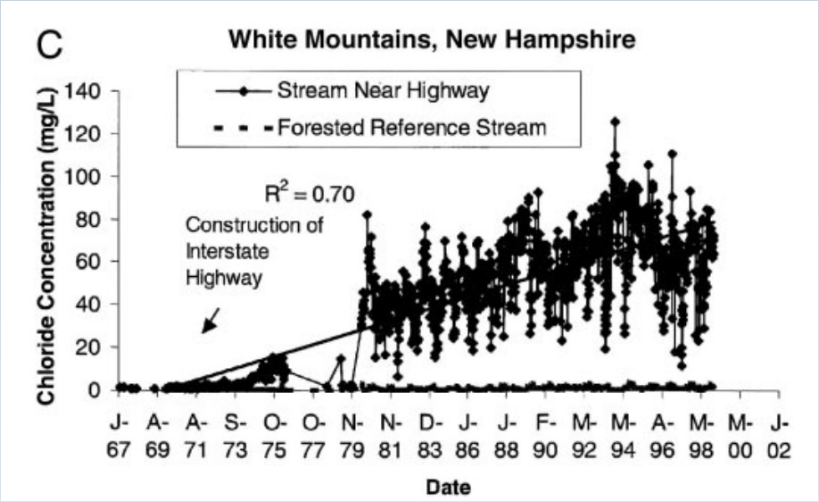
Road salt: Effect on plankton

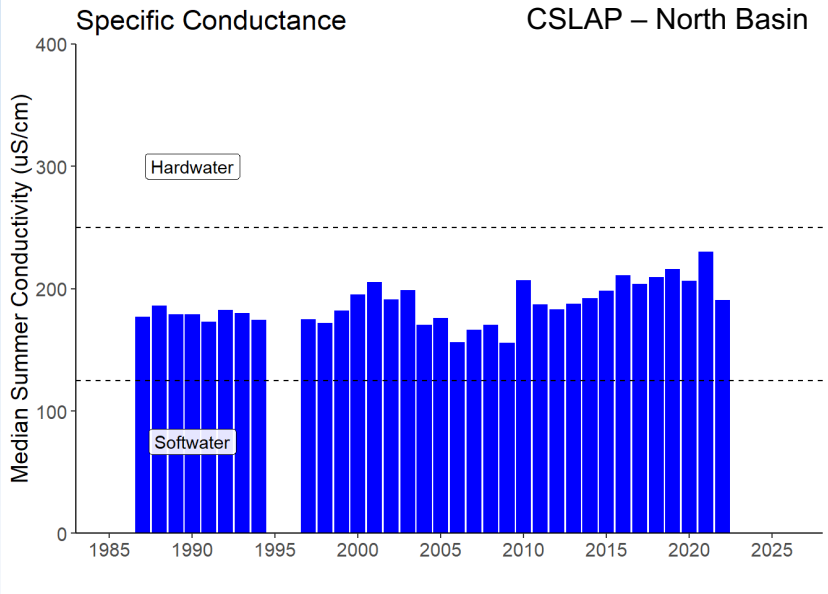
- **How does road salt affect lake ecosystems?**

- 24.5 million tons used in U.S. per year
- Salt is mobile…
- EPA guideline for natural waters is 230 mg/L set in 1988

- Chautauqua Lake
  - Conductivity increasing (CSLAP – significant long-term trends for both basins)

Kaushal et al. 2005





Road salt: Effect on plankton

- Zooplankton – animal plankton
  - Feed on algae

- *Daphnia* → Salt tolerance experiments (Dr. Shelley Arnott at Queens University)
  - Locally collected from different sites
  - Laboratory experiments
  - Multiple salt concentrations

- Chautauqua as a participating site
  - Explore local effects
  - Compare to other sites to learn more

Summary

- Range of projects!

- Drone surveillance of HABs
- Whole-lake temperature sensors
- Road salt effects on zooplankton
- *BGSU Stream Sampling

Acknowledgements

- Current and past students: Kasey Crandall, Kameron Finch, Sydney Hawkins, Todd Zimmer, Madison Miller, Marc Choi, and Mary Ann Schauman

- Community Partners: Chautauqua Institution, Chautauqua Marina, Chautauqua Lake and Watershed Management Alliance, Chautauqua Lake Association, Chautauqua Watershed Conservancy, Chautauqua Lake Partnership, Lakewood Rod & Gun Club
- Academic Colleagues: Jefferson Project, Bowling Green State University, Drone-HSI team, Shelley Arnott, Chris Dempsey

- Funding: Fredonia Biology Dept., Pennica Award, SUNY Construction Funds, SUNY Academic Equipment Replacement Fund, Corning Inc., NYS WRI, SUNY Research Foundation 4E Grant, Air Force Research Laboratory
- Summer Research Fellowships: Holmberg Foundation and Falcone Foundation


Questions?

Table 1. The Spearman's correlation matrix for all the samples from all flights combined. Bolded values indicate significant correlations ($P<0.01$). (Total Extracted Chlorophyll *a* (T-E), Total Fluoroprobe Chlorophyll *a* (T-FP), Total Biovolume (T-BV), Cyanobacterial Fluoroprobe measurements (Cy-FP), Cyanobacterial Biovolume (Cy-BV)).

Measurement	T-E	T-FP	T-BV	Cy-FP	Cy-BV
T-E	**1**	**0.94**	**0.90**	**0.91**	**0.89**
T-FP		**1**	**0.94**	**0.93**	**0.92**
T-BV			**1**	**0.93**	**0.99**
Cy-FP				**1**	**0.93**
Cy-BV					**1**

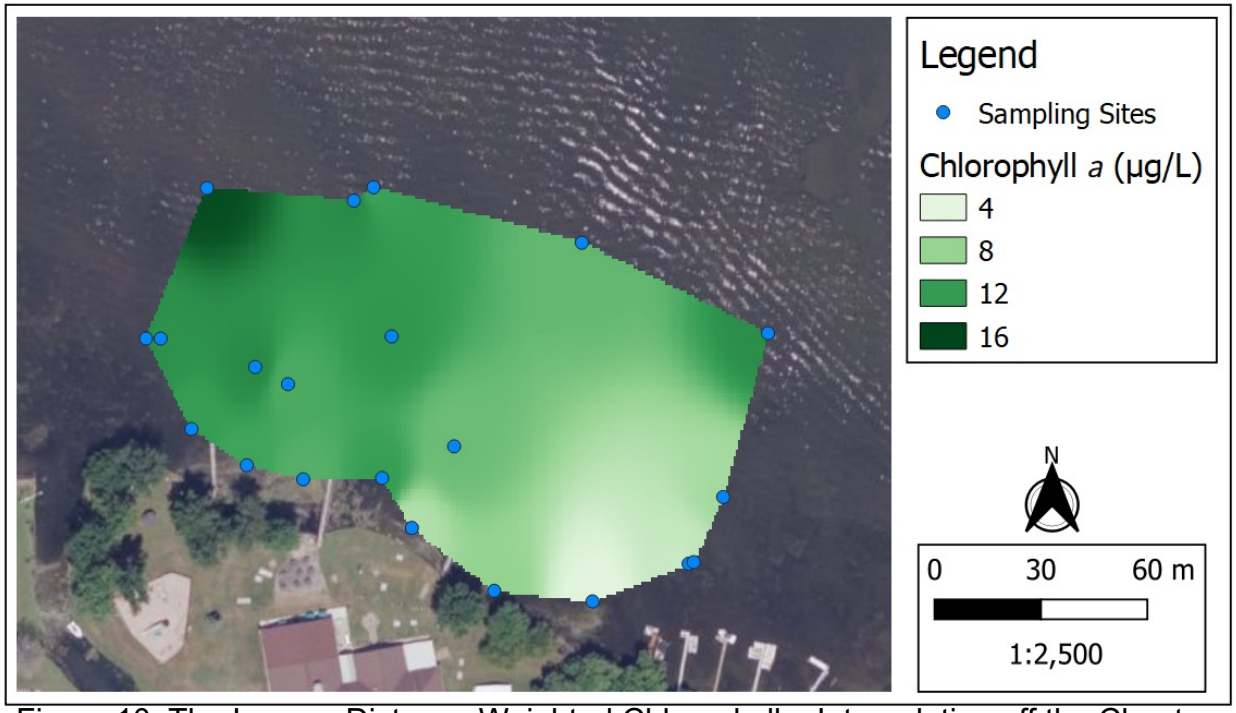


Figure 10. The Inverse Distance Weighted Chlorophyll *a* Interpolation off the Chautauqua Lake Road and Gun Club on October 2nd, 2021.

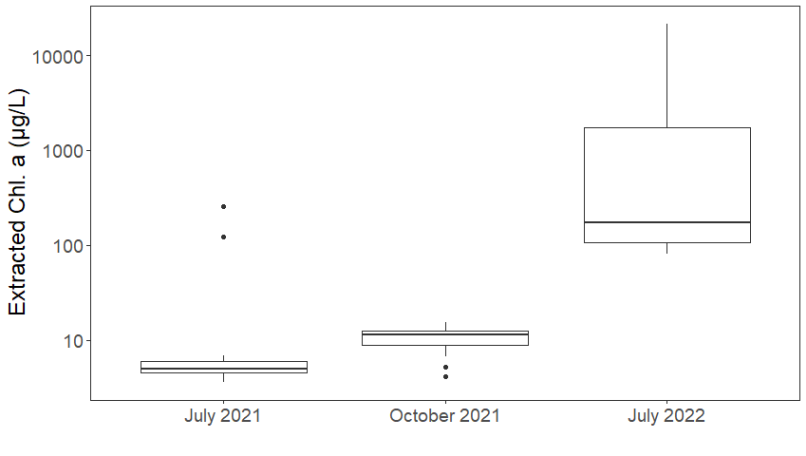


Figure 5. Box and Whisker plot of the Extracted Chlorophyll *a* measurements from each flight date.

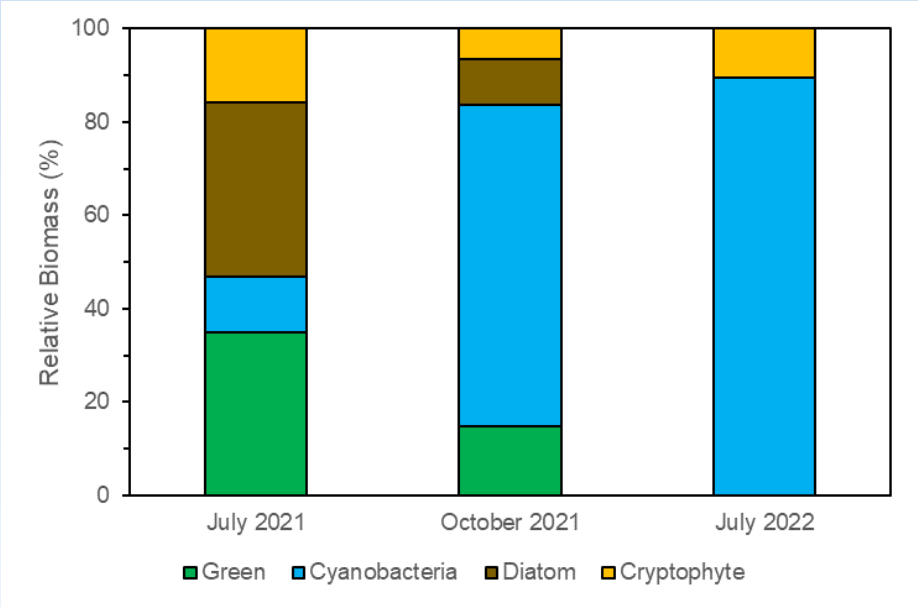


Figure 6. The relative biomass of phytoplankton groups by flight date, based on Fluoroprobe measurements.

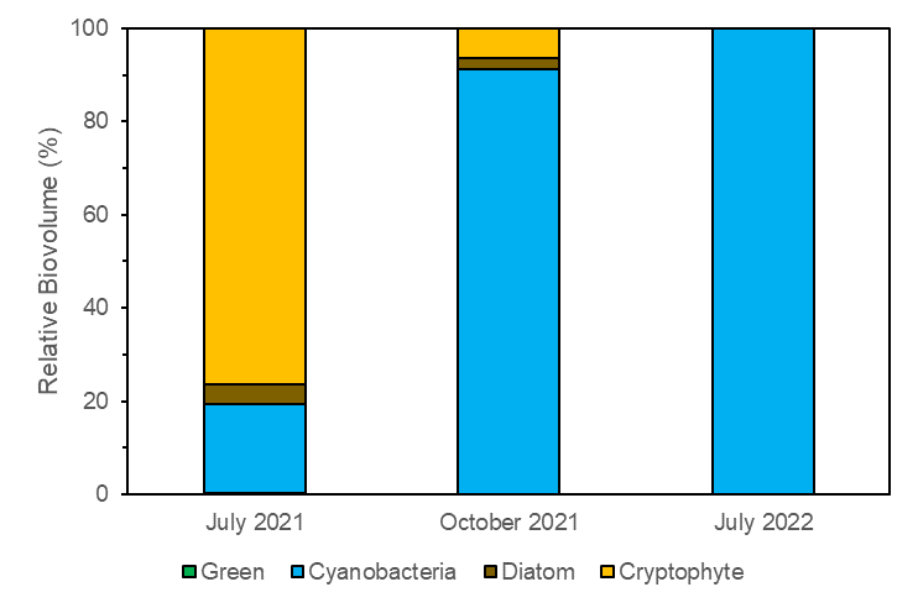
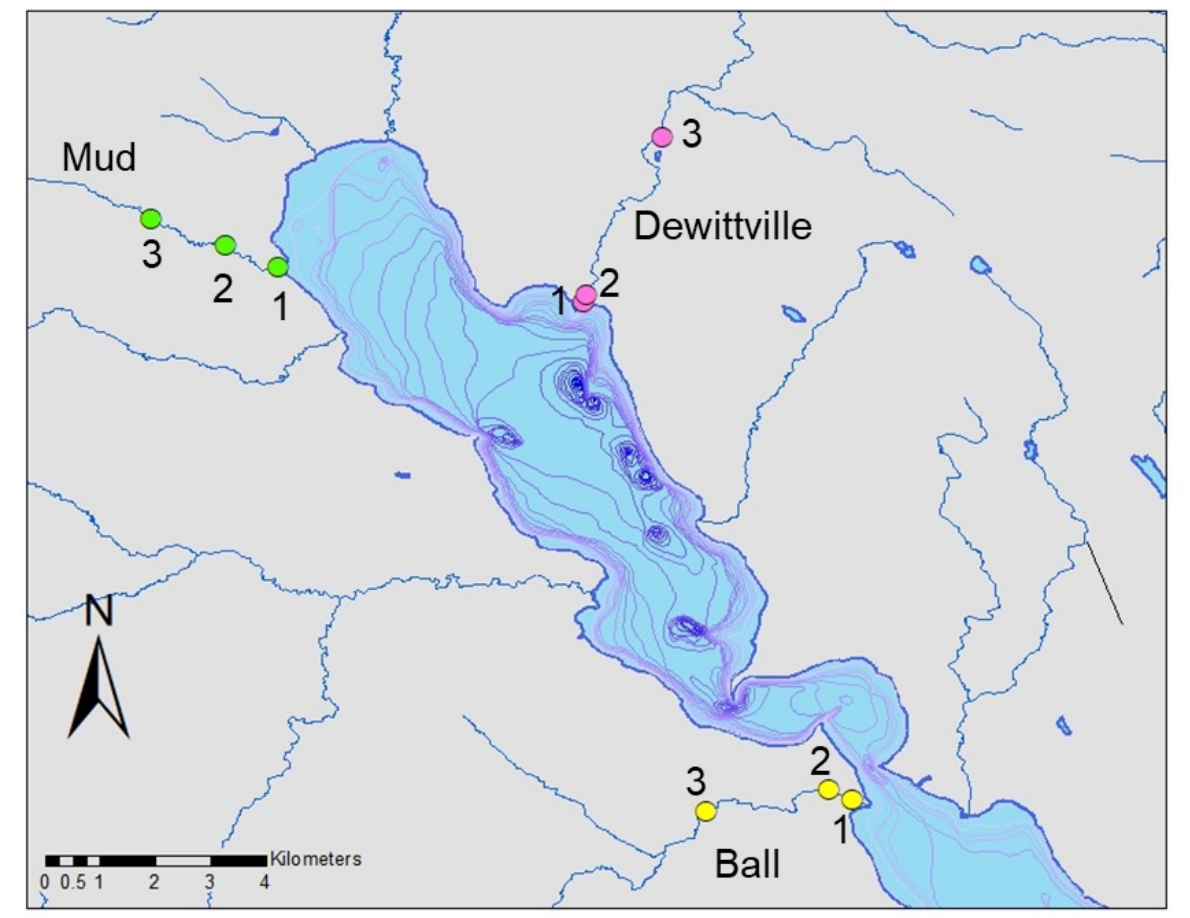
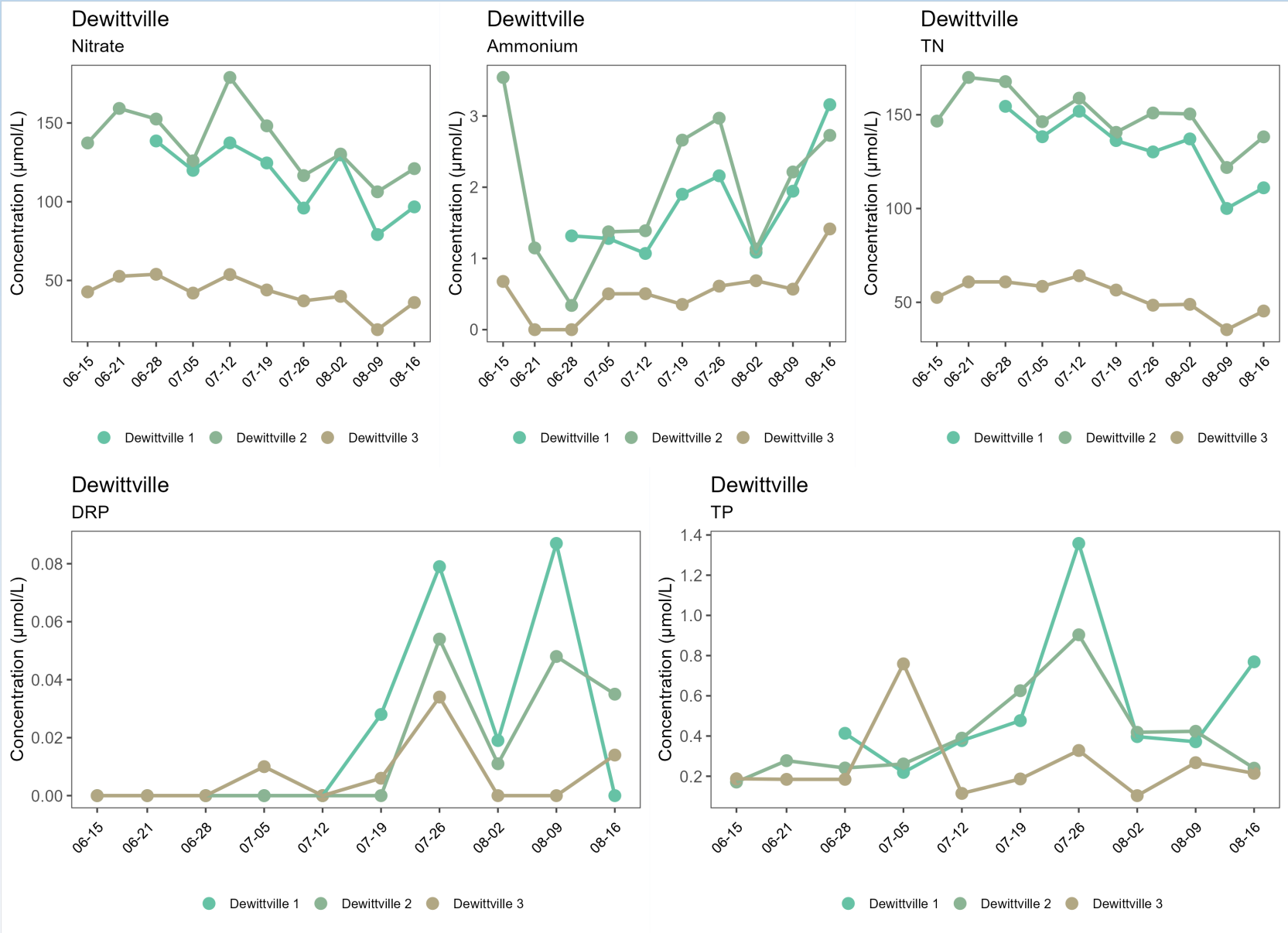


Figure 7. The relative biovolume of phytoplankton groups by flight date, based on biovolume estimates.

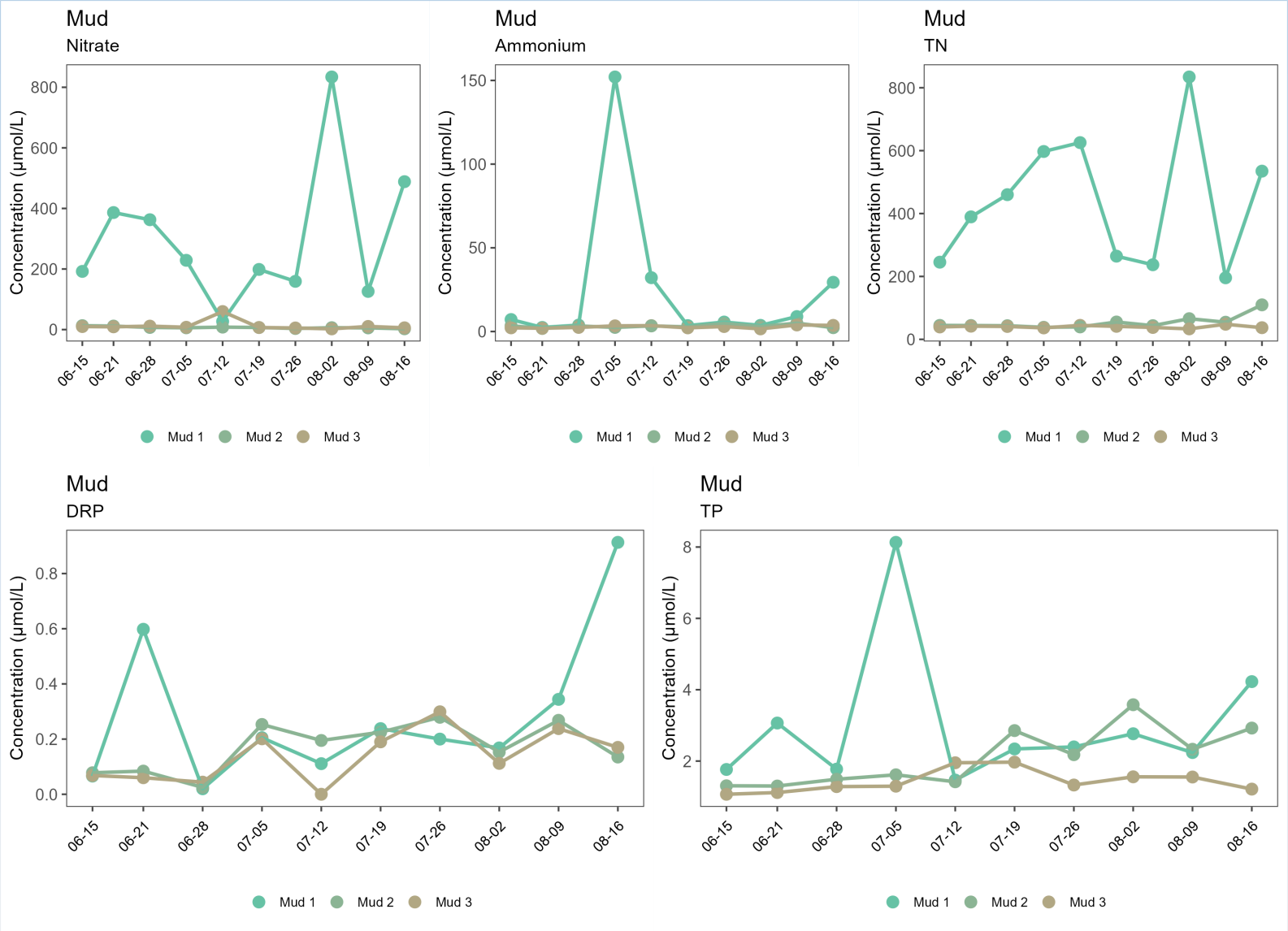
BGSU/Fredonia sampling locations



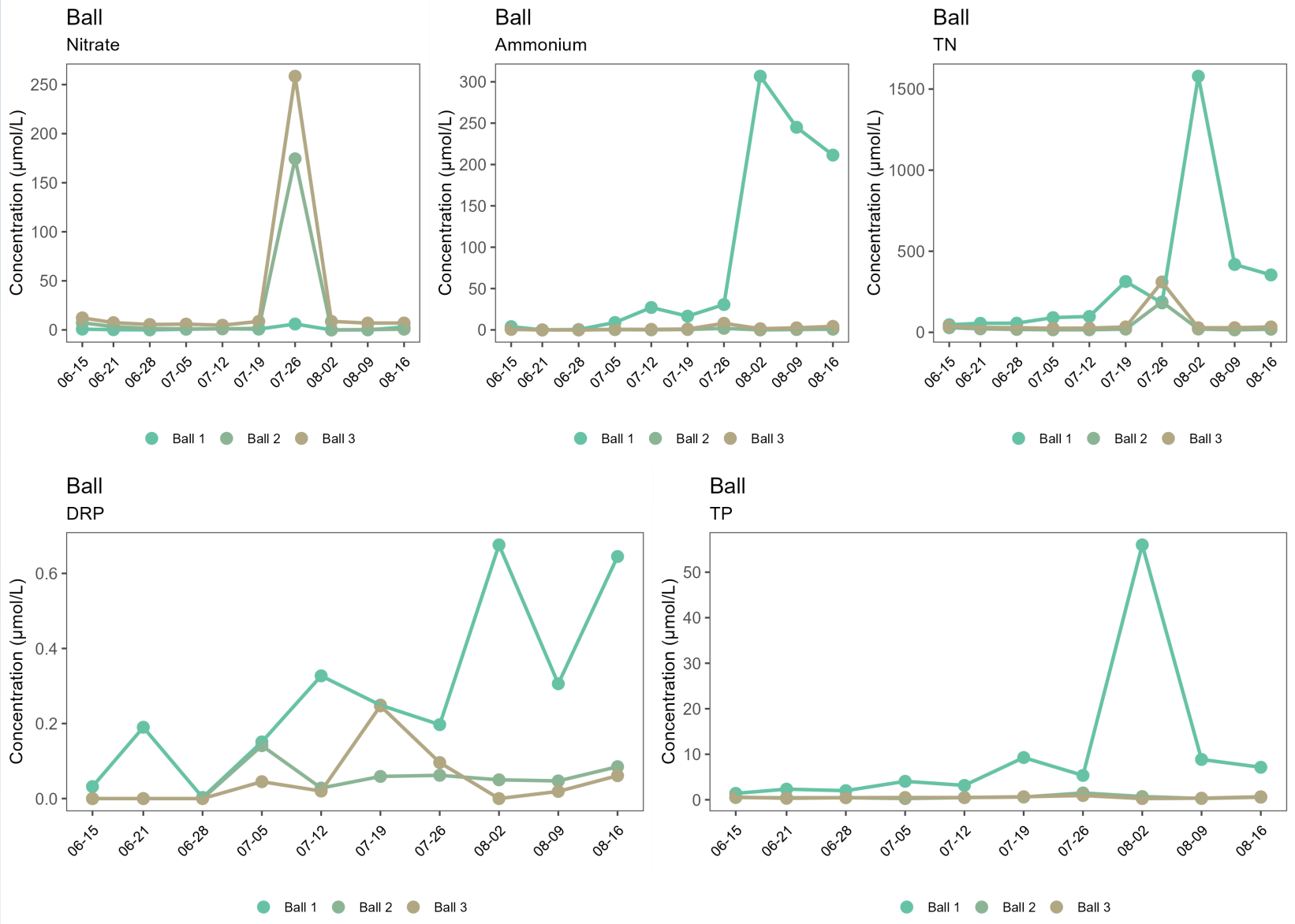
Dewittville 2022 - high nitrate, low P

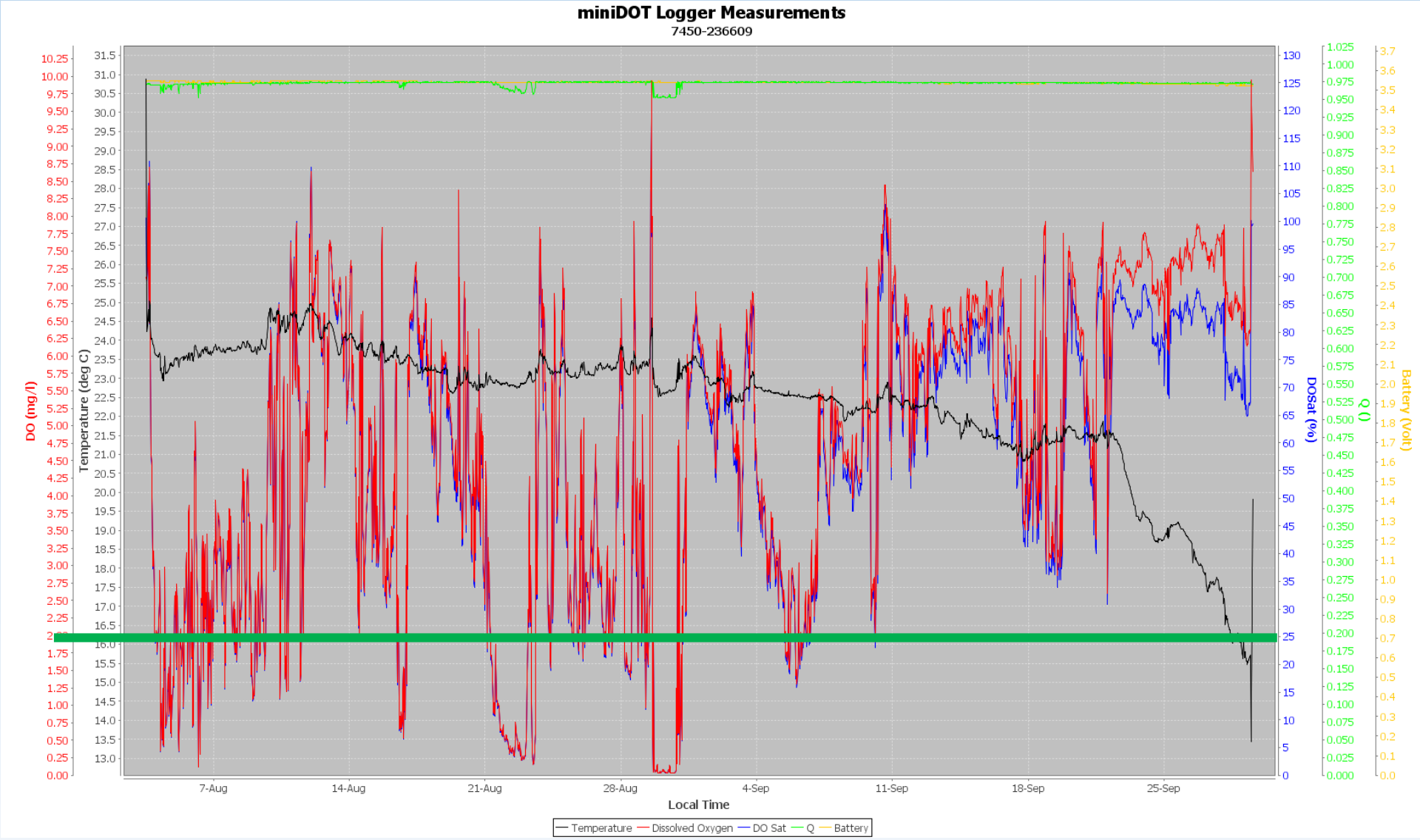


Mud Creek 2022 – transient very high N at mouth



Ball Creek – highest ammonium values, high TP




miniDOT Logger Measurements
7450-236609
DO (mg/l)
Temperature (deg C)
DOSat (%)
Q ()
Battery (Volt)
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
Local Time
Temperature
Dissolved Oxygen
DO Sat
Q
Battery