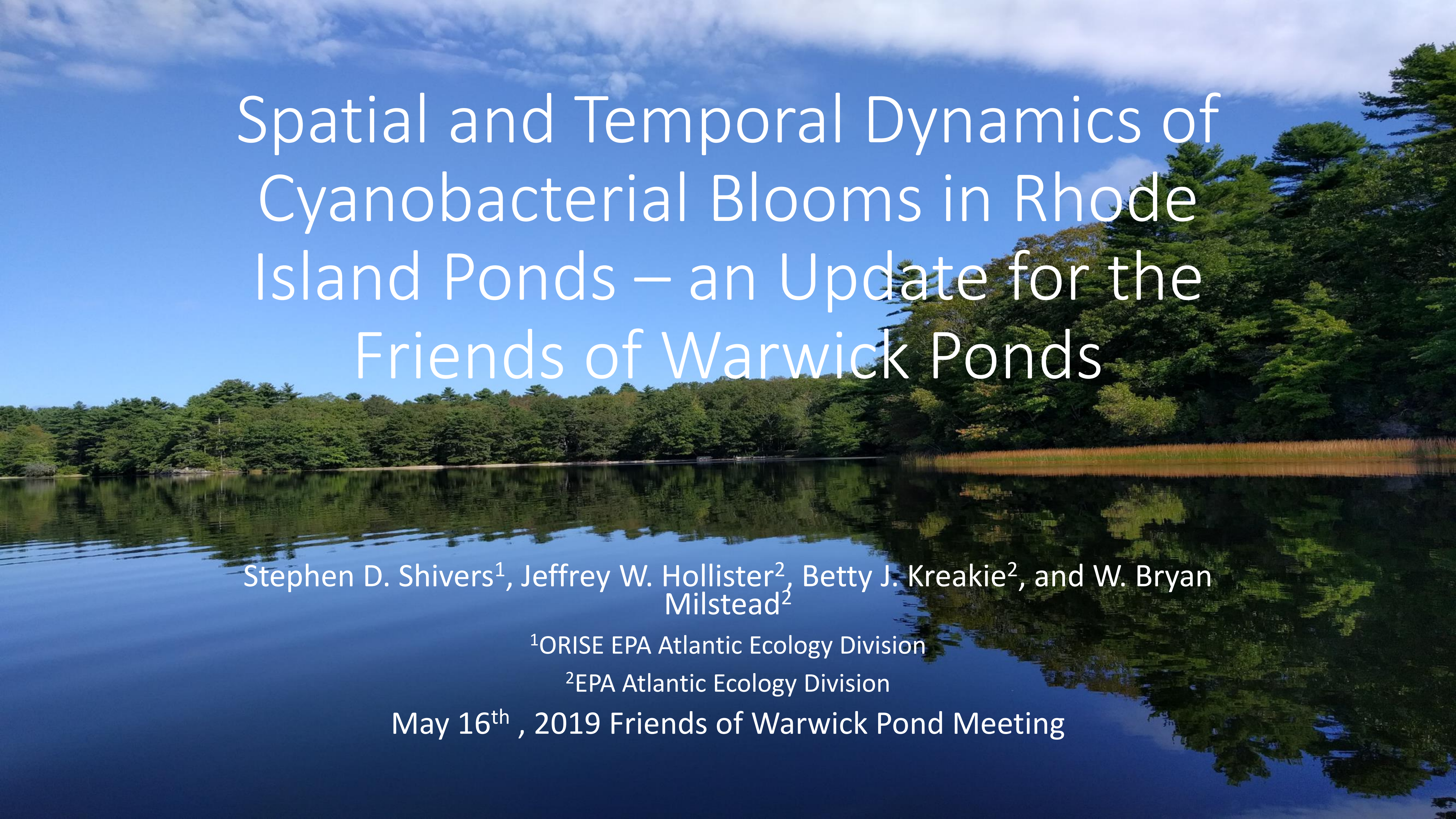


Spatial and Temporal Dynamics of Cyanobacterial Blooms in Rhode Island Ponds – an Update for the Friends of Warwick Ponds

Stephen D. Shivers[1], Jeffrey W. Hollister[2], Betty J. Kreakie[2], and W. Bryan Milstead[2]

[1]ORISE EPA Atlantic Ecology Division

[2]EPA Atlantic Ecology Division

May 16th , 2019 Friends of Warwick Pond Meeting

Overview

- Introduction
- Project goals
- Study ponds/methods
- Results from 2018 field season
- Preliminary conclusions

Cyanobacteria

- Part of the natural environment
- Found in wide variety of habitats (terrestrial, freshwater, and marine)
- Can form dense blooms when conditions (e.g. high nutrients) are appropriate

Cyanobacteria and HABs

- Depletes oxygen which can result in fish kills
- Reduces available sunlight for submerged plants
- Can impact human and animal health
- Certain species can produce toxins

Image Credit: USGS, Jennifer L. Graham

HABs

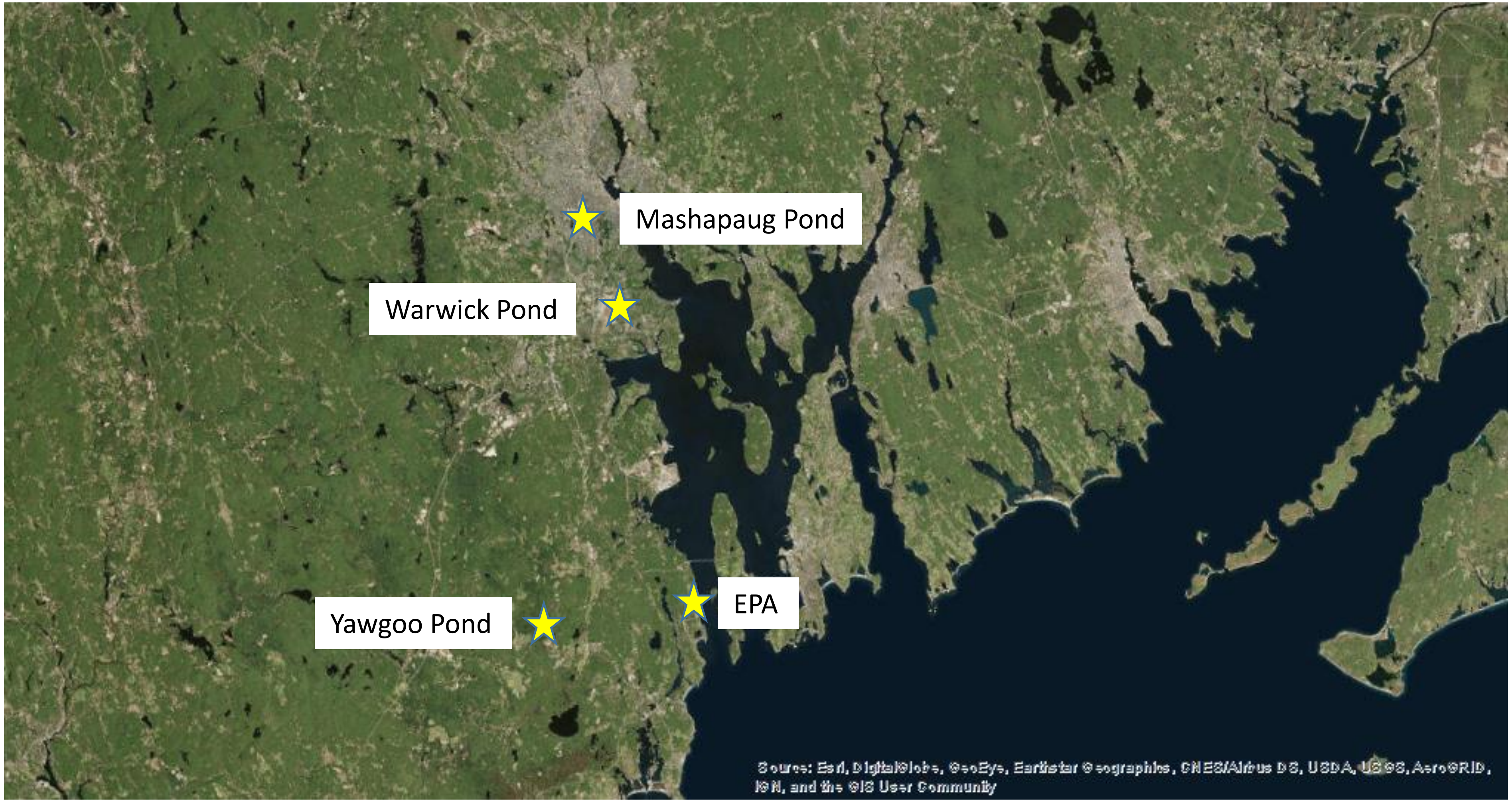
- Harmful algal blooms (HABs) impact human and environmental health
- Bloom frequency/severity increasing
- Consequences of HABs can be costly (drinking water supply, recreation, home value)

Image Credit: NASA

Project Goals

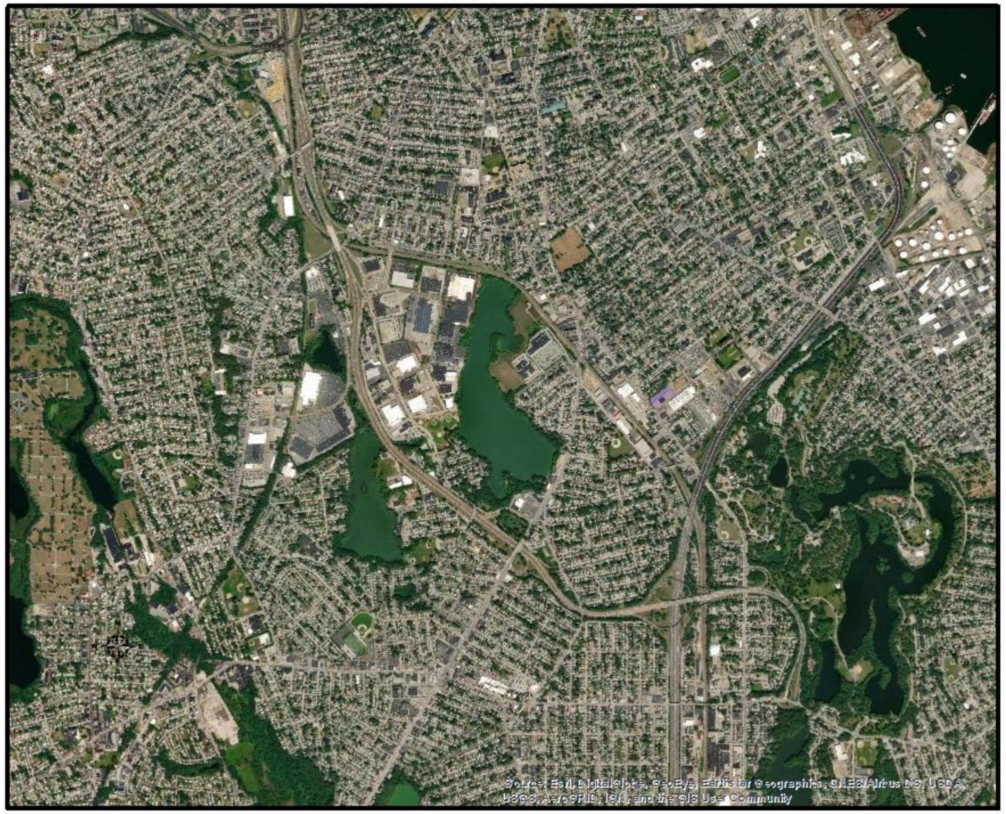
- How do cyanobacteria change over time and across a lake?
- How does the production of cyanotoxins change over space and time?
- What is driving the changes in cyanobacteria?
  - Temperature?
  - Nutrients?
  - Ecological communities?

Study Ponds

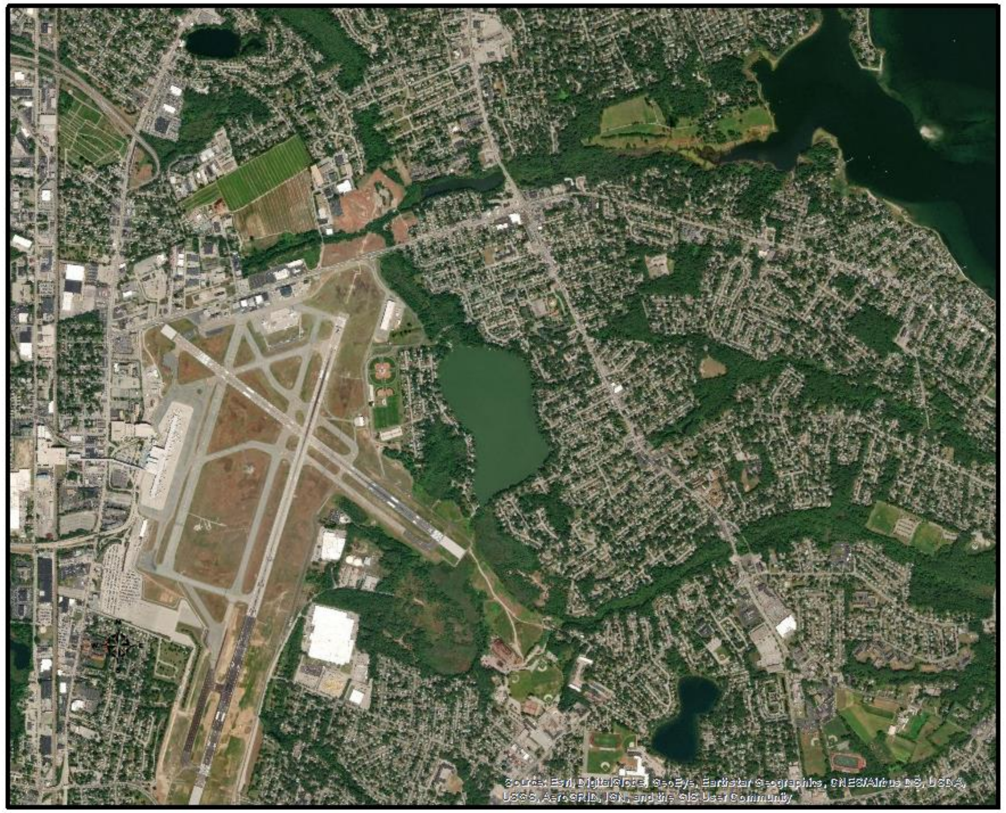

Mashapaug Pond
Warwick Pond
EPA
Yawgoo Pond
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Ponds

Mashapaug Pond

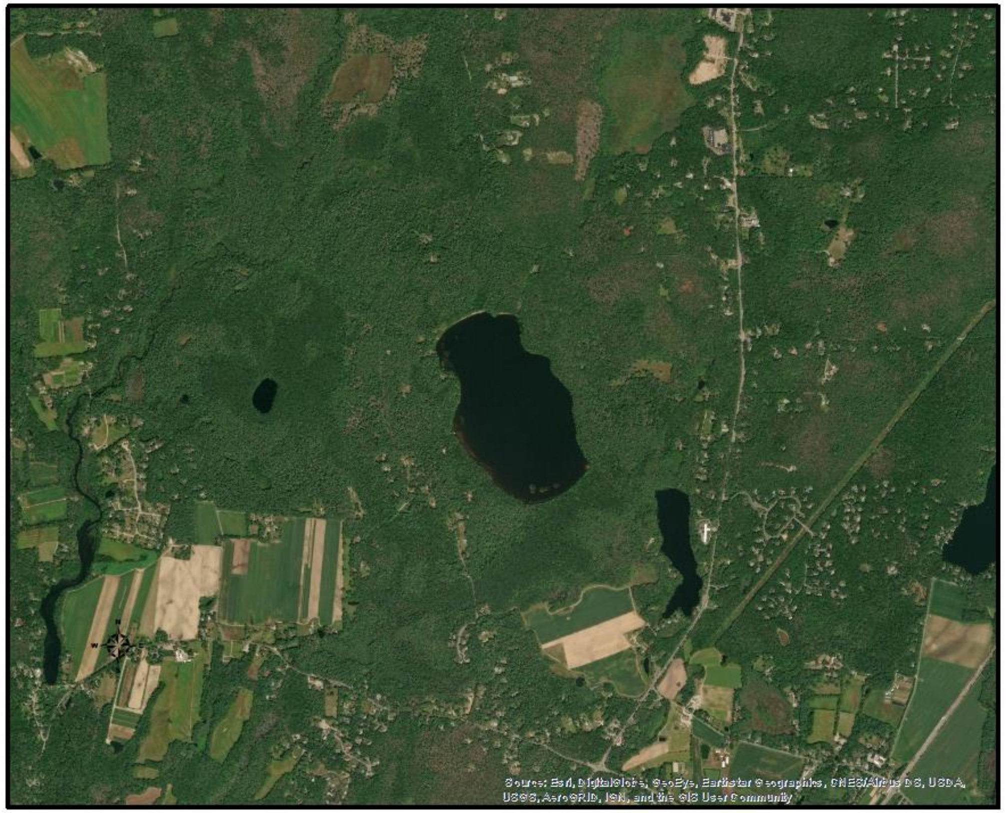


Warwick Pond

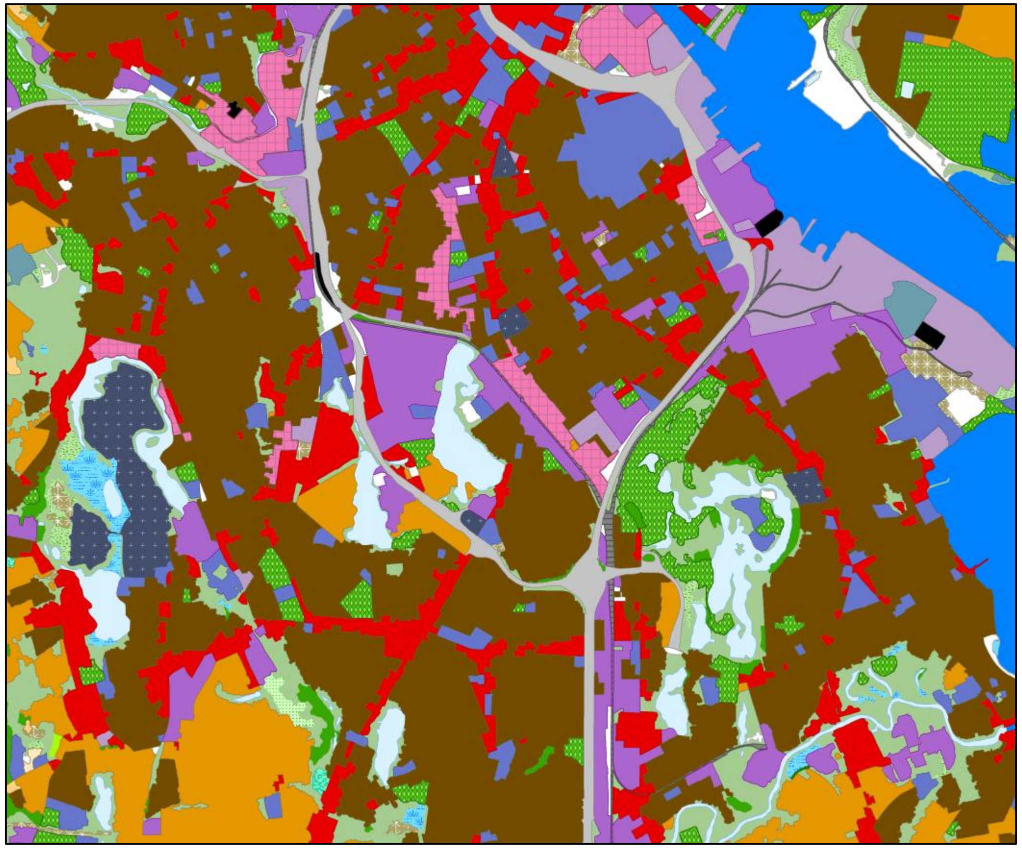


Study Ponds

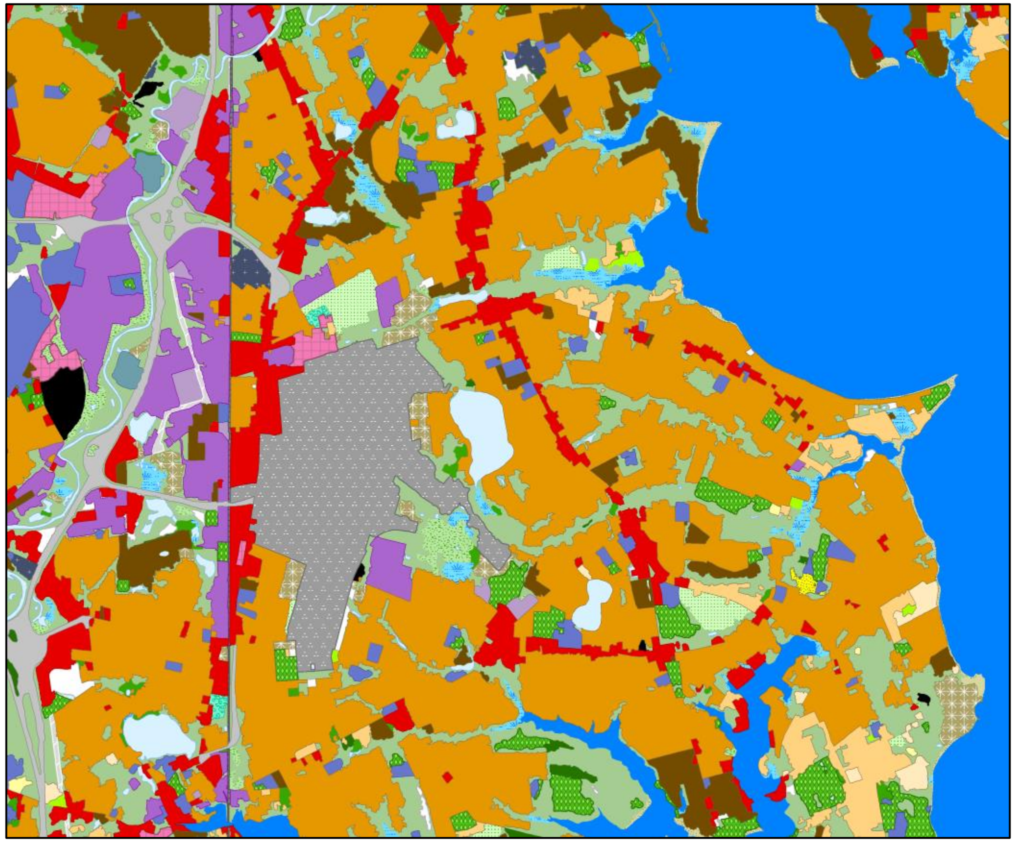
Yawgoo Pond



Mashapaug Pond



Warwick Pond



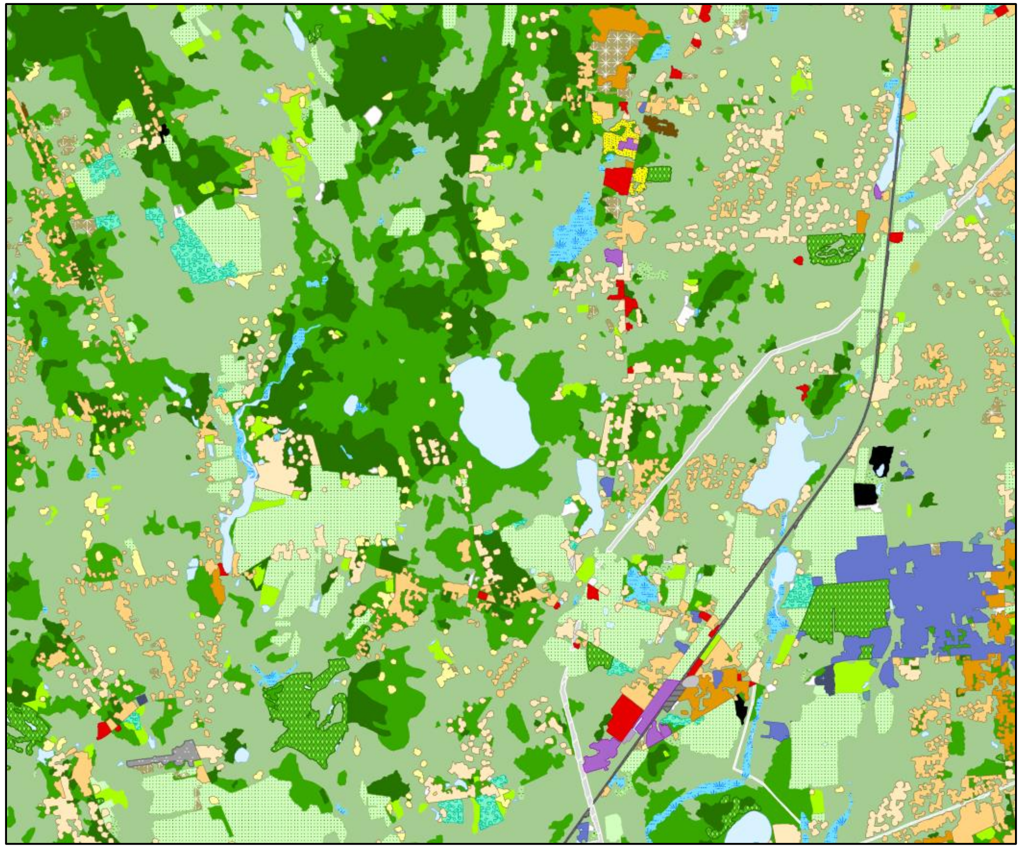
Legend

rilc11d

Land Description

- High Density Residential (<1/8 acre lots)
- Medium High Density Residential (1/4 to 1/8 acre lots)
- Medium Density Residential (1 to 1/4 acre lots)
- Medium Low Density Residential (1 to 2 acre lots)
- Low Density Residential (>2 acre lots)
- Commercial (Sale of products and services)
- Commercial/Residential Mixed
- Commercial/Industrial Mixed
- Industrial (manufacturing, design, assembly, etc.)
- Institutional (schools, hospitals, churches, etc.)
- Cemeteries
- Power Lines (100' or more width)
- Roads (divided highways > 200' plus related facilities)
- Airports (and associated facilities)
- Railroads (and associated facilities)
- Waste Disposal (landfills, junkyards,etc.)
- Water and Sewage Treatment
- Other Transportation (terminals, docks, etc.)
- Developed Recreation (all recreation)
- Cropland (tillable)
- Orchards, Groves, Nurseries
- Confined Feeding Operations
- Pasture (agricultural not suitable for tillage)
- Idle Agriculture (abandoned fields and orchards)
- Brushland (shrub and brush areas, reforestation)
- Deciduous Forest (>80% hardwood)
- Softwood Forest (>80% softwood)
- Mixed Forest
- Water
- Wetland
- Vacant Land
- Transitional Areas (urban open)
- Mines, Quarries and Gravel Pits
- Beaches
- Sandy Areas (not beaches)
- Mixed Barren Areas
- Rock Outcrops

Yawgoo Pond



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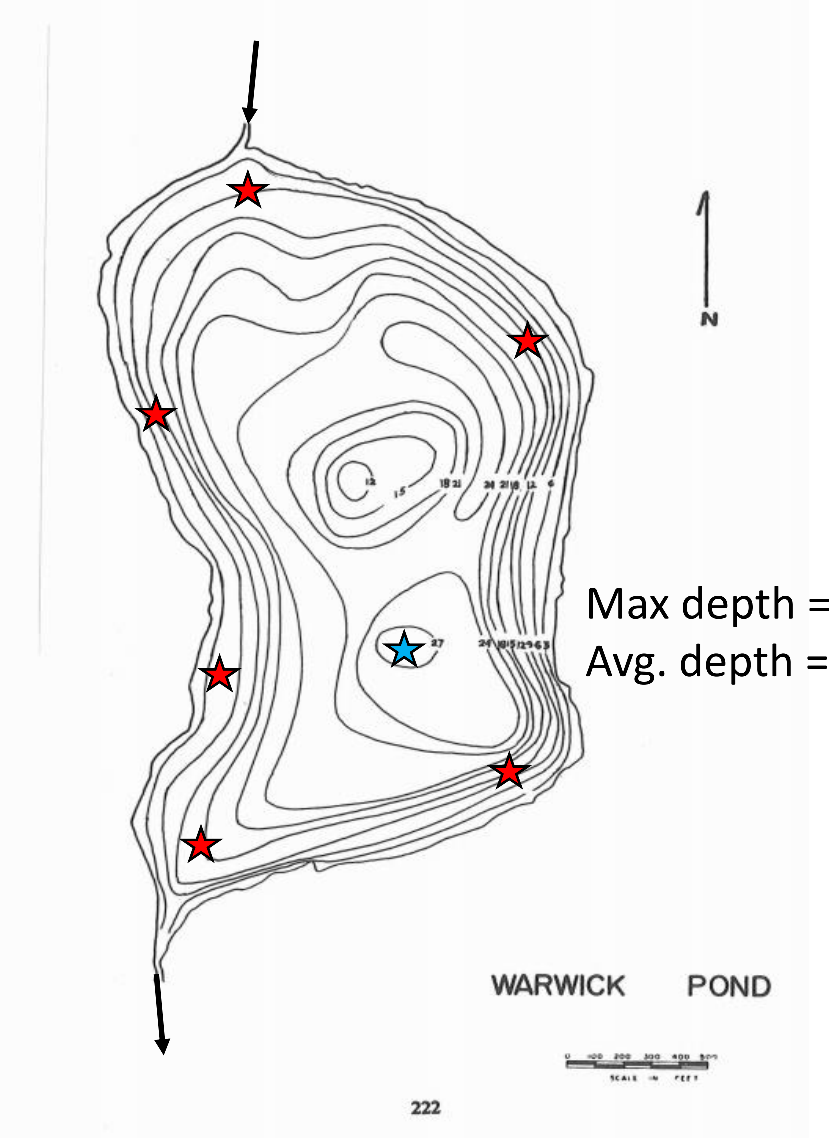
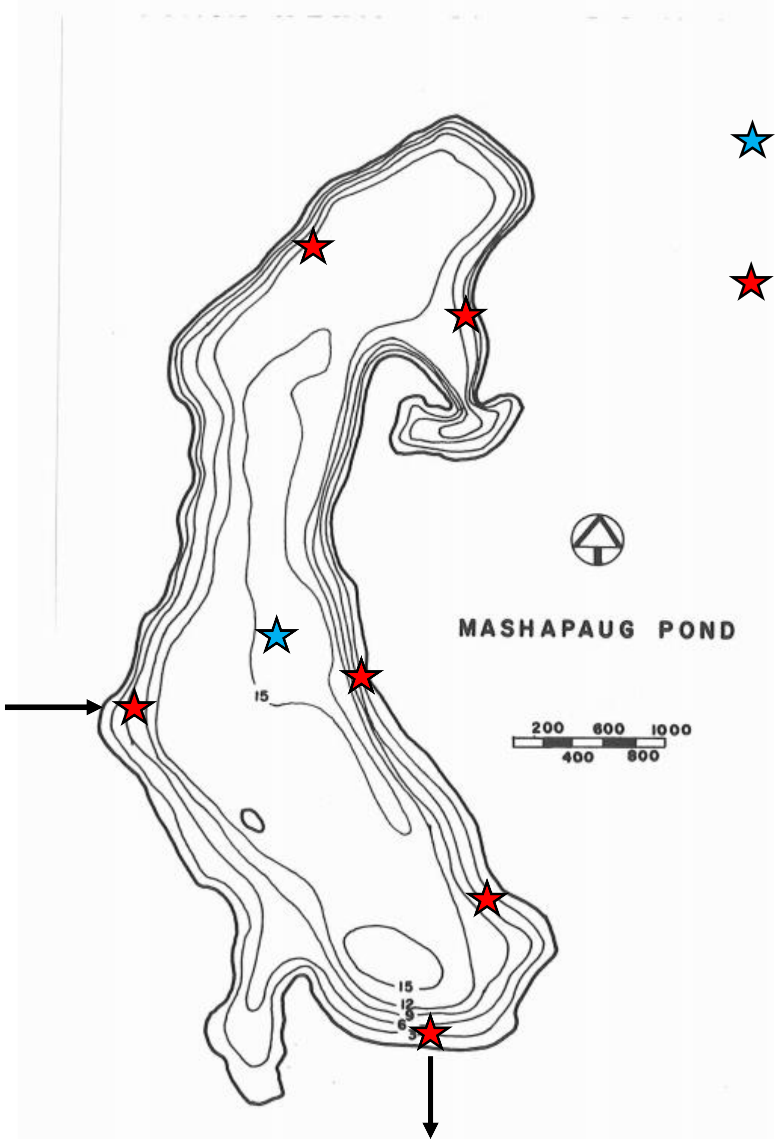
Methods – Sampling Sites



Max depth = 7.9 m
Avg. depth = 4.3 m



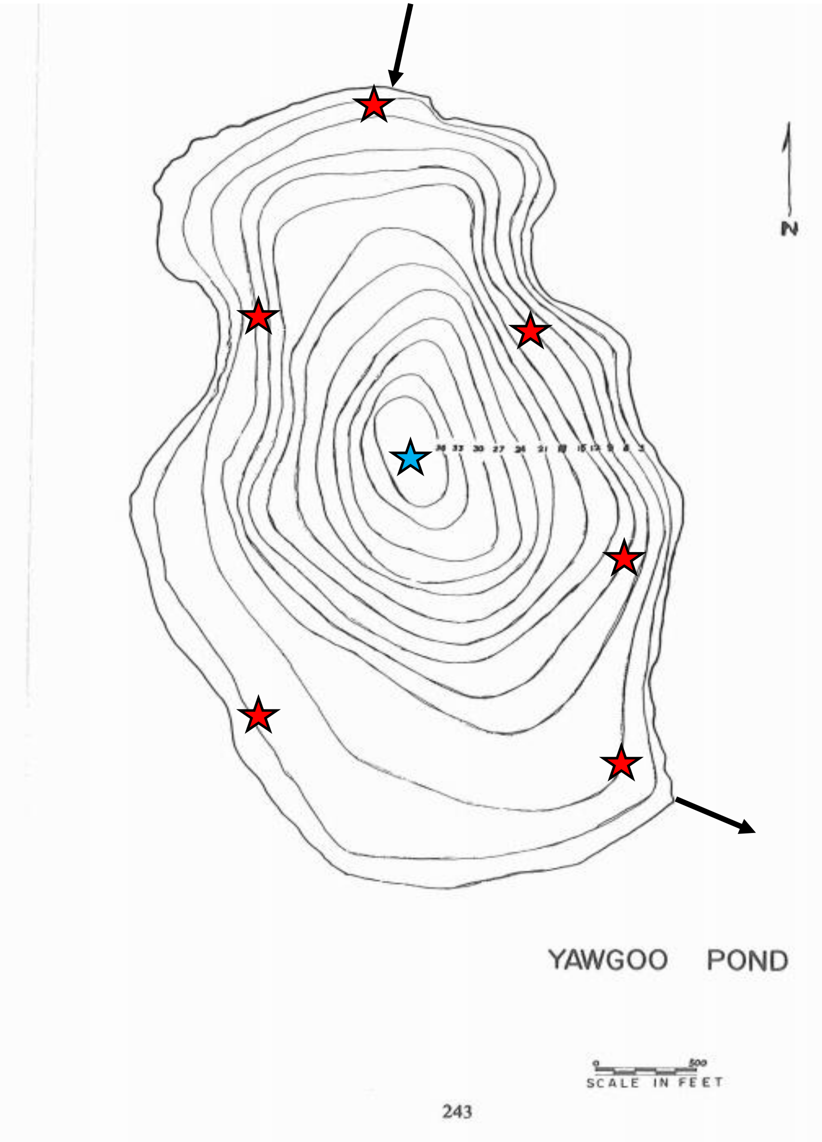
Deep Site
Depth = max

Littoral Sites
Depth = >2m

Max depth = 5.2 m
Avg. depth= 2.1 m

Bathymetry maps and basic limnology from Guthrie and Stolgitis 1977

Methods – Sampling Sites



Deep Site
Depth = max

Littoral Sites
Depth = >2m

Max depth = 11.2 m
Avg. depth= 2.7 m

Bathymetry maps and basic limnology from Guthrie and Stolgitis 1977

Methods – Littoral Sites

- Physical parameters (temperature, DO, pH, conductivity) measured with a YSI sonde at 0, 1, and 2 m
- Secchi depth
- 2 m integrated water samples collected
- Water samples analyzed for chlorophyll *a,* phycocyanin, turbidity, and toxins

Why do we measure these biological parameters?

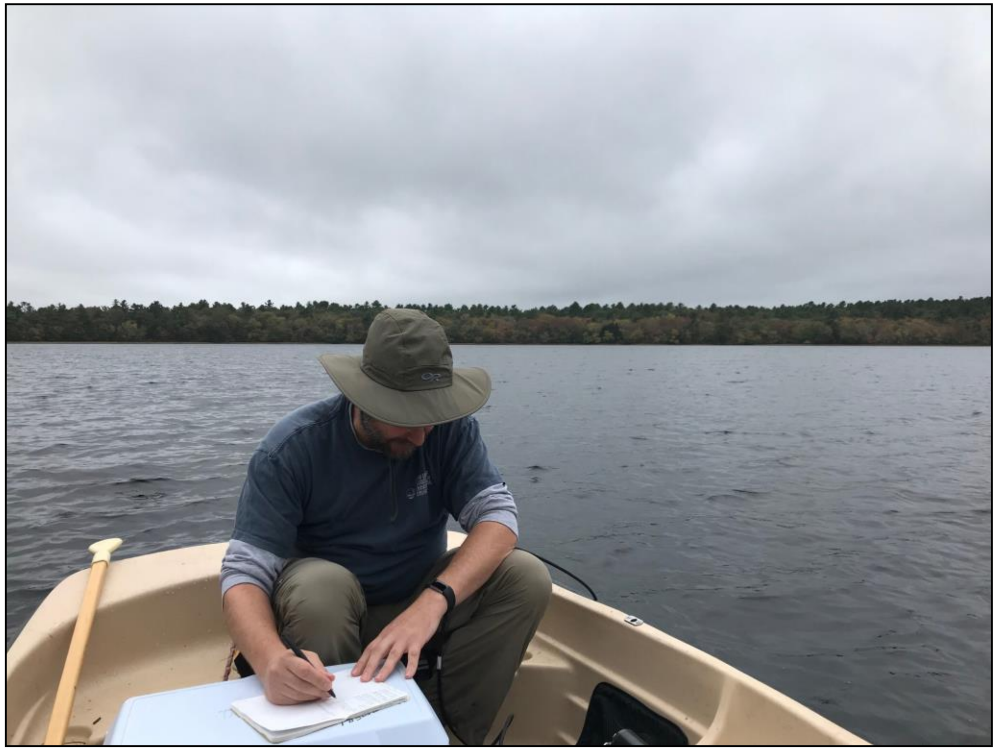
- Chlorophyll a
  - Pigment in photosynthetic organisms
  - A proxy for total algal (both green algae and cyanobacteria) biomass

- Phycocyanin
  - An accessory pigment found in cyanobacteria
  - A proxy for cyanobacteria biomass

Why do we measure these physical parameters?

- Temperature
  - May be considered a “master variable” affecting bloom dynamics
  - Generally, warmer water increases bloom activity

- Dissolved oxygen
  - As the bloom dies, decomposition consumes oxygen
  - If enough oxygen is consumed, aquatic life (i.e. fish) cannot be supported



Why do we measure these water clarity parameters?

- Turbidity
  - A measure of water clarity based on suspended particulates
  - Increases during a bloom and with increased runoff
- Secchi depth
  - A visual measure of water transparency
  - Very easy to perform with one piece of equipment

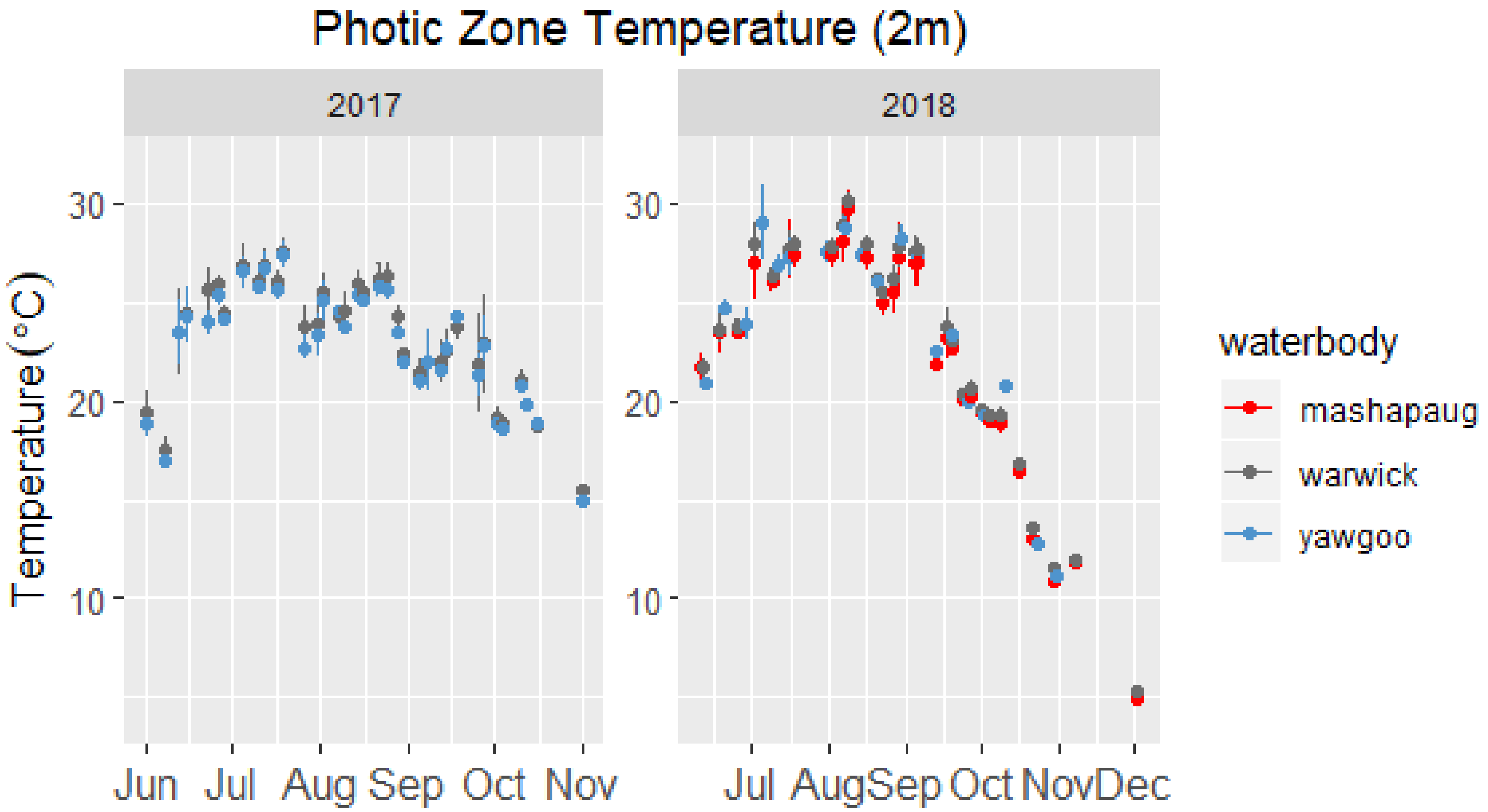
Methods – Deep Sites

- Depth profile of physical parameters (1 m increments)
- Secchi depth
- 2 m integrated water samples collected
- Water samples analyzed for chlorophyll *a,* phycocyanin, turbidity, toxins, and nutrients (NO_3, PO_4, NH_4, TN, and TP)
- 5 m zooplankton tows (50 *u*m and 150 *u*m mesh)

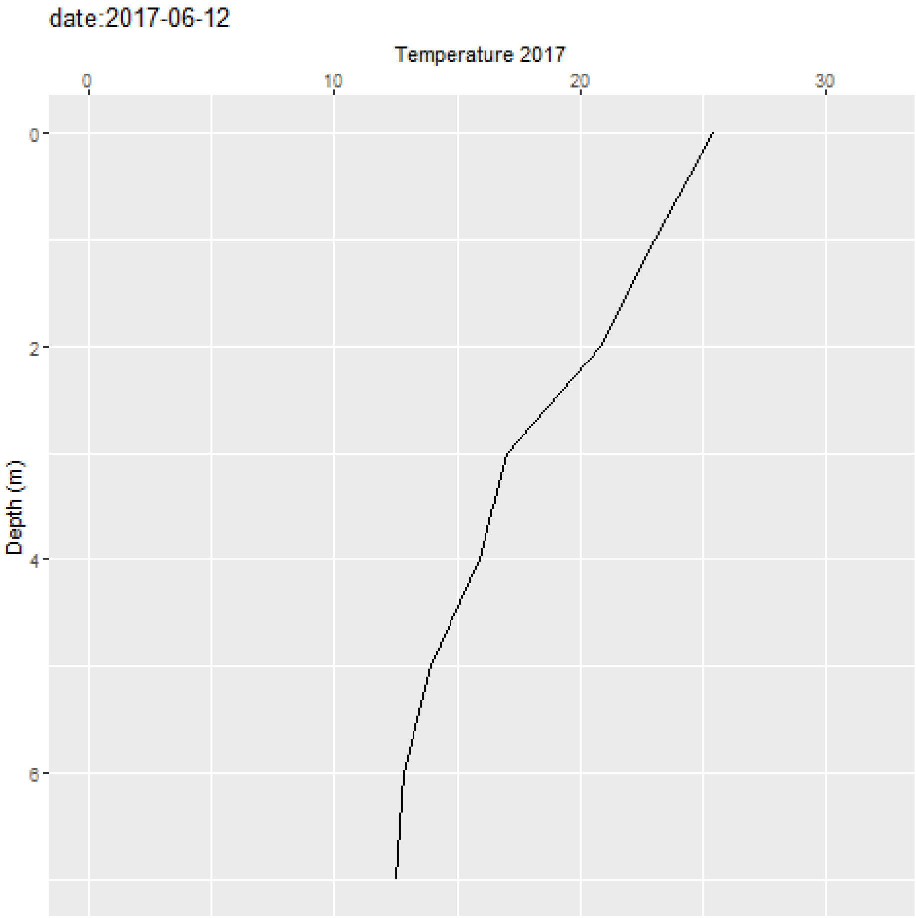
Methods – Frequency

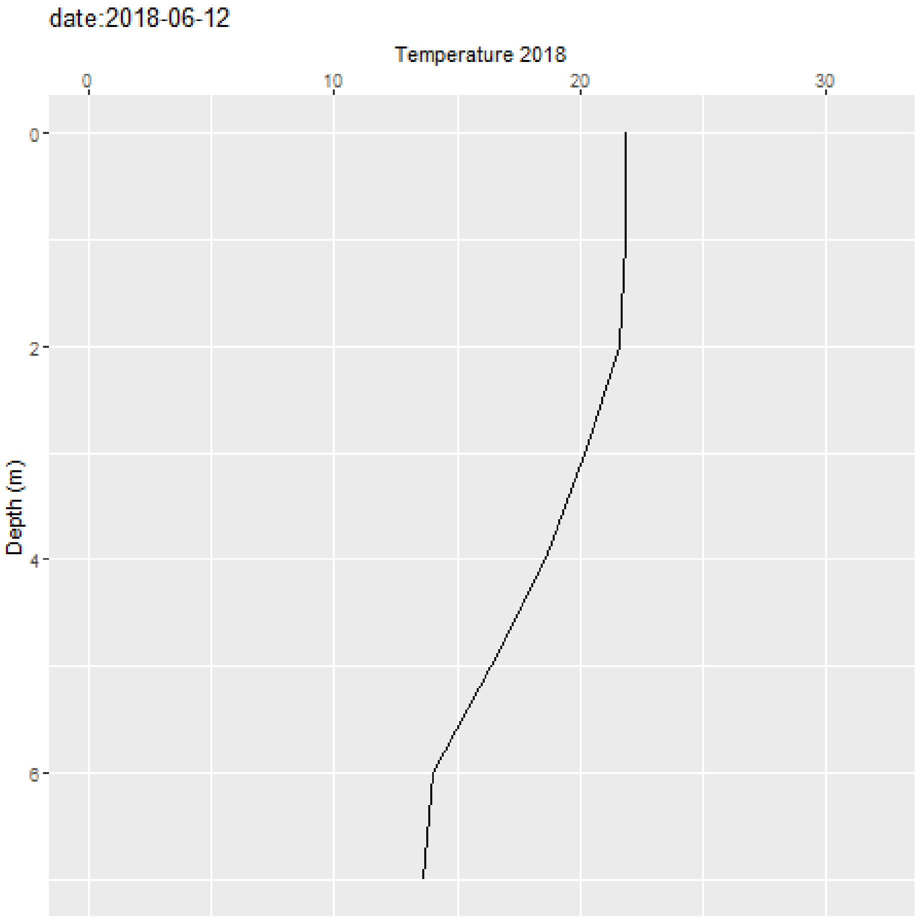
- Weekly or 2X weekly
- June 2018-November 2018
- 27 sampling trips

Results – Temperature

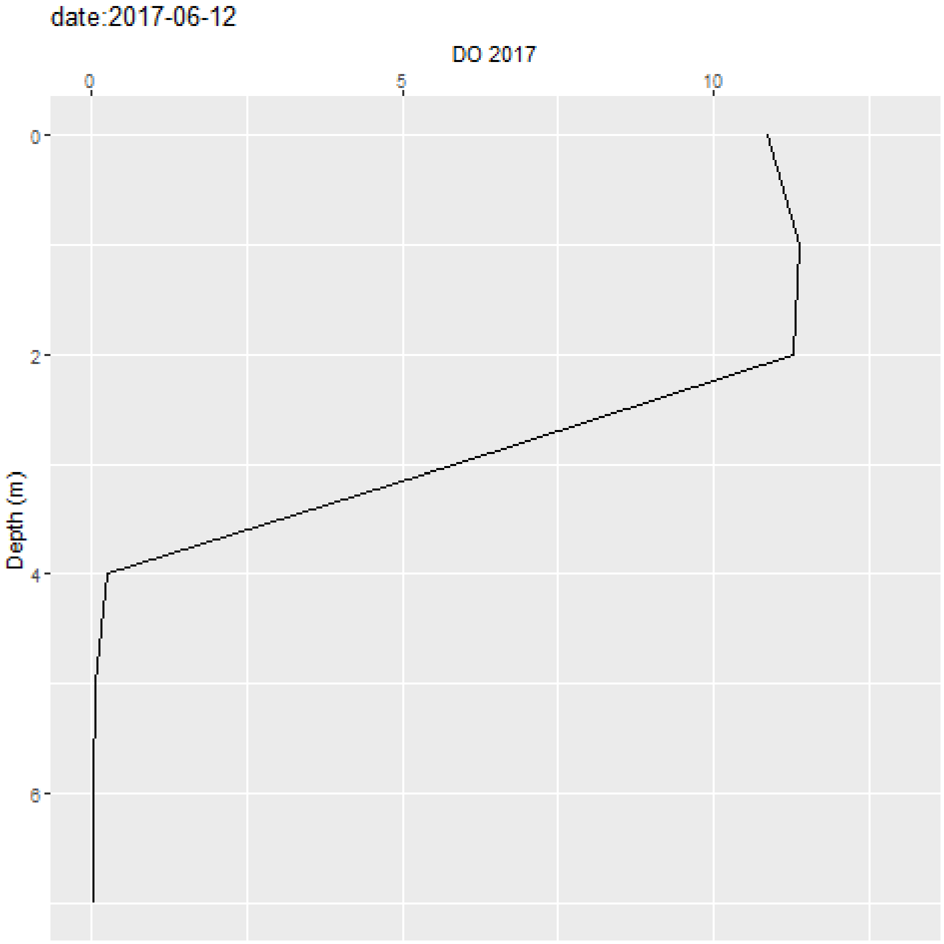


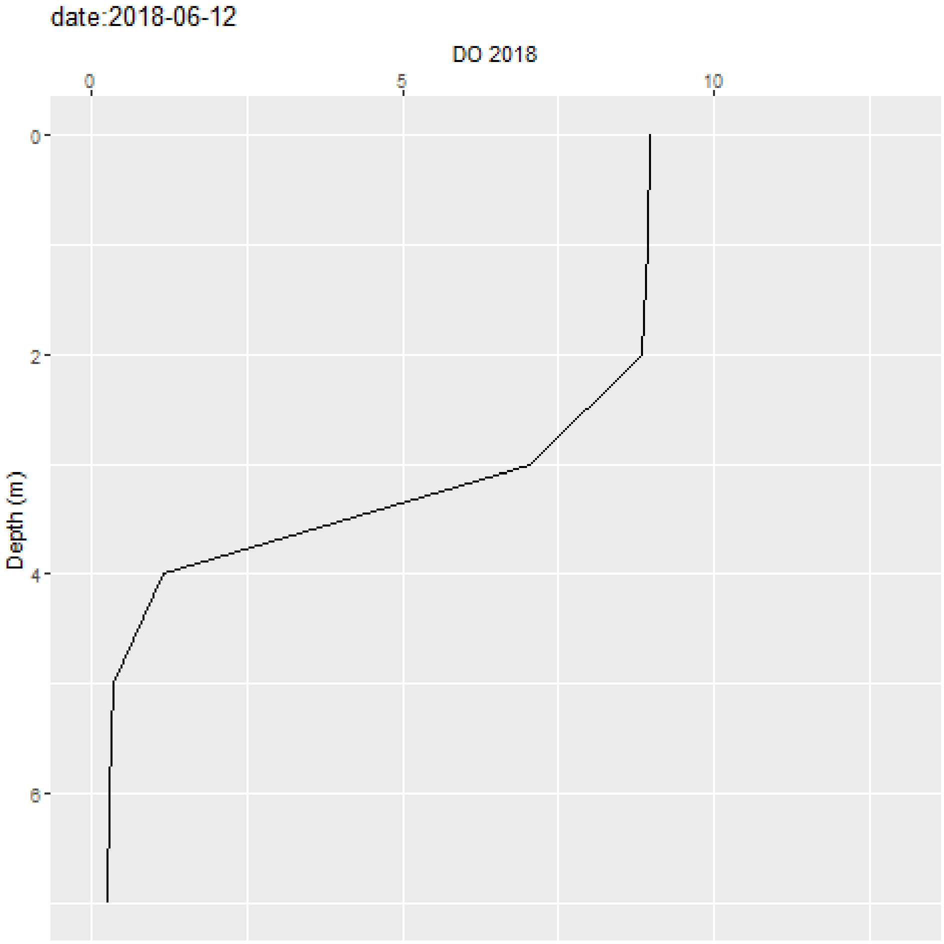
Results – Temperature Depth Profiles



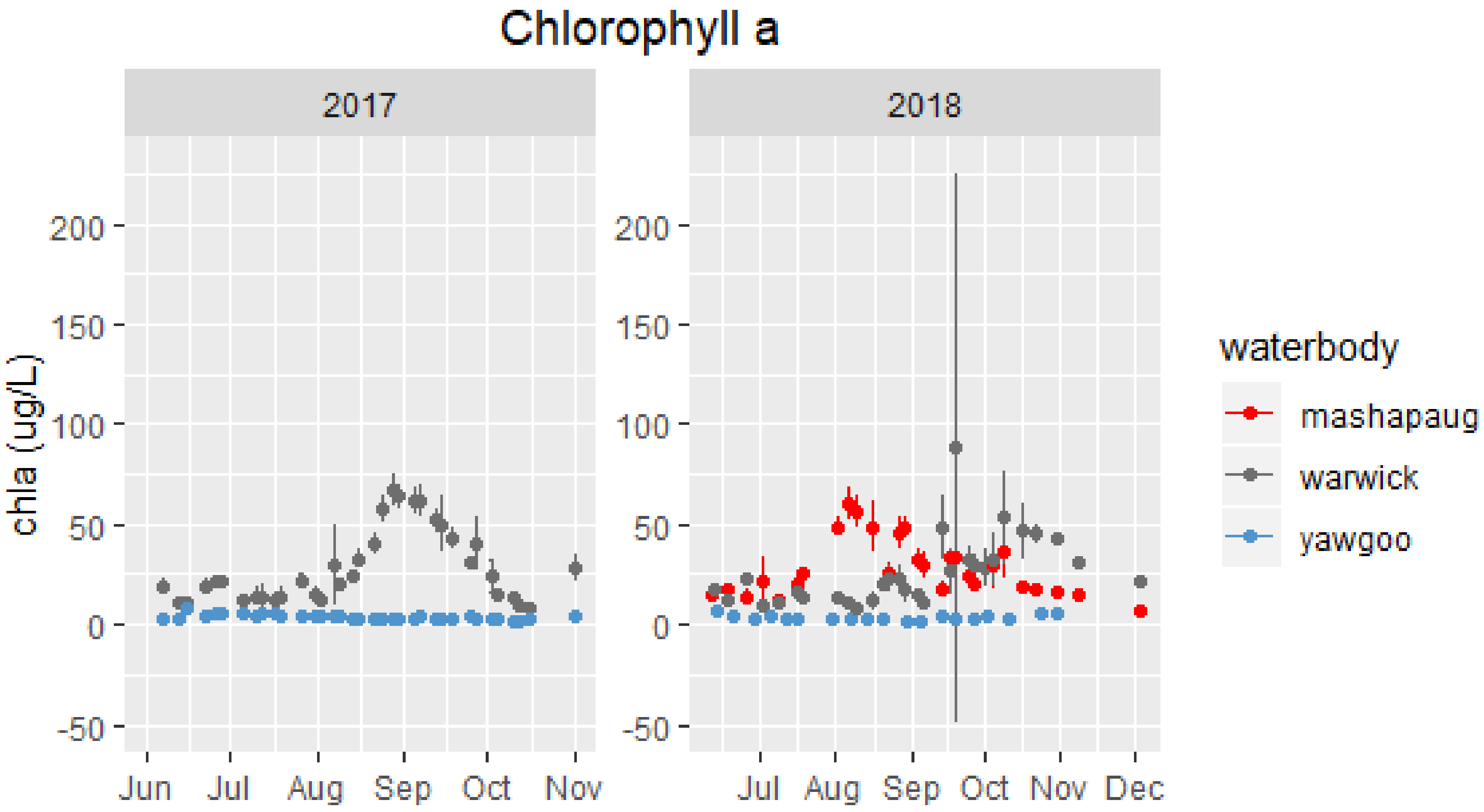


Results – Dissolved Oxygen Depth Profiles

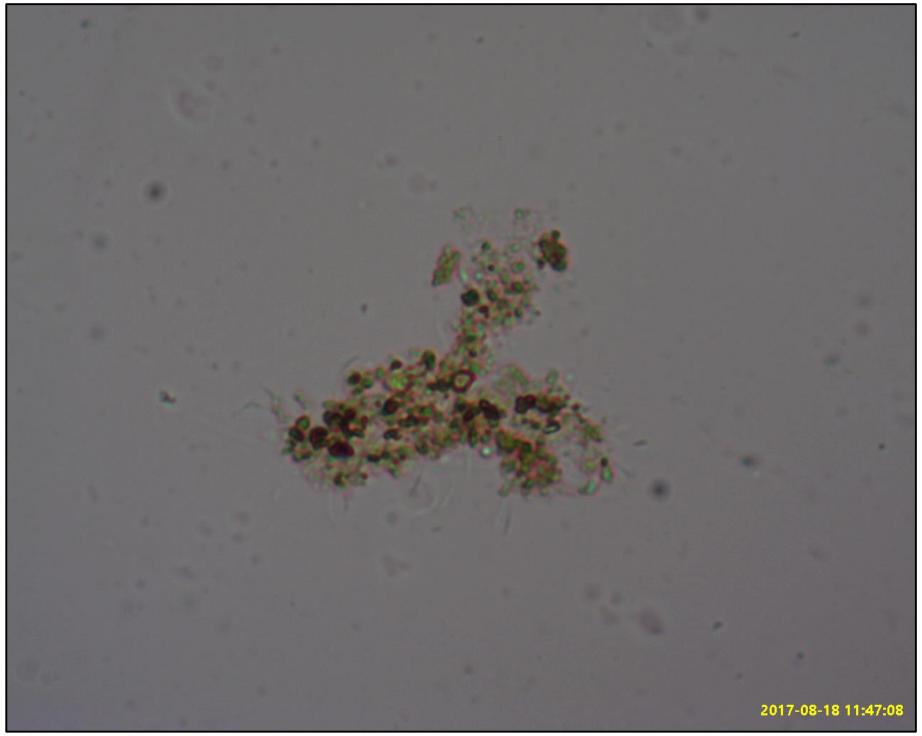


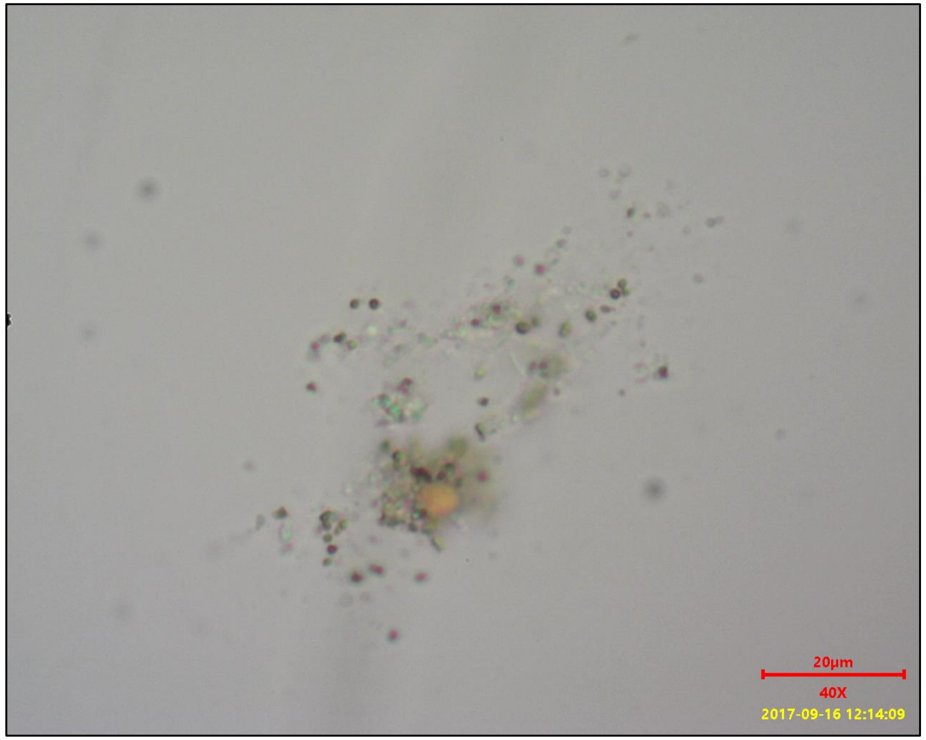


Results – Chlorophyll a



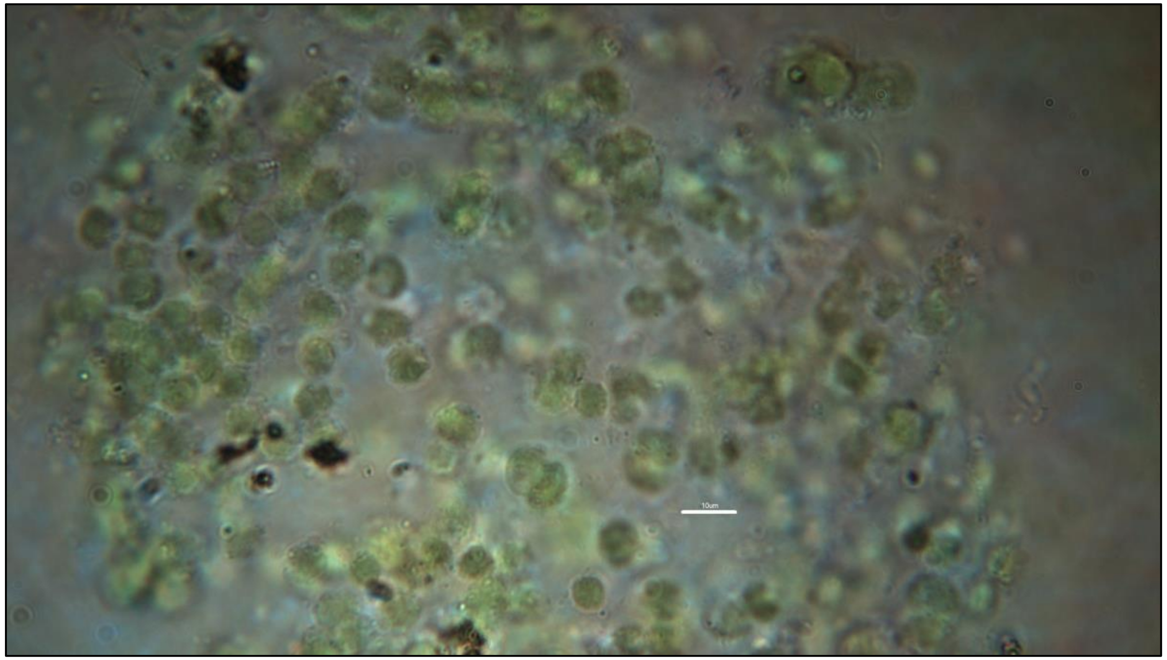
Warwick Bloom 2017



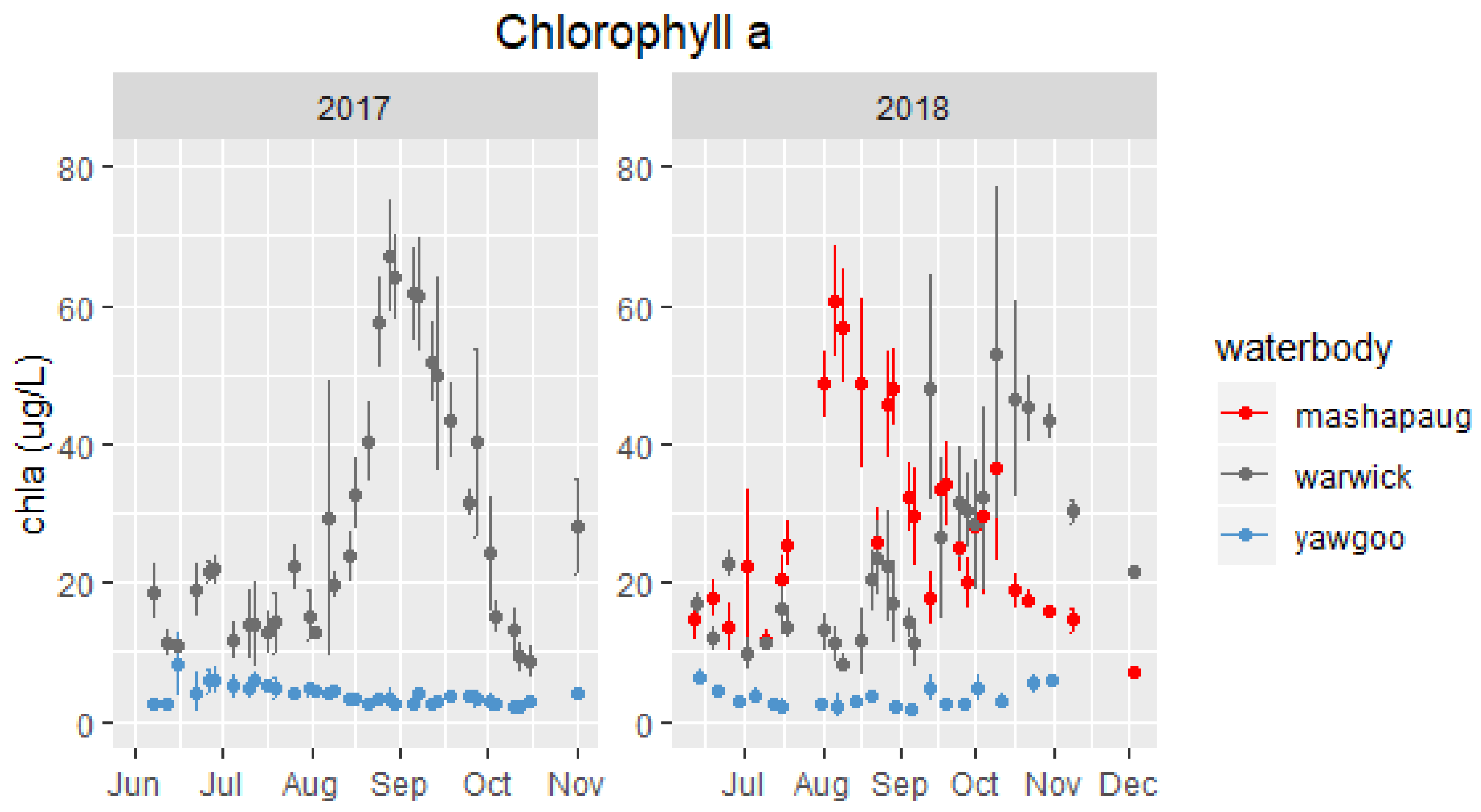


Warwick 2018

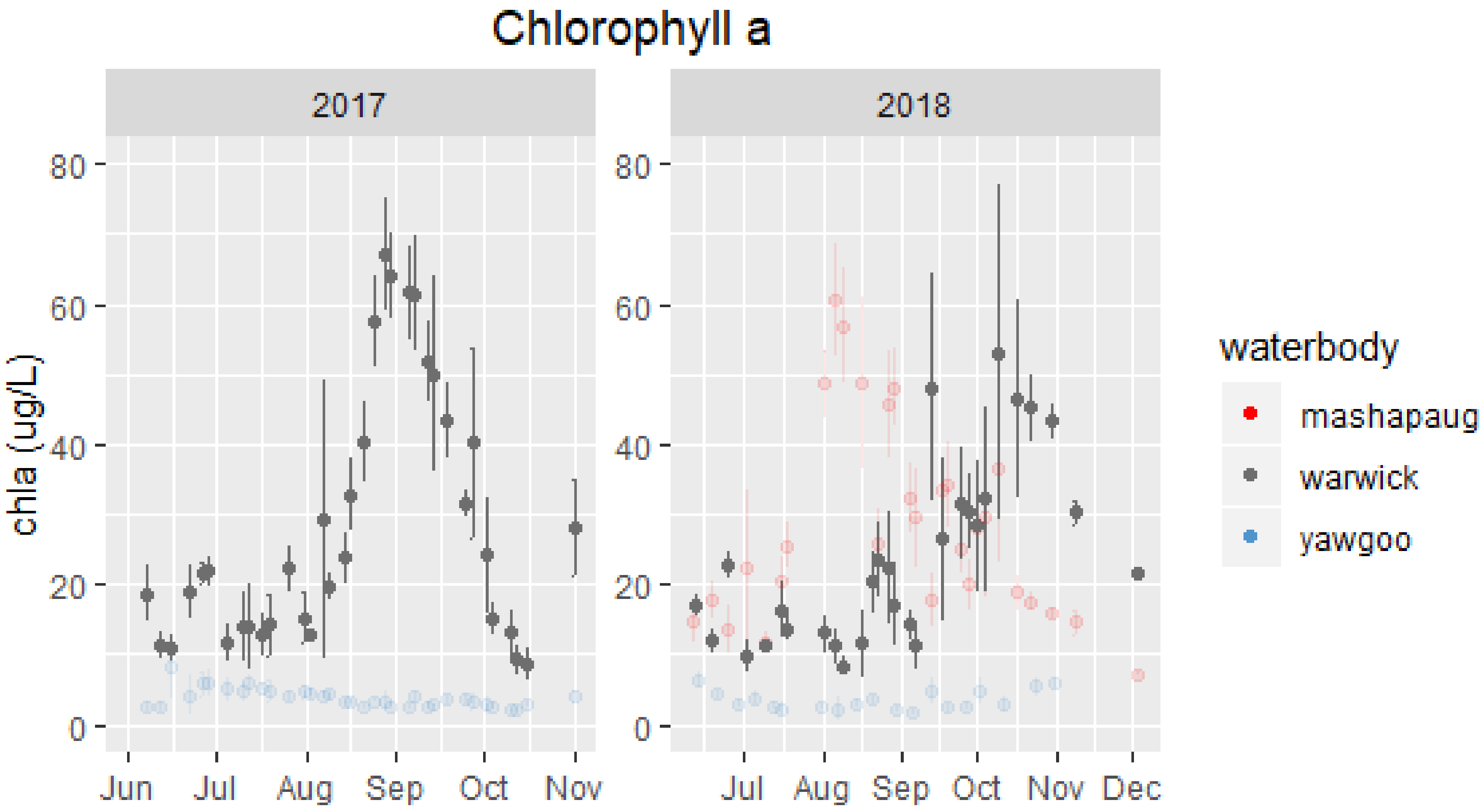
- Most likely a picocyanobacteria



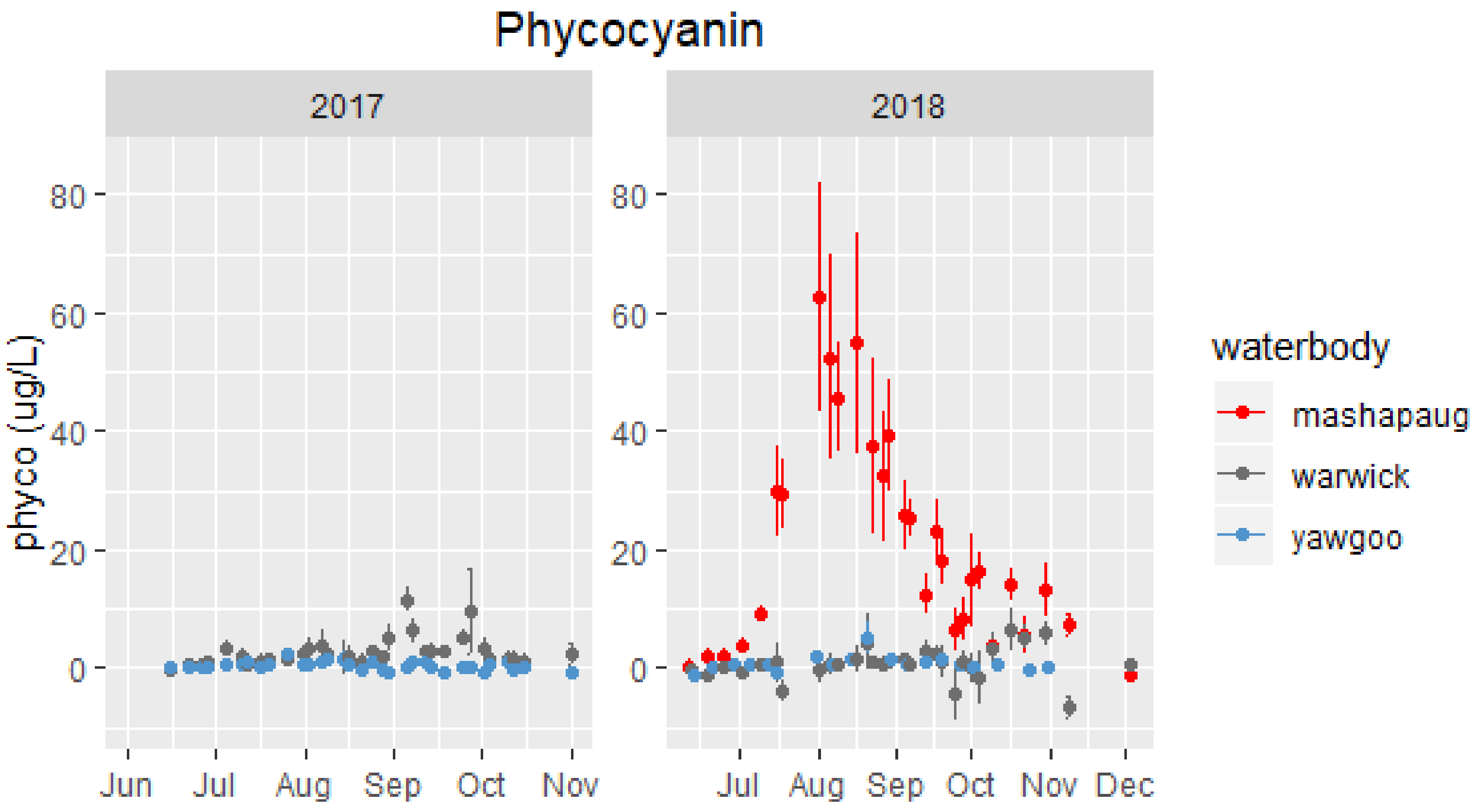
Results – Chlorophyll a



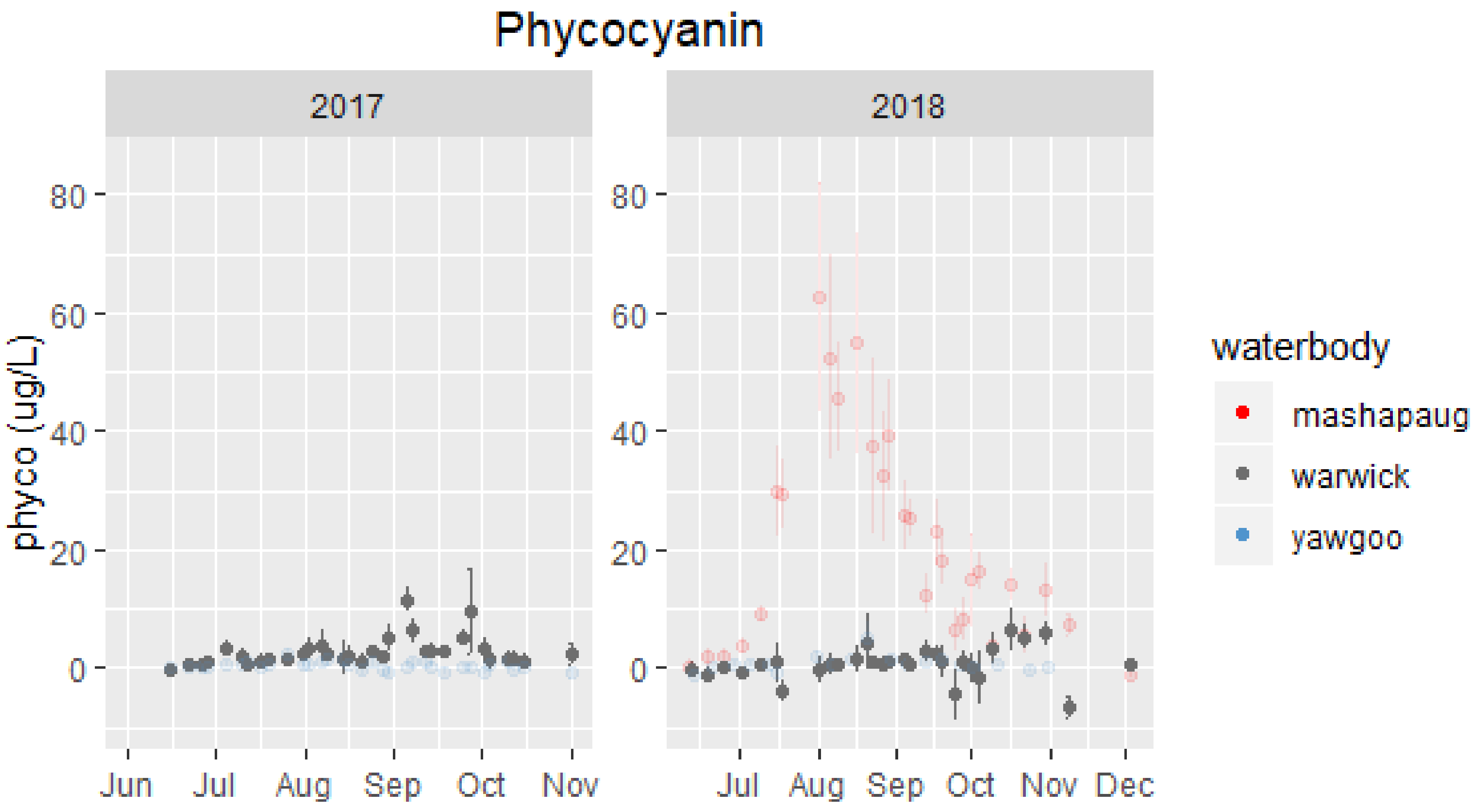
Results – Chlorophyll a



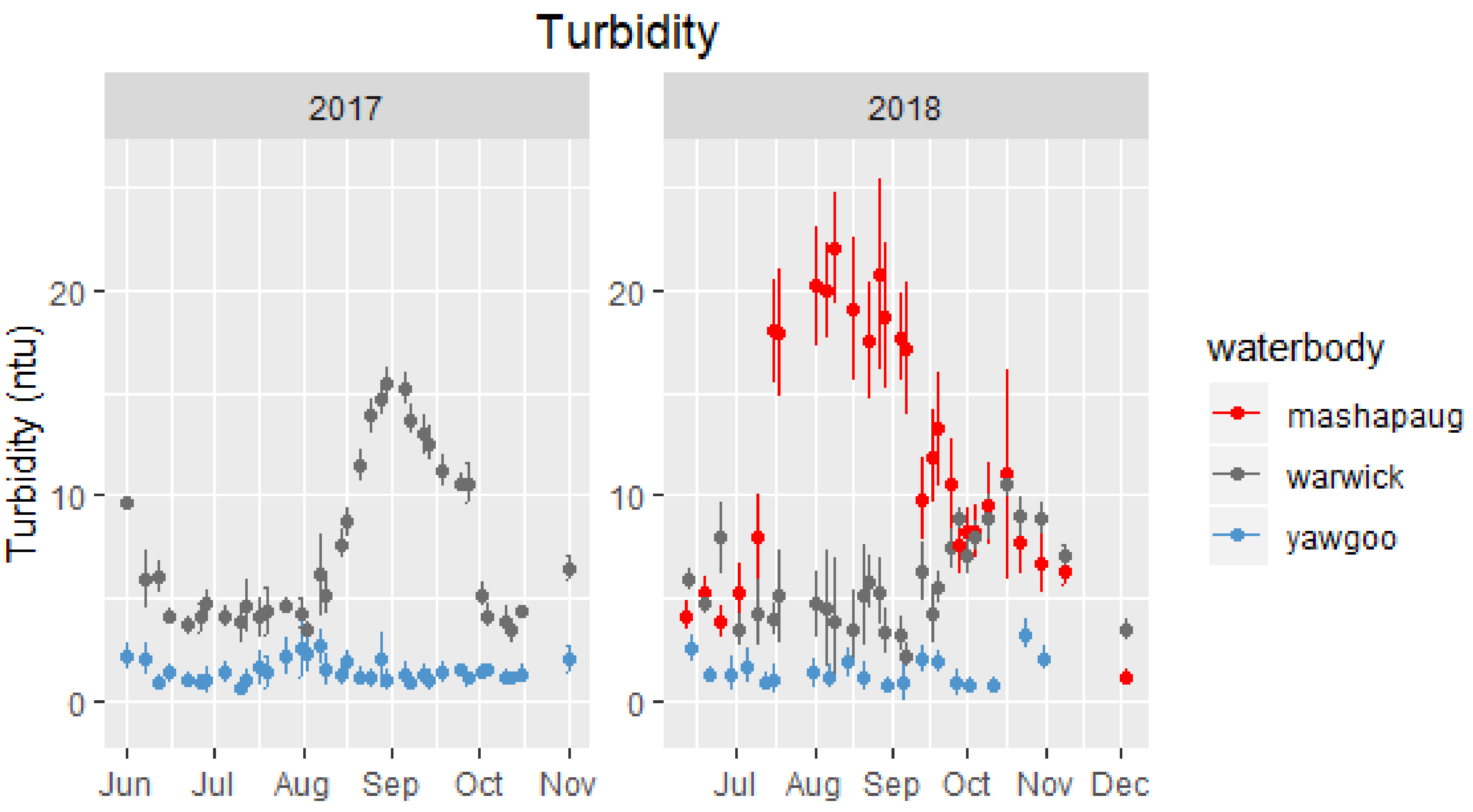
Results – Phycocyanin



Results – Phycocyanin



Results – Water Clarity (Turbidity)



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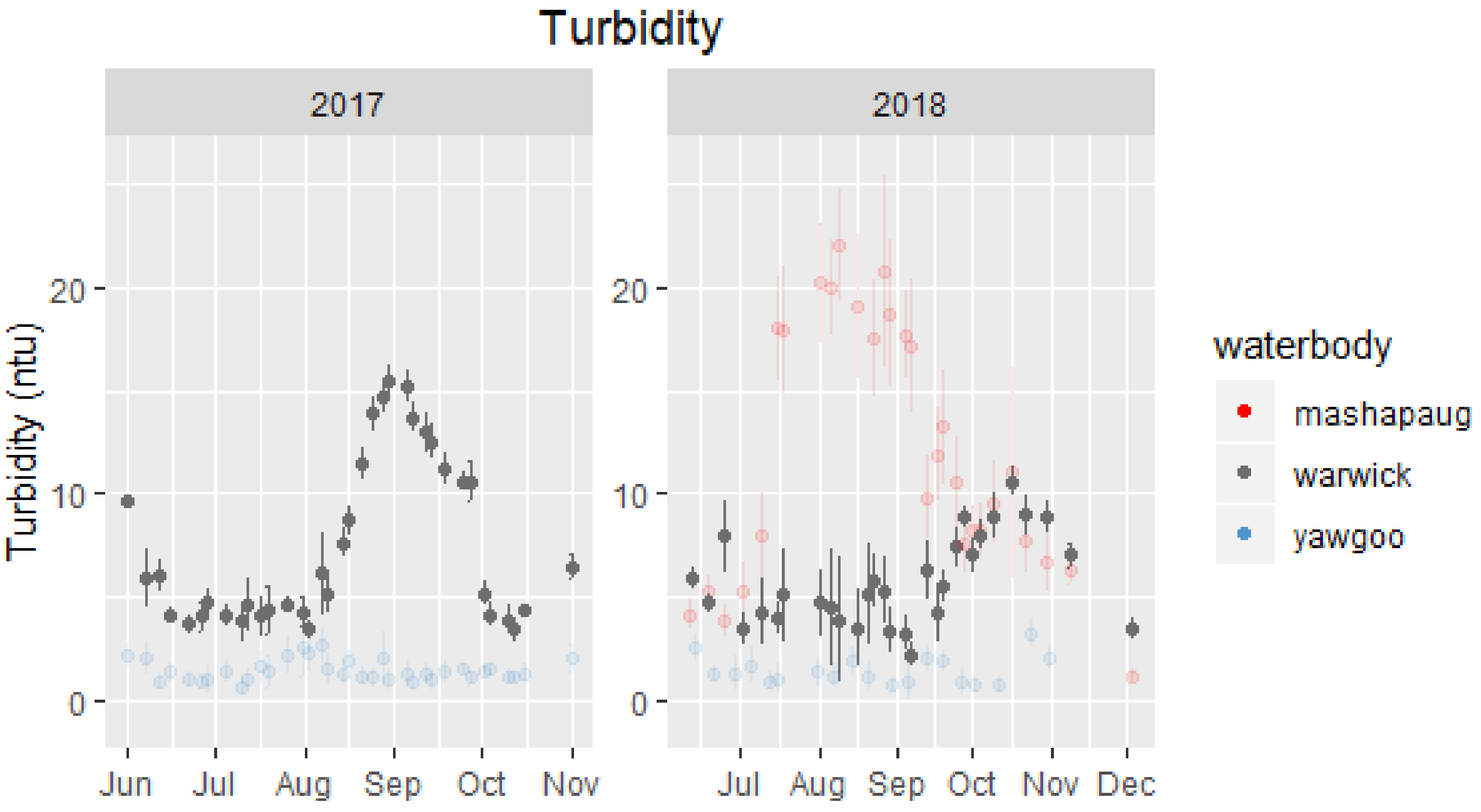
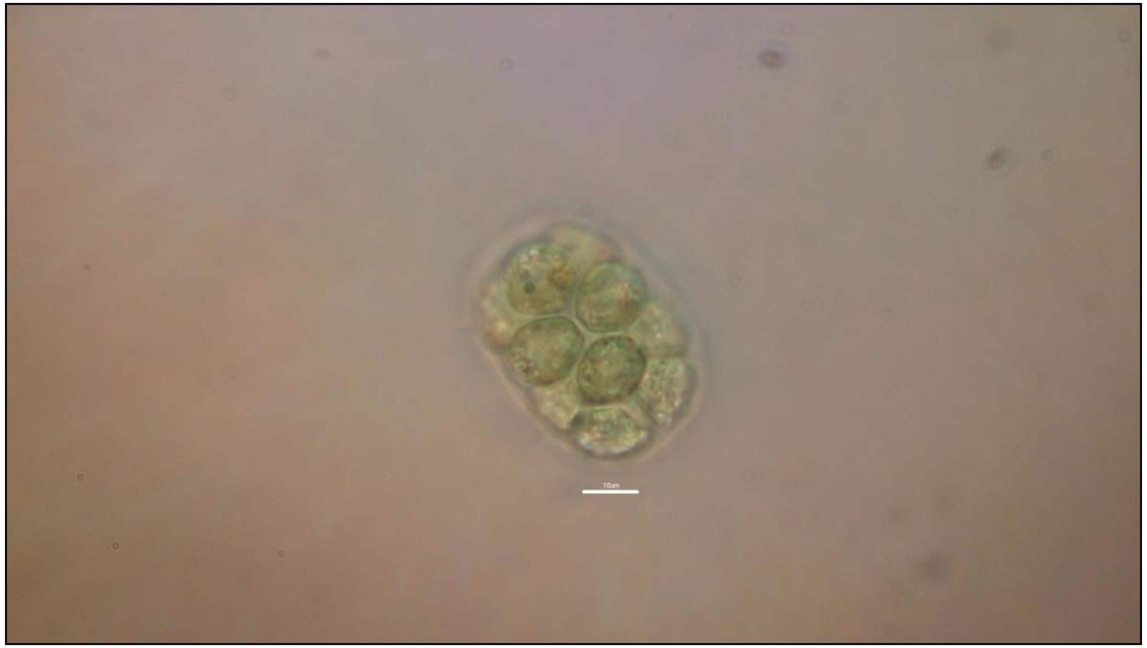


Water Clarity – Mashapaug 2018

Water Clarity – Warwick 2018

Water Clarity – August 27, 2018

August 27, 2018 – Green Algae (Pandorina)

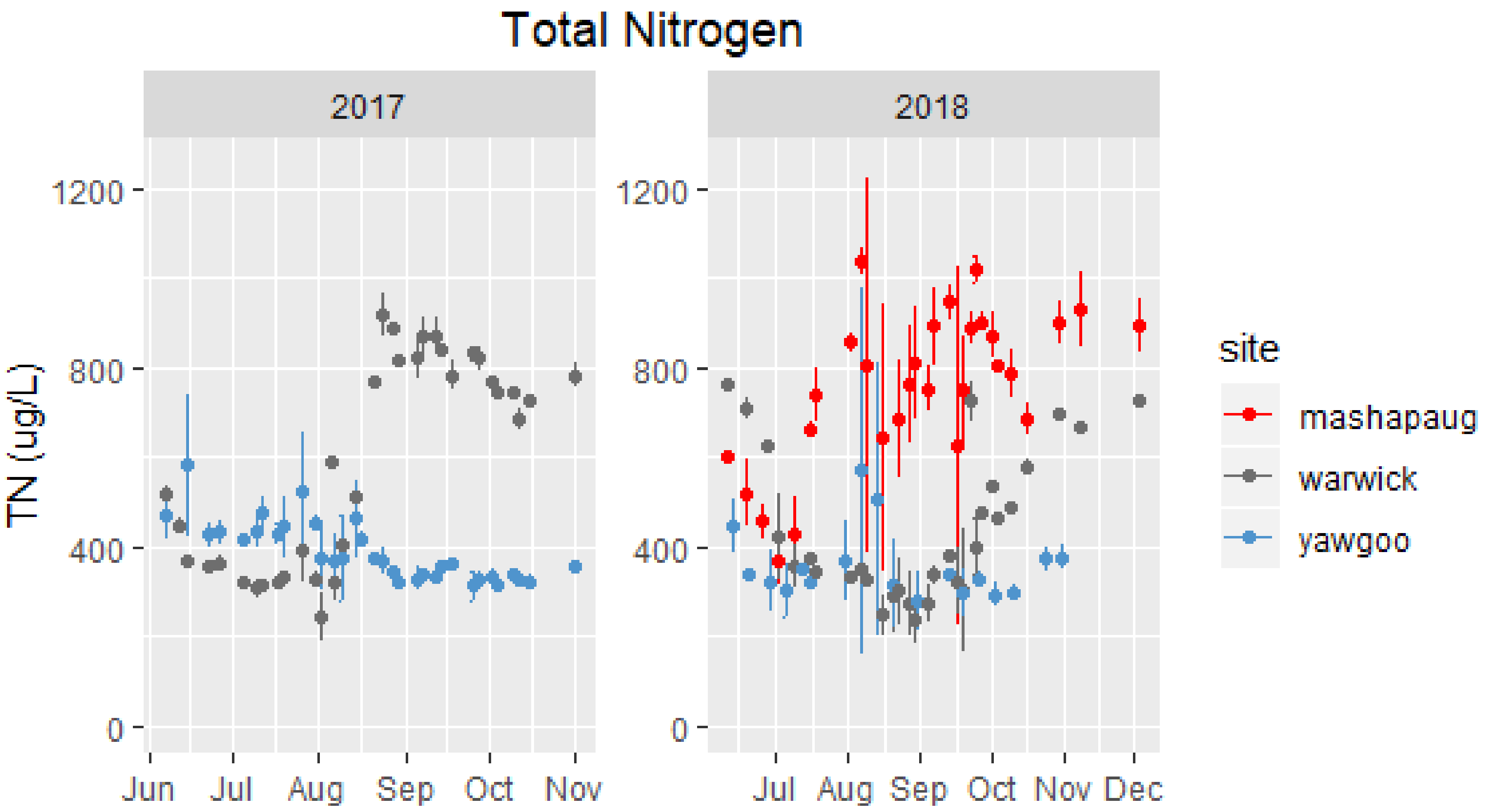


Warwick – Euglenoids

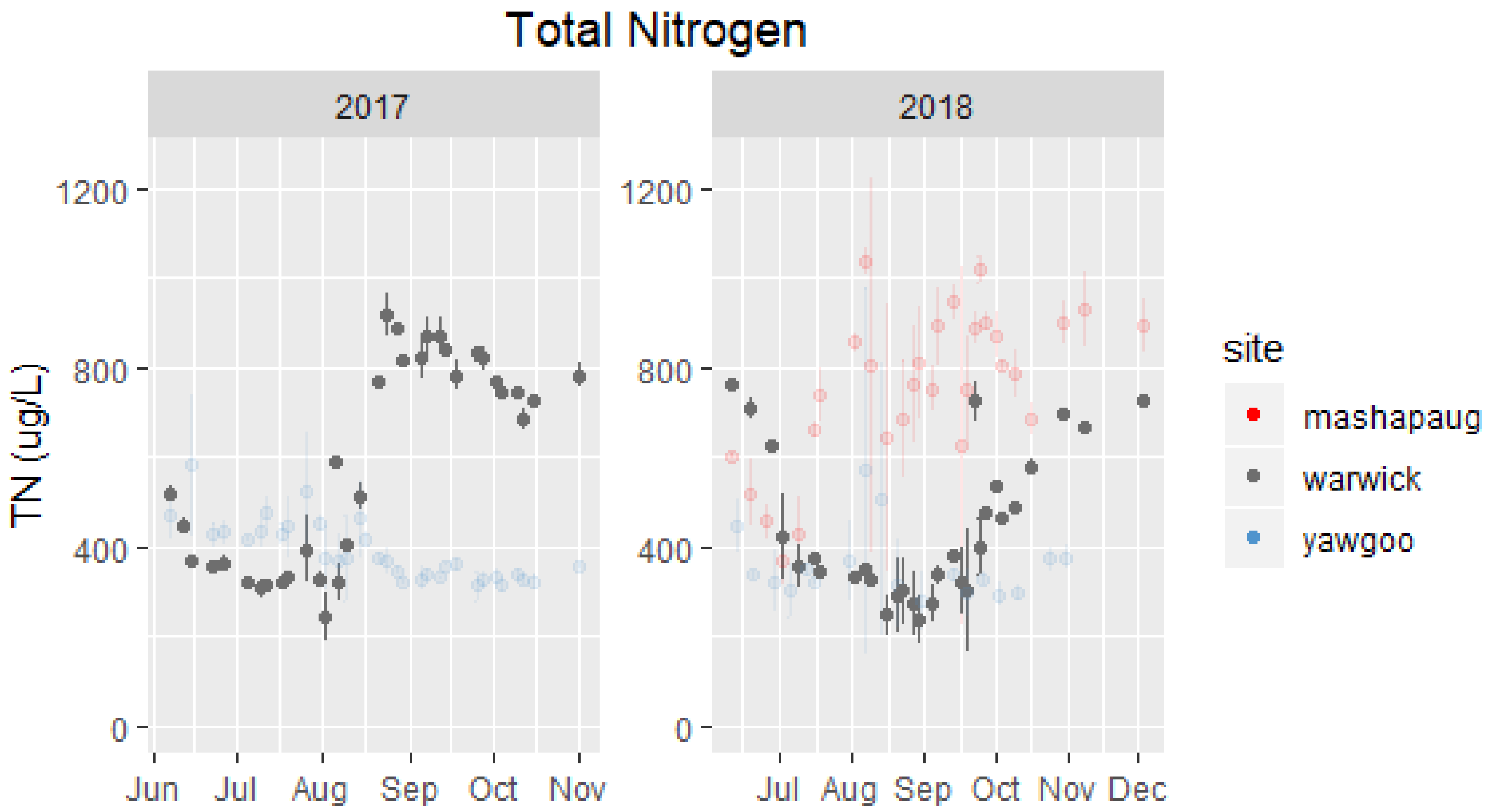
https://www.youtube.com/watch?v=5j2dSJnHa28

https://www.youtube.com/watch?v=piSpSREQsag

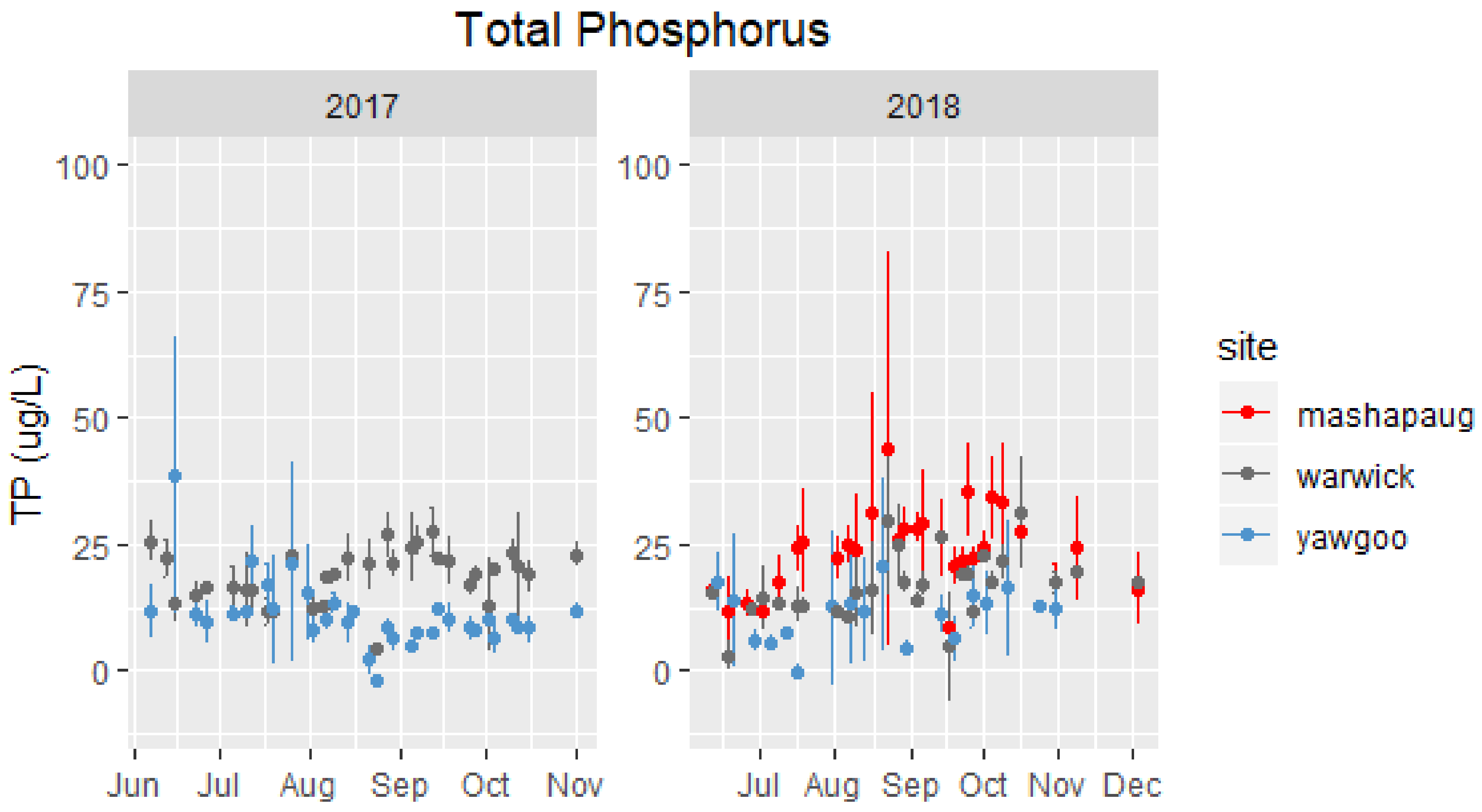
Total Nitrogen



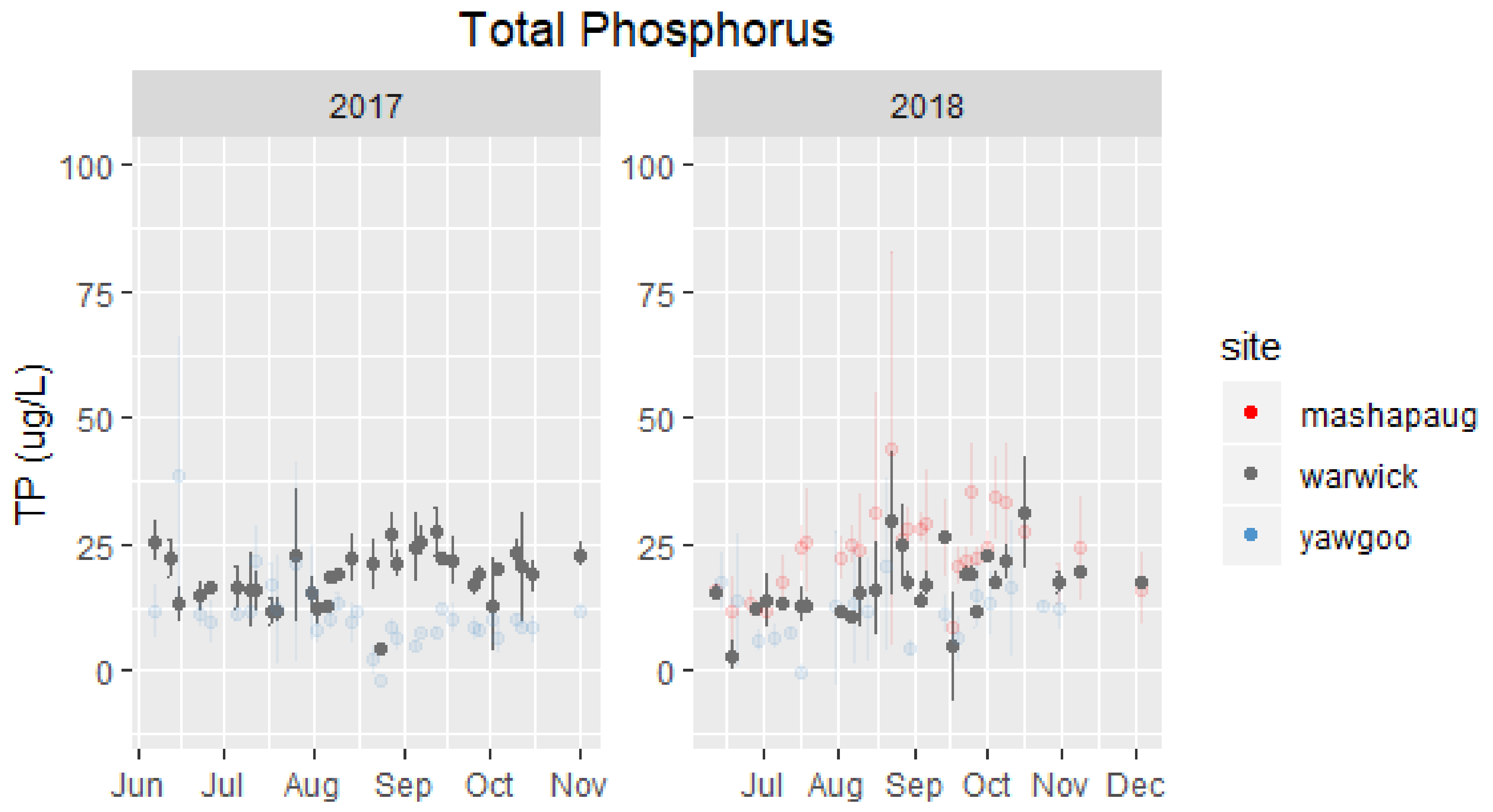
Total Nitrogen



Total Phosphorus



Total Phosphorus

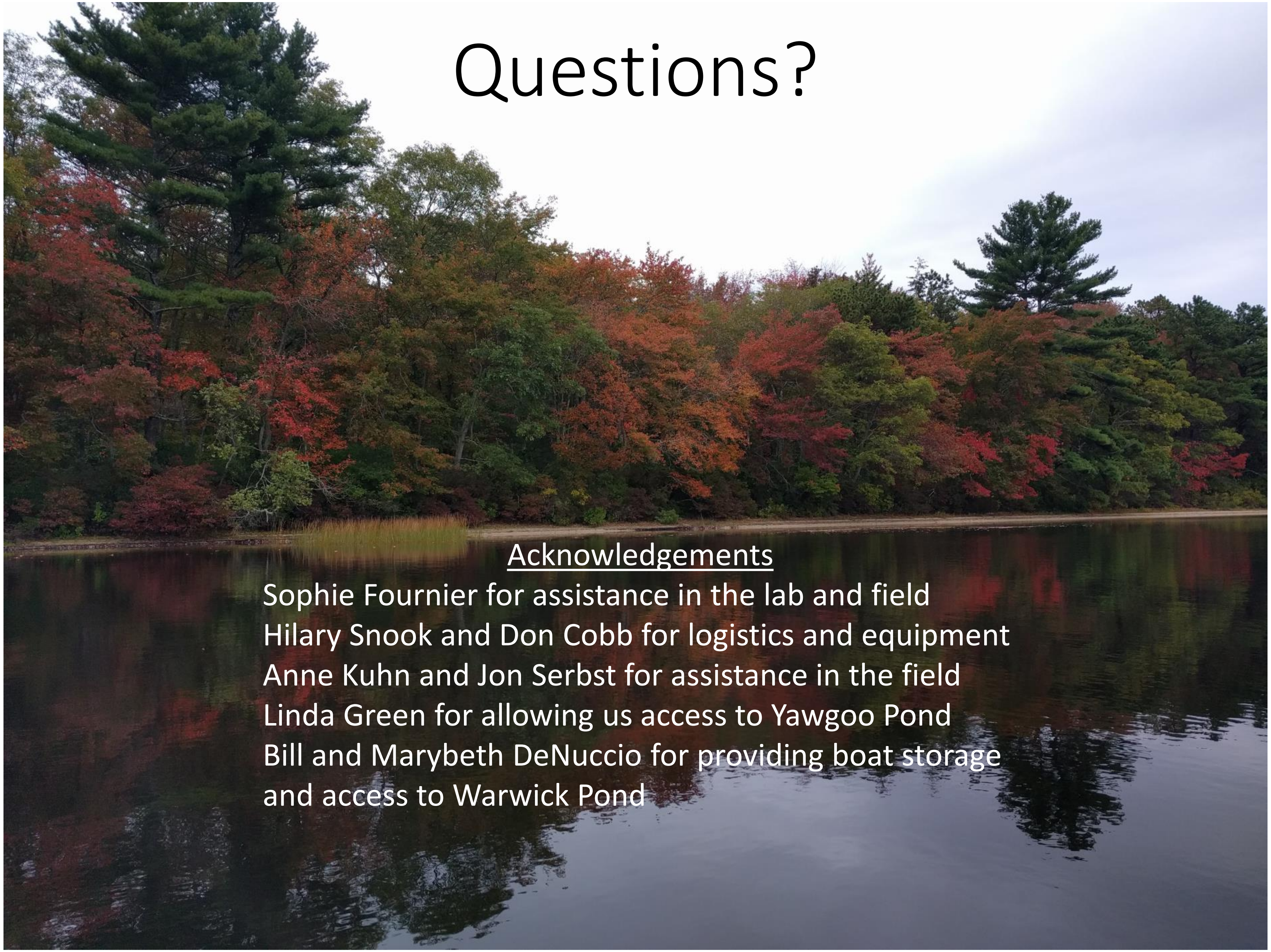


Preliminary Conclusions

- Warwick Pond was very different comparing 2017 to 2018
- Bloom indicators can change on a short time scale, possibly driven by temperature
- Total nitrogen was dynamic in both ponds and may be related to chlorophyll a concentration variation

Next Steps

- Finish analyses (toxins, phyto identification and enumeration)
- Analyze the dataset
- Confirm Warwick Pond bloom is caused by a picocyanobacteria and identify if possible



Questions?

Acknowledgements

Sophie Fournier for assistance in the lab and field
Hilary Snook and Don Cobb for logistics and equipment
Anne Kuhn and Jon Serbst for assistance in the field
Linda Green for allowing us access to Yawgoo Pond
Bill and Marybeth DeNuccio for providing boat storage and access to Warwick Pond