# Monitoring effects of bioremediation in a Kansas urban pond with a persistent toxic cyanobacterial bloom

Janaye D. Figge[1], Katlynn Decker[2], Elizabeth Smith[2], and **Lydia H. Zeglin[1]**

[1]*Division of Biology, KSU;* [2]*Watershed Planning, Monitoring & Assessment, KDHE*

Special thanks: Brett Lamer, Jesse Moran et al. *Salina Parks & Recreation;* Anson Liski, Matt Slough et al. *EnBiorganic Technologies*

# Jerry Ivey Pond, Salina

Problem: Chronic, year-round blue-green algae bloom

Solution? “Bioaugmentation” with soil bacteria to outcompete algae

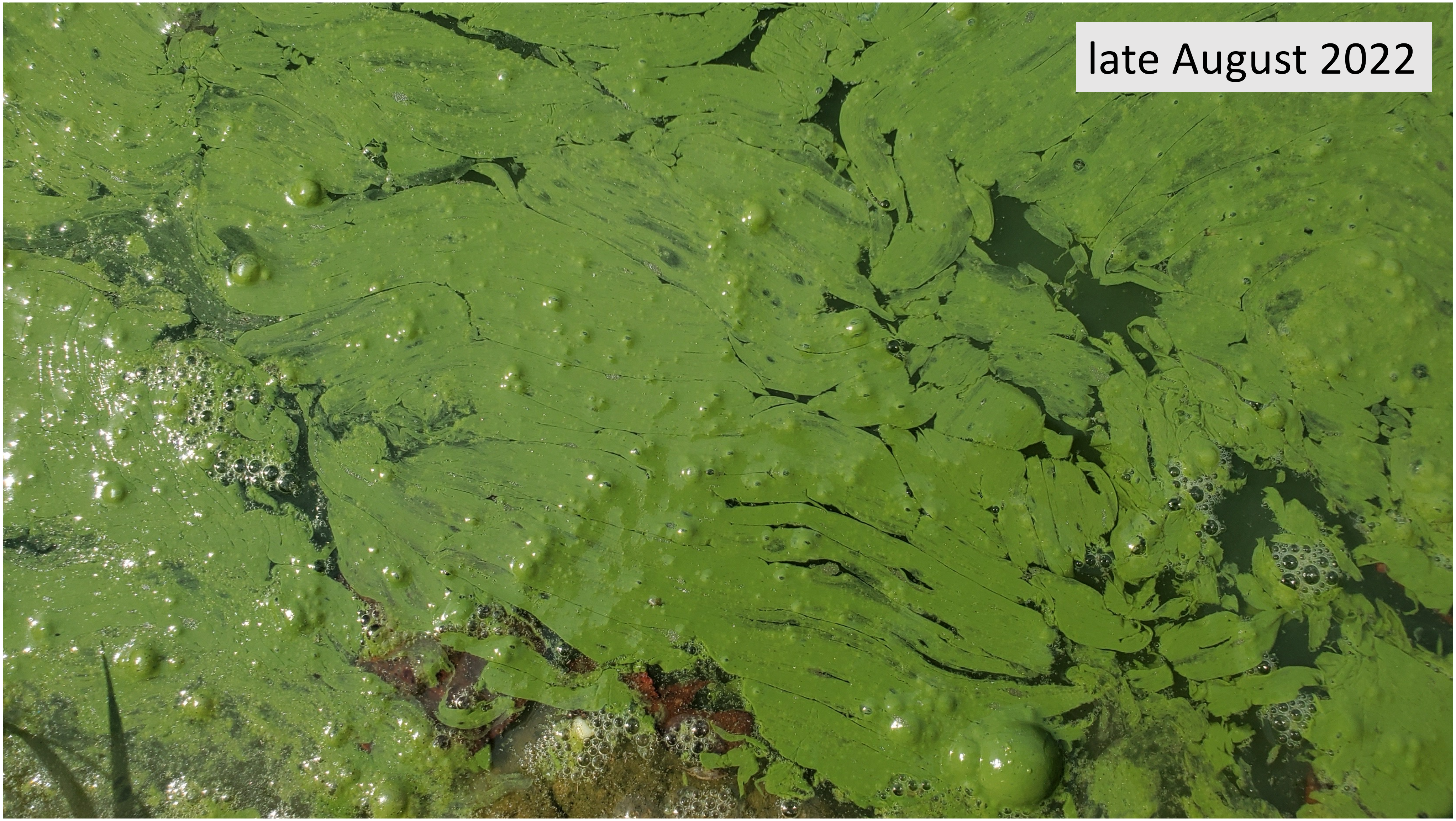
# Biological control of Harmful Algal Blooms

- Problem: excess nutrients allow blue-green algae (Cyanobacteria) to grow excessively (“bloom”); usually worse when temperature is high
- Solutions can be physical, chemical, or biological
  - Physical: Aeration, mixing, draw-down…
  - Chemical: Algicide, coagulation, flocculation…
  - Biological: Augmentation with predators, algicidal, or competitive bacteria
- “Bioaugmentation” = Competitive bacteria should remove nutrients through their growth and remediate the Cyanobacterial bloom

Gallardo-Rodrıguez et al. 2019


August 2022


late August 2022


late August 2022

Late September 2022


November 2022

# Sampling

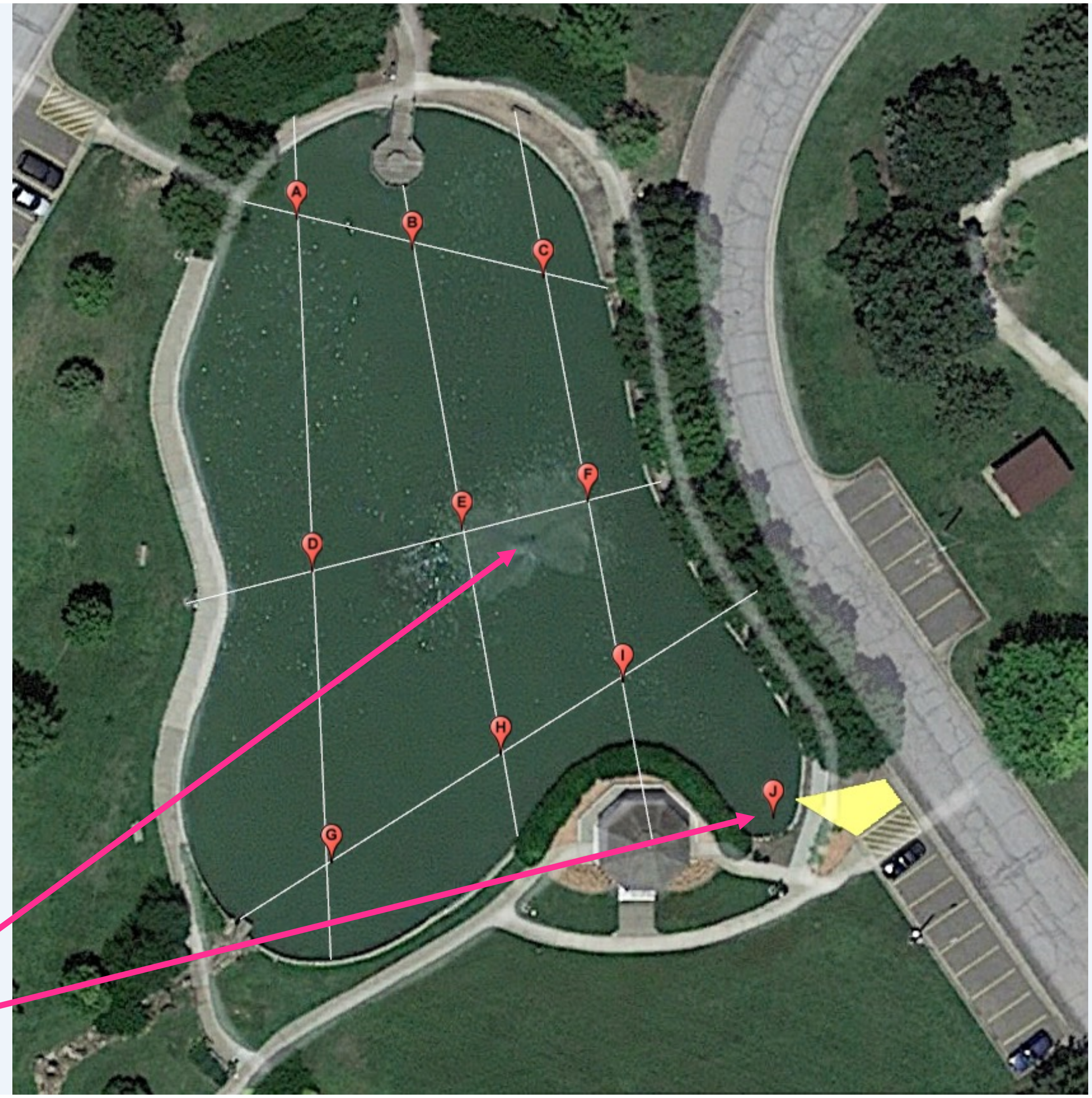
10 locations, 6 times

Before/after treatment

Before/after aeration

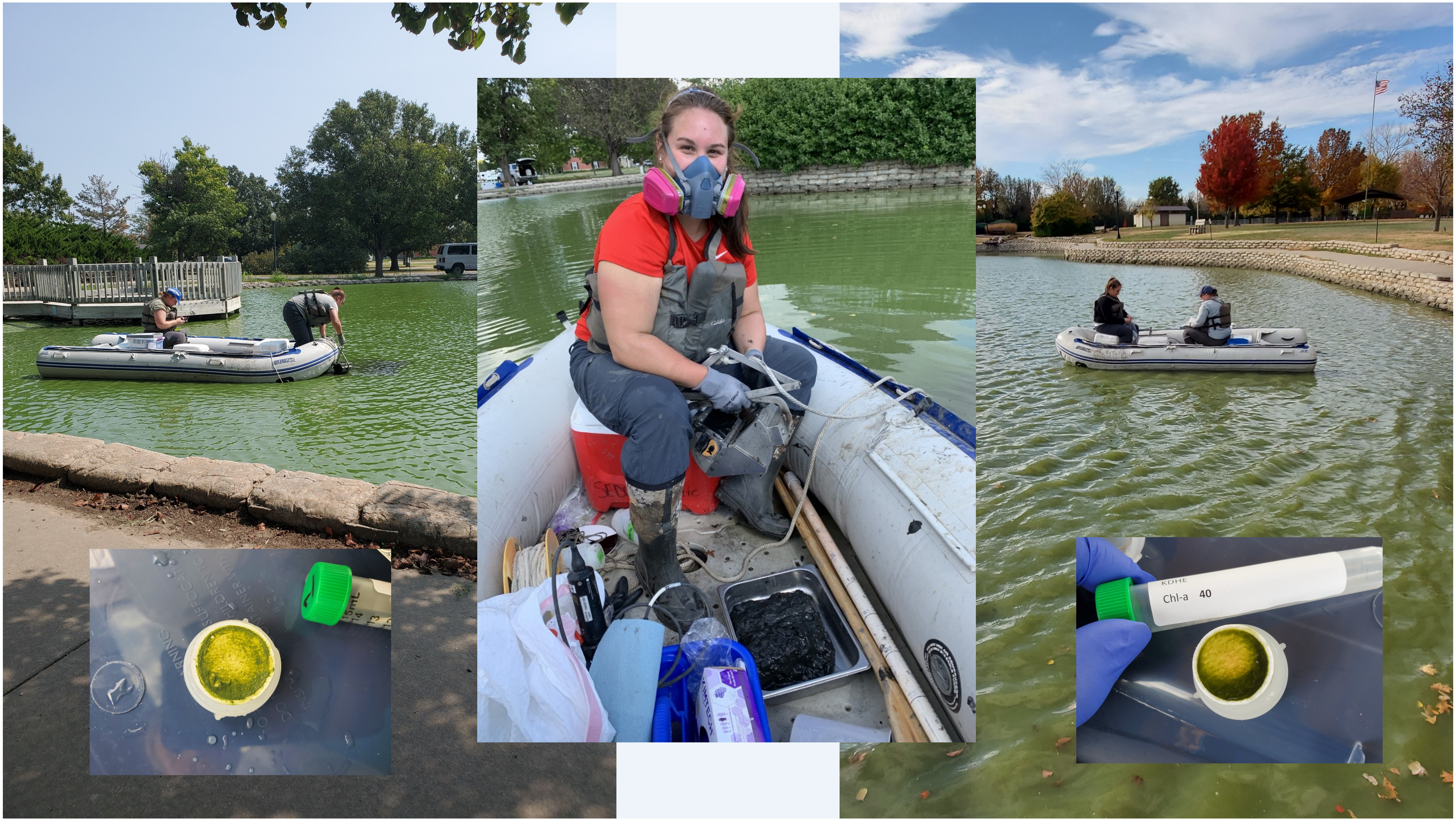
Before/after cessation

Water and sediment

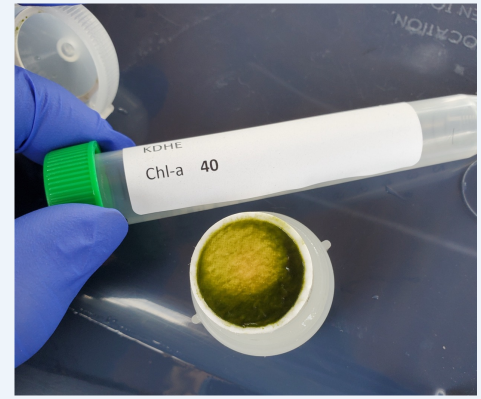


Fountain (aeration)

Bioaugmentation input


15mL
KDHE
Chl-a 40

# Data collection




## Physicochemistry

- **Temperature,** pH
  **dissolved oxygen (DO)**
- Total suspended solids (TSS)
- Dissolved nutrients:
  inorganic and total N & P,
  DOC, micronutrients
- Sediment chemistry:
  total nitrogen (TN),
  **total phosphorus (TP)**

## Microbiology

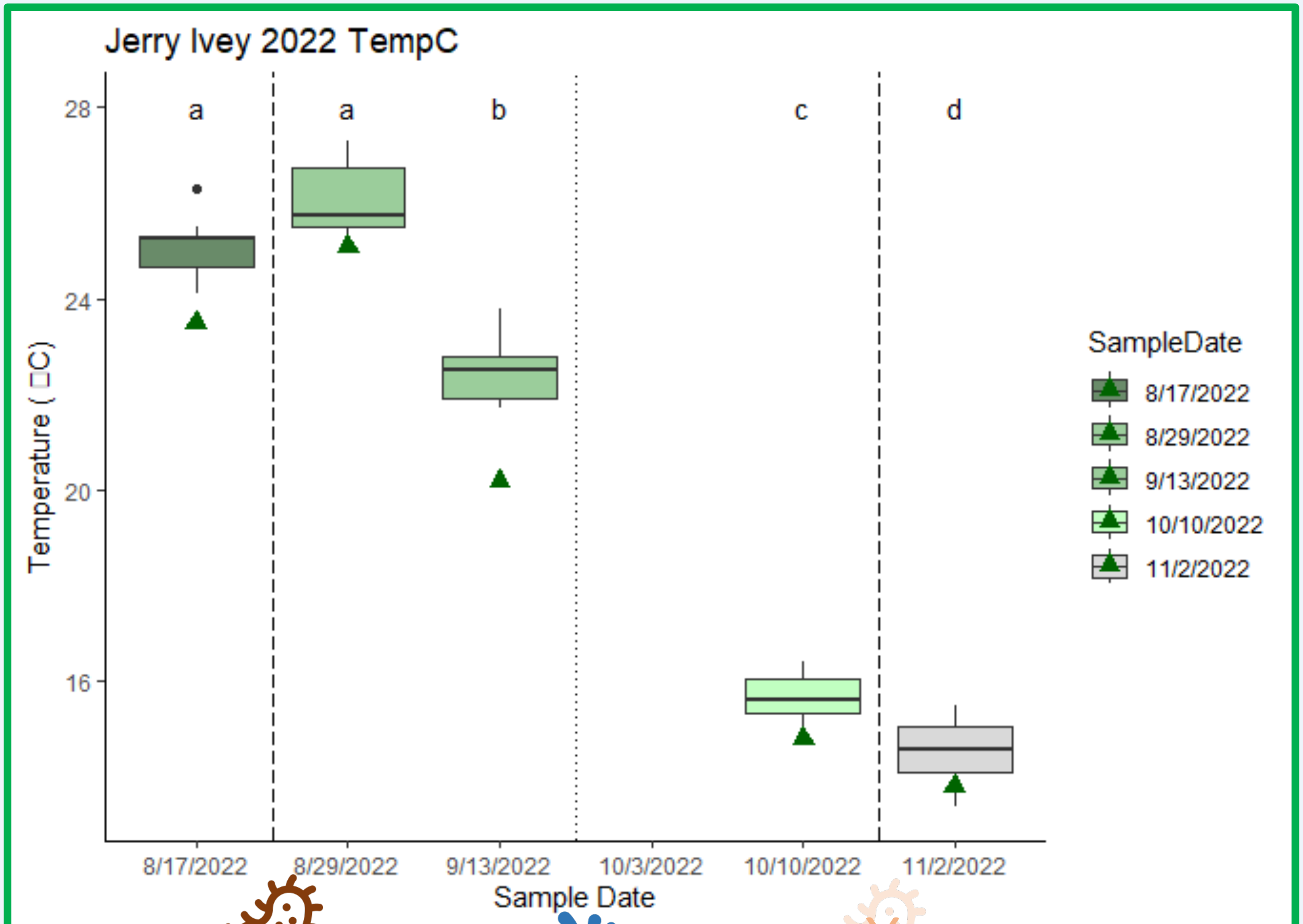
- **Chlorophyll-a (chl-a)**
- Ash-free dry mass (AFDM)
- **Toxin concentrations**
- DNA extraction, then
  **bacterial and archaeal community composition** and total bacterial counts in water and sediment
- Algal analysis (selected samples only)

# Results

## Water temperature

Peak in August, close to 80° F

Drops thereafter to 50s° F in Nov



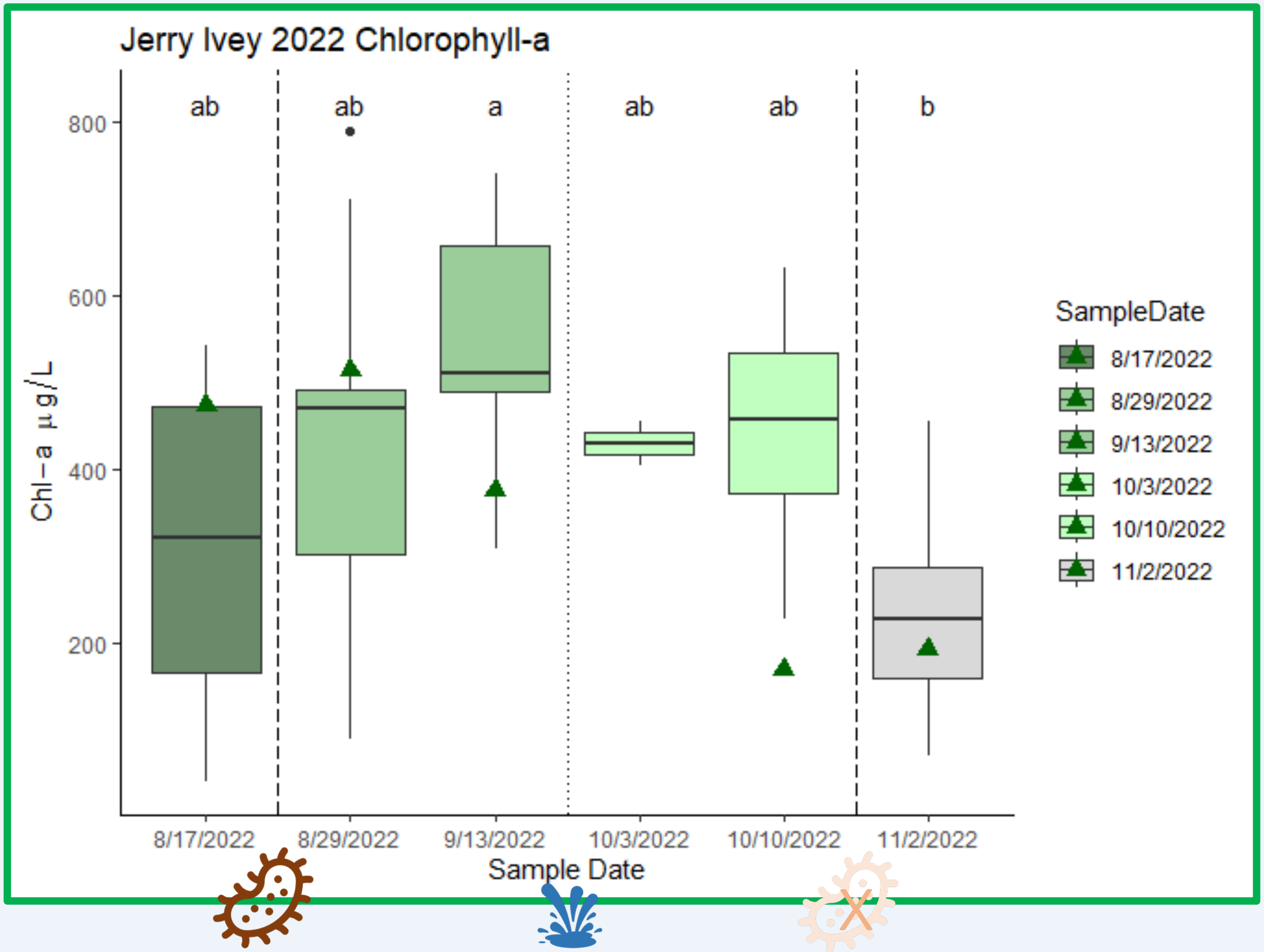
# Results

## <u>Chlorophyll-a</u>

Peak in Sept.

Lowest in Nov.

Total suspended solids (TSS) > 100 mg $L^{-1}$



# Trophic State = Hypereutrophic

| Trophic Class | Chla (ug/L) | TSS (mg/L) |
|---|---|---|
| Oligotrophic | 0-2.6 | Clear (<20) |
| Mesotrophic | 2.6-7.3 | Moderately clear (20-40) |
| Eutrophic | 7.3-56 | Low transparency (>40) |
| Hypereutrophic | 56-155+ | No transparency |

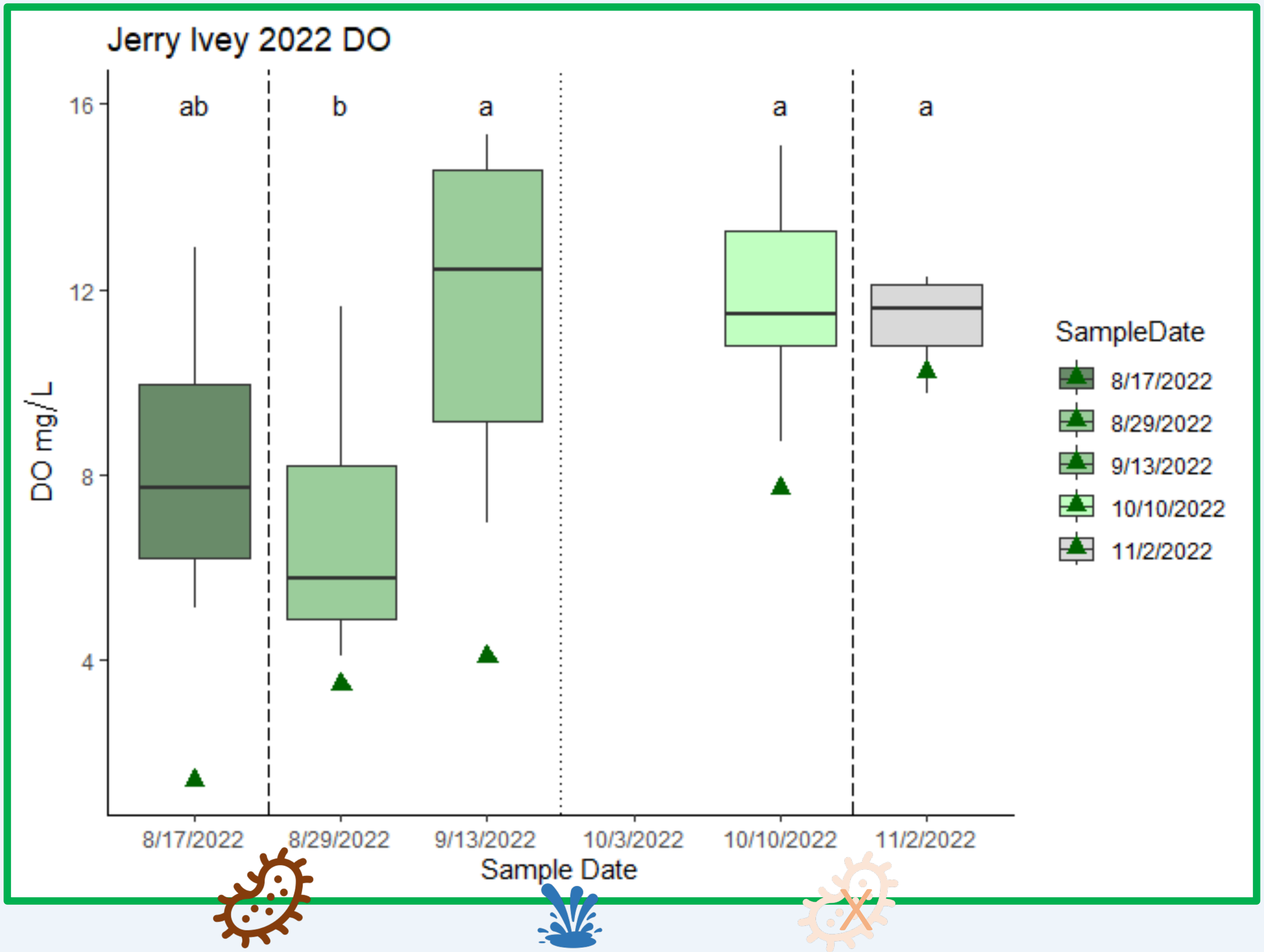
After Carlson & Simpson 1996

# Results

<u>Dissolved Oxygen (DO)</u>

Peak in Sept.
low in August

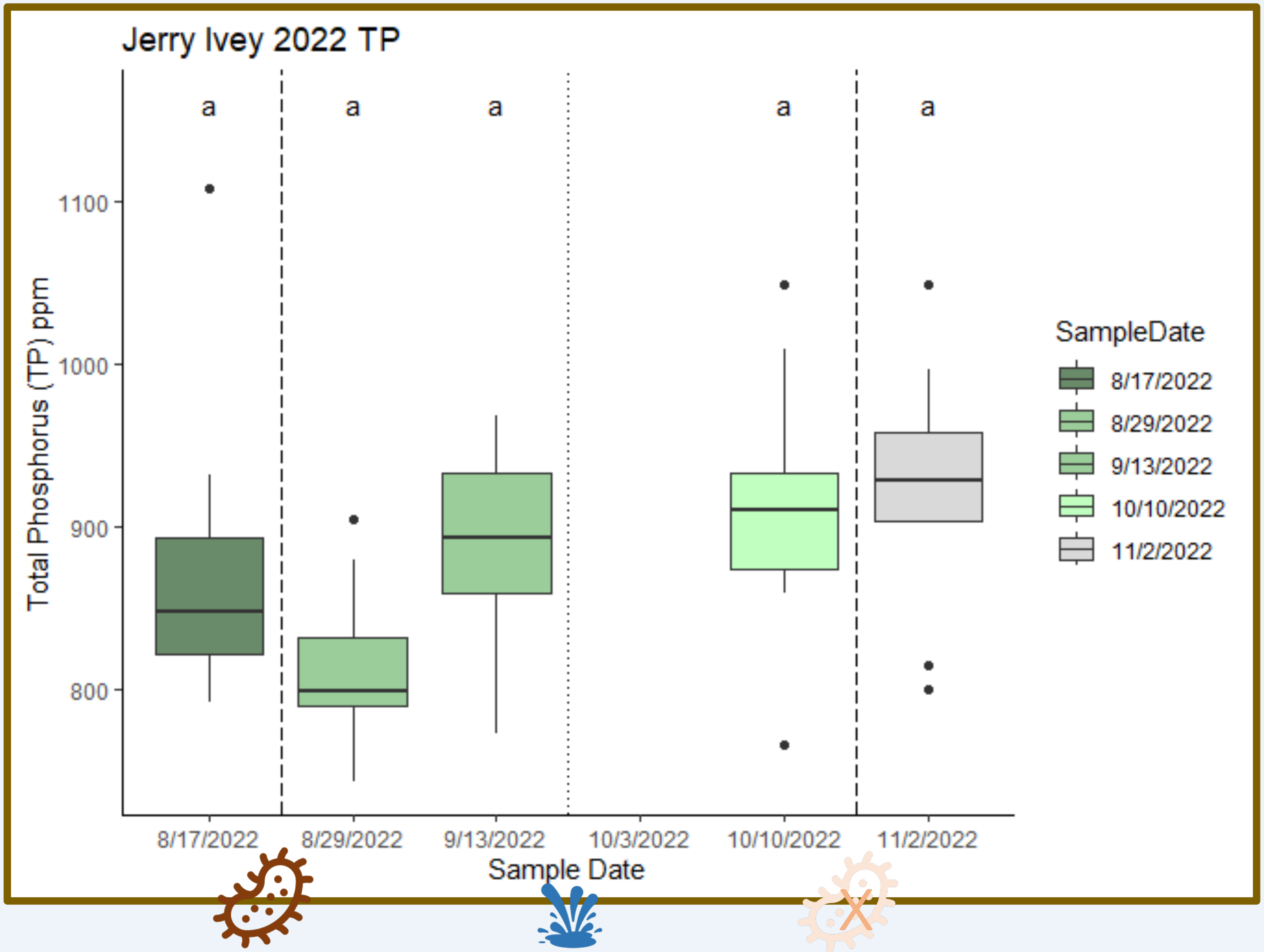
Biological oxygen demand highest in late August



# Results

## <u>Sediment total P (phosphorus)</u>

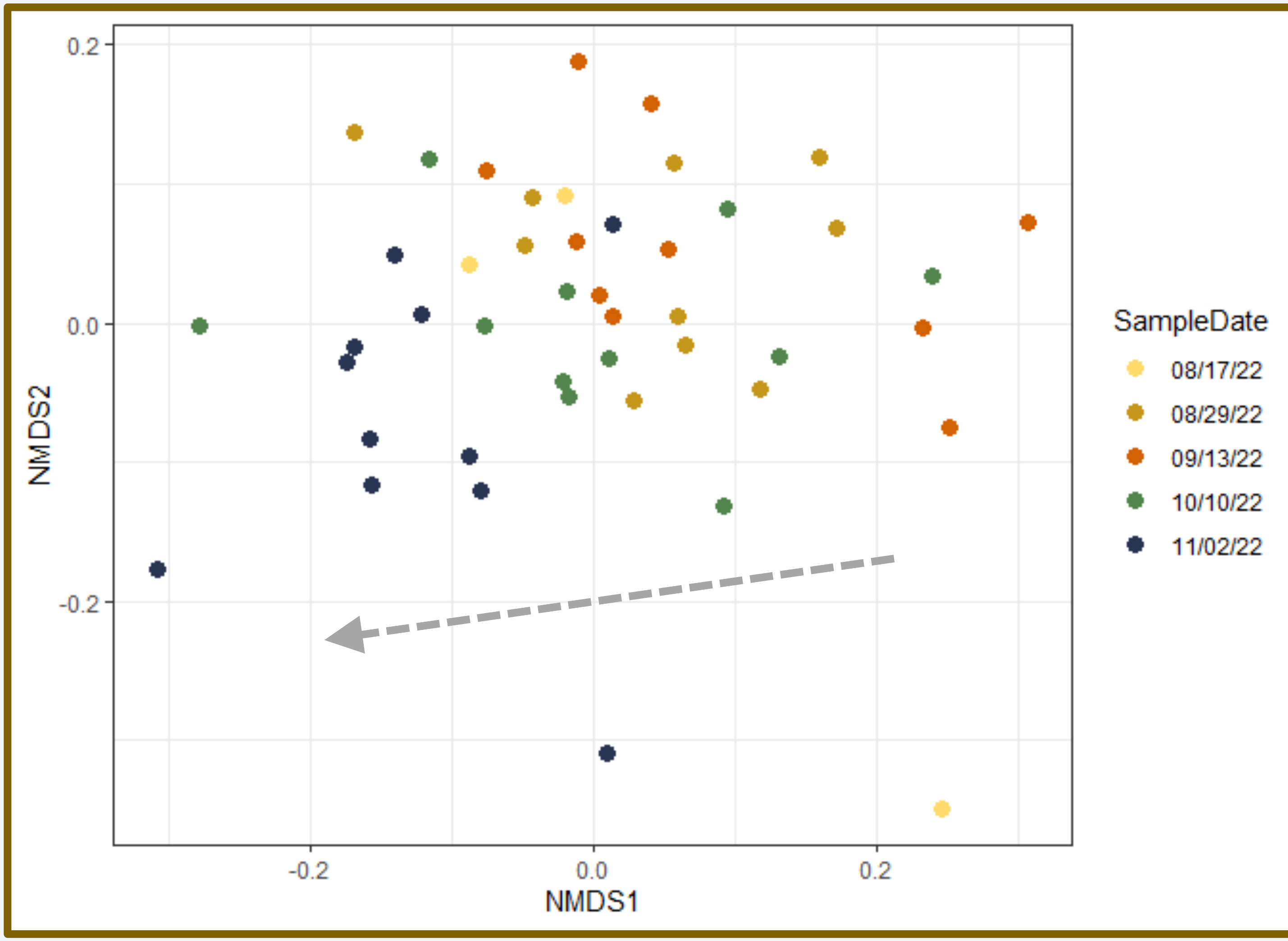
Low variability over time, but high sediment P suggests potential for internal loading



# Results

<u>Sediment microbial community</u>

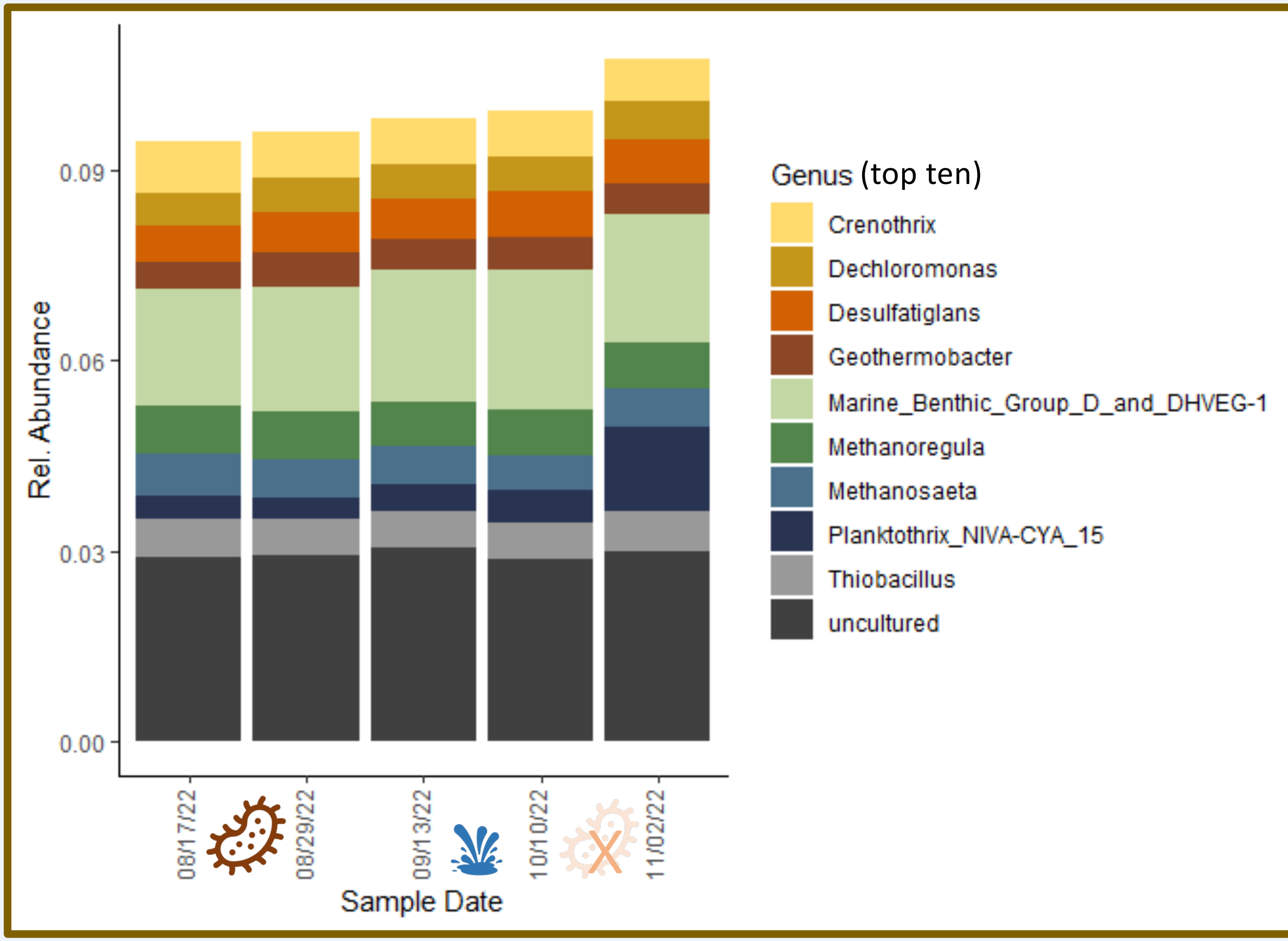
Not predictable by sampling date
*(P > 0.05)*



# Results

## Sediment dominant micro-taxa

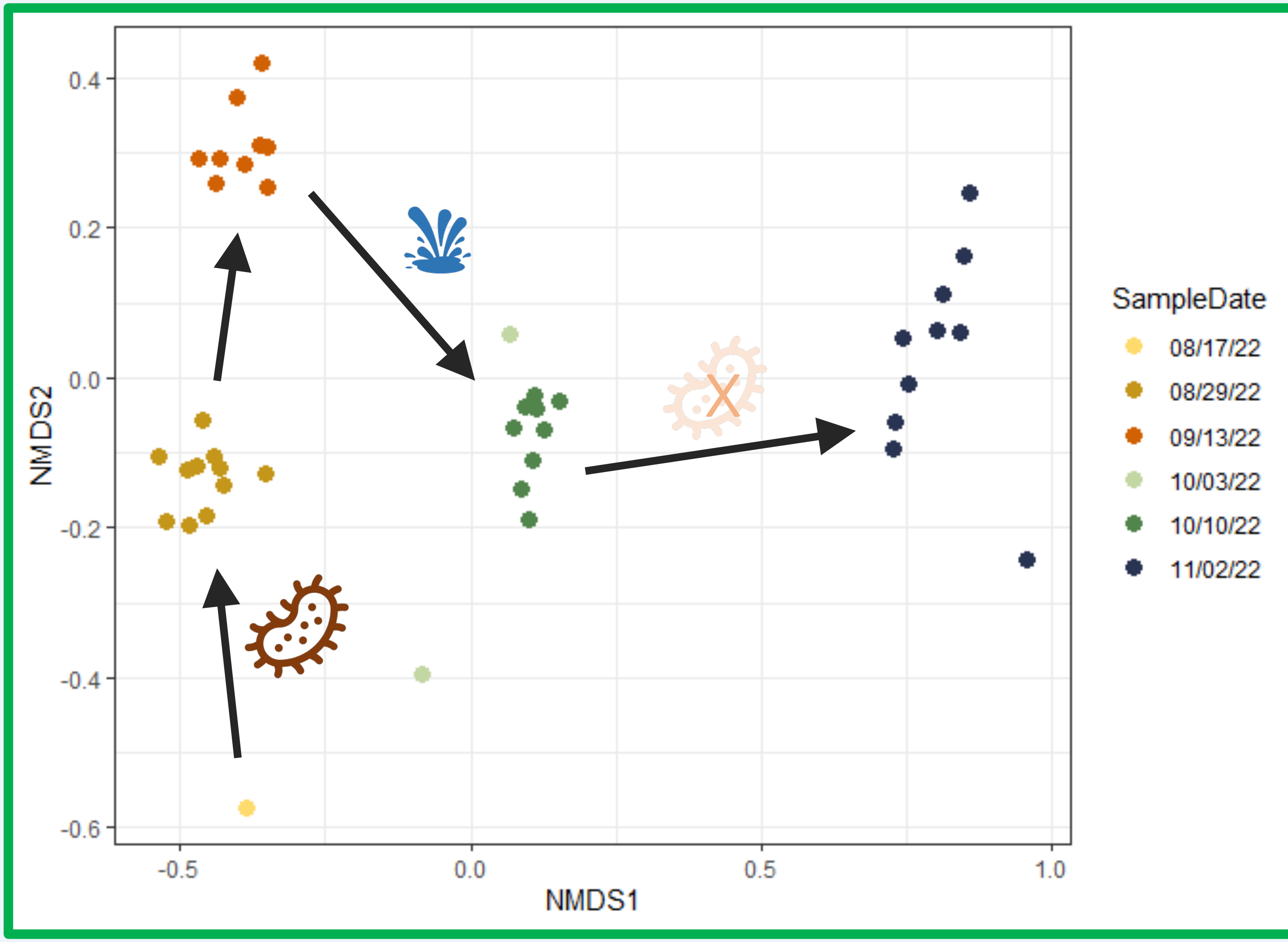
Methane and sulfur life histories consistent with anoxic conditions



# Results

## Water total bacterial & archaeal community

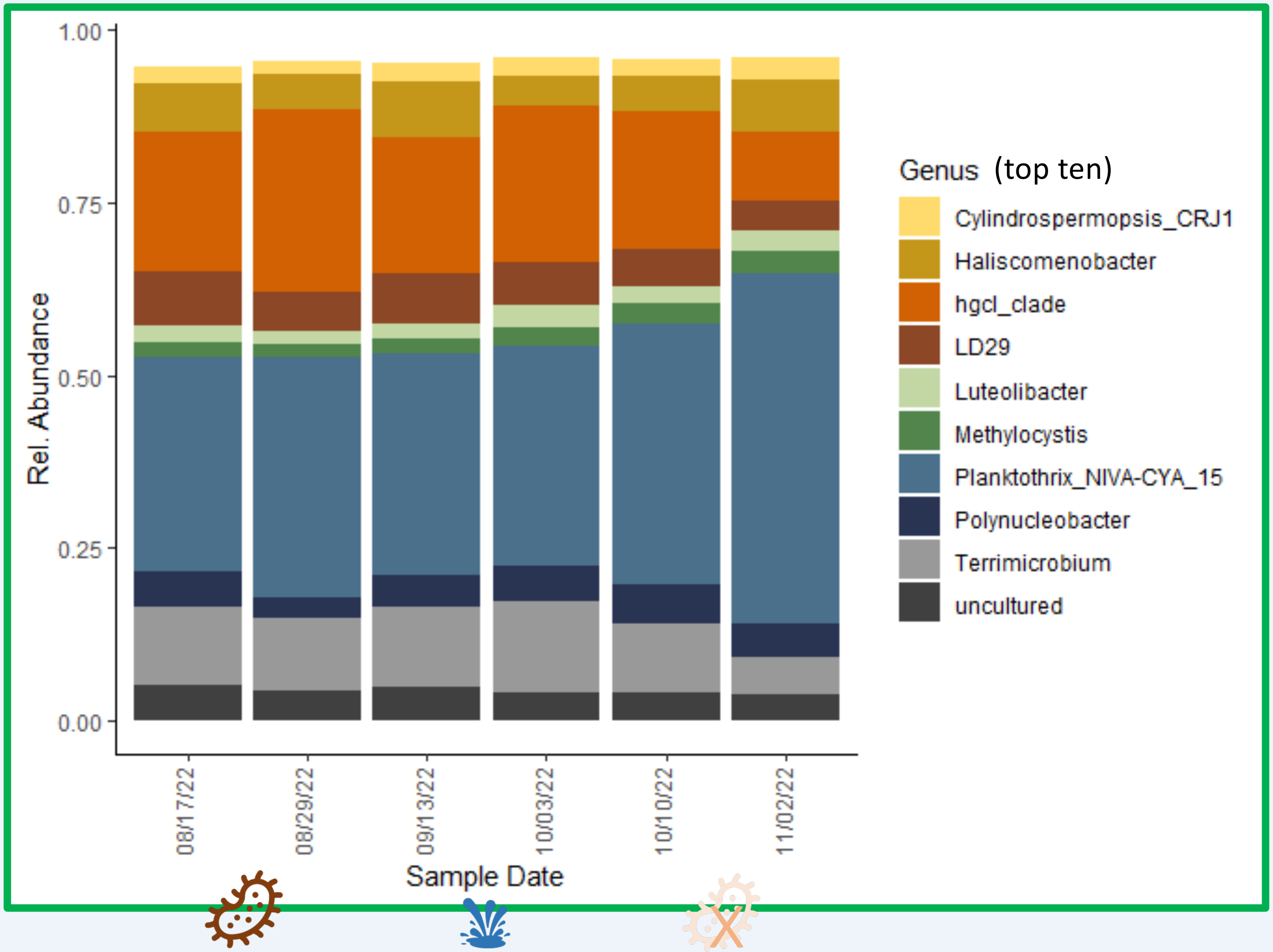
75% of variation explained by sampling date
*($P < 0.001$)*



# Results

## <u>Water dominant micro-taxa</u>

*Planktothrix agardhii* is highly dominant, increases in November



# *Planktothrix agardhii*

Global distribution

Common in shallow, well mixed lakes

Wide temperature range

Can produce hepatotoxic microcystins and other secondary compounds

McKindles et al. 2022

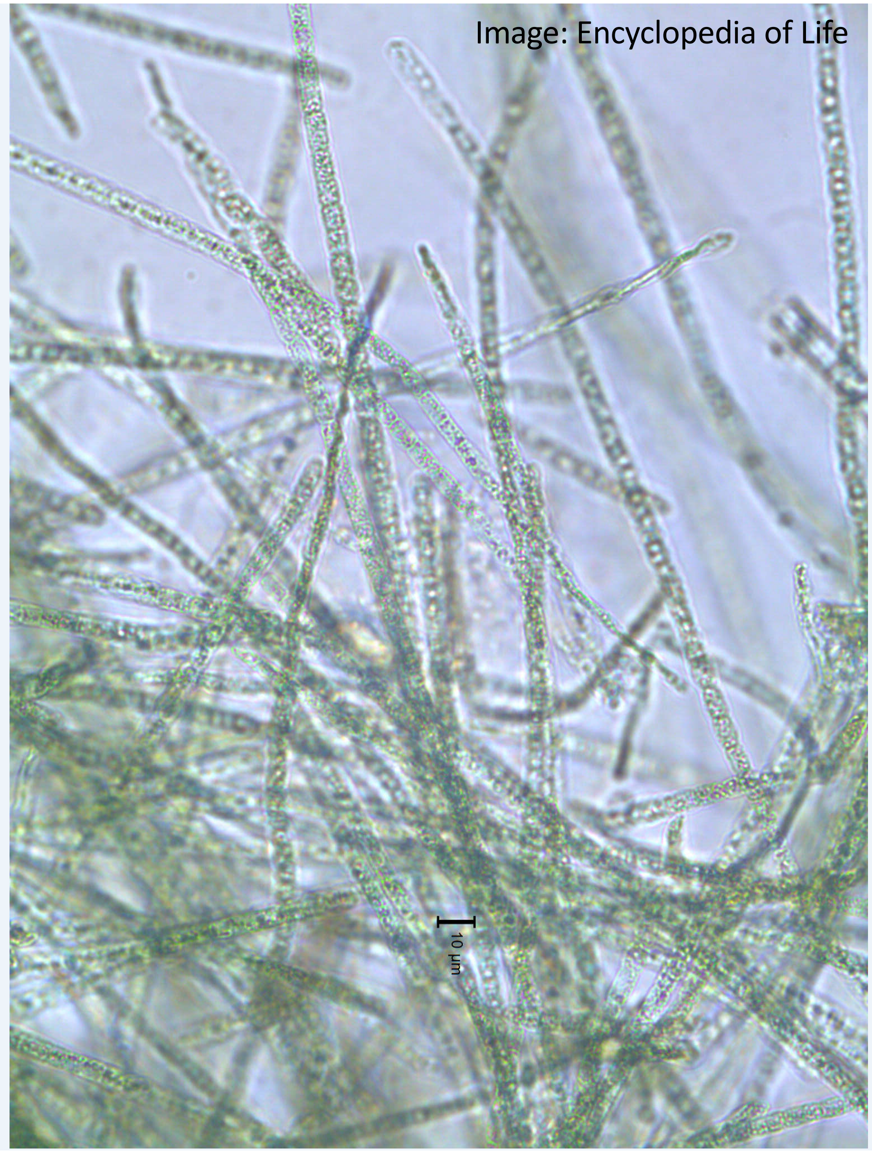



Image: Encyclopedia of Life

# Results

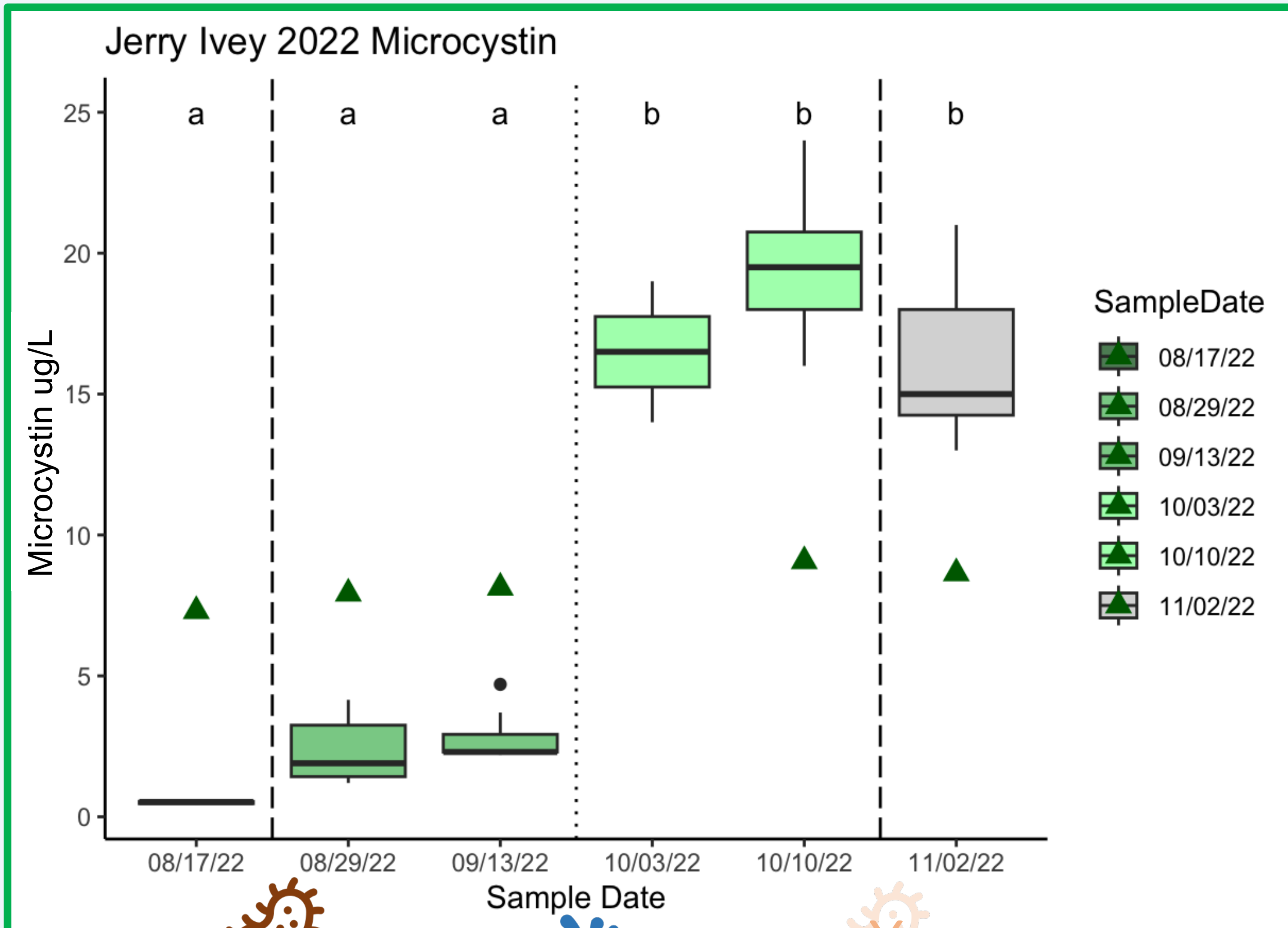
## <u>Microcystin</u>

Increases in October

One study: toxicity ↑ as irradiance ↓

Toxins may also ↑ with death

Many possible factors




Tonk et al. 2005; Neilan et al. 2013

# Conclusions

- Hypereutrophic, toxic, *Planktothrix* bloom
- Bioaugmentation had some effect but did not outcompete Cyanobacteria
- High internal nutrient loading possible
- Chronic bloom, particularly challenging to mitigate
- Biological controls may be more successful in weaker, more susceptible blooming populations

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EnBiorganic Technologies

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Questions??

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