Phosphorus, Grazers, and Temperatures May Intensify Utah Lake HABs

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Not all nutrients are created equal

*Anderson and McIntosh 1991
Cyanobacteria are not created equally
* 16s rRNA gene amplicon sequencing
What Ecological factors are controlling the blooms?
Ecological factors

- Date, pH, DO (mg/L), Temp, Secchi depth, TP, TDP, SRP, TOC, TDN, NO₃-, NH₄⁺, B, Ca, Cu, Fe, K, Mg, Mn, S, Zn

**Calanoida** (Calanoids)

**Phylophoda** (Diplostraca, Notostraca)

**Diplostraca** (Cladocera)

**Cyclopoidea** (Cyclopoids)

**Monogononta** (Rotifers)

**Ploimida** (Rotifers)
A picocyanobacteria, potentially overlooked, may produce microsytins, β-N-methylamino-L-alanine (BMAA), lipopolysaccharides, and other odor associated compounds.
Model

* % Rel recovery of Cyanobium = 17.82 + 0.70 (Mg) + 111.13 (Zn) + 7.38 (cond) – 2.14 (pH) – 18.16 (NH4) – 0.04 (Calanoida) – 300.51 (Mn) – 5.10 (S)

* AIC: 367.9189
- Can regulate their own buoyancy
- Heavily influenced by N:P ratio
- May produce Microcystin or Anatoxin-a
- Filamentous

![Microcystis](image)

**Site**
- Bird Island Buoy
- Lindon Marina
- Mouth of Goshen Bay
- Mouth of Provo Bay
- Provo Buoy
- Saratoga Marina
- Vineyard Buoy

**Relative Abundance**

<table>
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<th>Week Number</th>
<th>Relative Abundance</th>
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<tr>
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<tr>
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Model

* % Relative recovery of Microcystis = -143.6 + 34.64 (Date) + 6.12 (SRP) + 0.014(temp) – 0.0061 (TOC)

* AIC: 136.4564

* % Cyanobium = 17.82 + 0.70 (Mg) + 111.13 (Zn) + 7.38(cond) – 2.14(pH) – 18.16(NH4) – 0.04(Calanoida) – 300.51(Mn) – 5.10(S)  AIC: 367.9189
* Formerly known as Anabena
* Can fix Nitrogen with heterocysts
* Filamentous
* May produce Microcystins, Anatoxin-A, Cylindrospermopsin, or Saxitoxins
% Dolichospermum = -1.04 + 25.75(TP) + 0.0012(Calanoida) – 41.82(SRP) – 13.42(Mn) – 4.39(NH4)  
* AIC: 311.548

% Microcystis = -143.6 + 34.64(Date) + 6.12(SRP) + 0.014(temp) – 0.0061(TOC)  
* AIC: 136.4564

% Cyanobium = 17.82 + 0.70(Mg) + 111.13(Zn) + 7.38(cond) – 2.14(pH) – 18.16(NH4) – 0.04(Calanoida) – 300.51(Mn) – 5.10(S)  
* AIC: 367.9189
* Capable of fixing Nitrogen through Heterocysts
* Forms large colonies
* May produce Anataxin-a, β-N-methylamino-L-alanine (BMAA), Cylindrospermopsin, or Saxitoxin
% Relative recovery of Aphanizomenon = -2515.2 + 603(date) + 2.19(DO) + 0.29(TOC) + 21.43(NH4) + 0.47(Ploimida) - 1.01(Secchi) - 4.40(TDN) - 13.9(NO3) - 44.54(Zn) - 1.35(P)

AIC: 395.99

% Dolichospermum = -1.04 + 25.75(TP) + 0.0012 (Calanoida) - 41.82(SRP) - 13.42(Mn) - 4.39(NH4)  AIC: 311.548

% Microcystis = -143.6 + 34.64 (Date) + 6.12 (SRP) + 0.014(temp) - 0.0061 (TOC)  AIC: 136.4564

% Cyanobium = 17.82 + 0.70 (Mg) + 111.13 (Zn) + 7.38(cond) - 2.14(pH) - 18.16(NH4) - 0.04(Calanoida) - 300.51(Mn) - 5.10(S)  AIC: 367.9189
- Capable of fixing Nitrogen through Heterocysts
- Filamentous
- May produce Anataxin-a, β-N-methylamino-L-alanine (BMA A), Cylindrospermopsin, or Saxitoxin
% Relative recovery of Aphanizomenon 2 = 0.31 + 0.0061(Phyllopoda) + 7.32(Zn) – 3.77(SRP) – 0.0059(Diplostraca) – 0.06(S)  
AIC: 62.74

% Aphanizomenon = -2515.2 + 603(date) + 2.19(DO) + 0.29(TOC) + 21.43(NH4) + 0.47(Ploimida) – 1.01(Secchi) – 4.40(TDN) – 13.9(NO3) – 44.54(Zn) – 1.35(P)  AIC: 395.99

% Dolichospermum = -1.04 + 25.75(TP) + 0.0012 (Calanoida) – 41.82(SRP) – 13.42(Mn )– 4 .39(NH4)  AIC: 311.548

% Microcystis = -143.6 + 34.64 (Date) + 6.12 (SRP) + 0.014(temp) – 0.0061 (TOC)  AIC: 136.4564

% Cyanobium = 17.82 + 0.70 (Mg) + 111.13 (Zn) + 7.38(cond) – 2.14(pH) – 18.16(NH4) – 0.04(Calanoida) – 300.51(Mn) – 5.10(S)  AIC: 367.9189
% Aphanizomenon 2 = Intercept + Phyllopoda + Zn – SRP – Diplostraca – S

% Aphanizomenon = Intercept + date + DO + TOC + NH4 + Ploimida – Secchi – TDN – NO3 – Zn – P

% Dolichospermum = Intercept + TP + Calanoida – SRP – Mn – NH4

% Microcystis = Intercept + Date + SRP + temp – TOC

% Cyanobium = Intercept + Mg + Zn + cond – pH – NH4 – Calanoida – Mn – S
Conclusions

- Picocyanobacteria are important
- Interactions are important
- Phosphorus and nitrogen form is important
- HABs are complex ecological issues
- If you want to investigate a specific interaction, let us know!
  - Scott Collins: scottcollins@gmail.com
  - Erin Jones: erinfjones3@gmail.com
Future Work
Public Engagement

Utah Lake Research Collaborative

I WANT YOU TO SAVE UTAH LAKE
Peteetneet Creek

October 3rd

October 12th
Shanae Tate
Neil Hansen Lab

35+ years of satellite images

Chlorophyll-a detection

Hot Spot Analysis
Legacy phosphorus in Utah Lake sediments
BYU is committed to Utah Lake’s future

Dr. Neil Hansen, Dr. Greg Carling, Dr. Ben Abbott, Dr. Michelle Baker, Amber Call, Eric Shipp

Questions?

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erinfjones3@gmail.com

PC: Jeffery D Allen, Deseret News