Utah Lake Water Quality Study
Science Panel Meeting
December 10-11, 2019
Salt Lake City, UT

Data Characterization Update

Utah Lake Nutrient Criteria Development Technical Support

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY

Data Characterization

- Continued analysis and updates based on feedback
- No updated report, but that will be coming soon
- We propose organizing the report still around the charge questions and NNC information needs – assuming that is still useful?

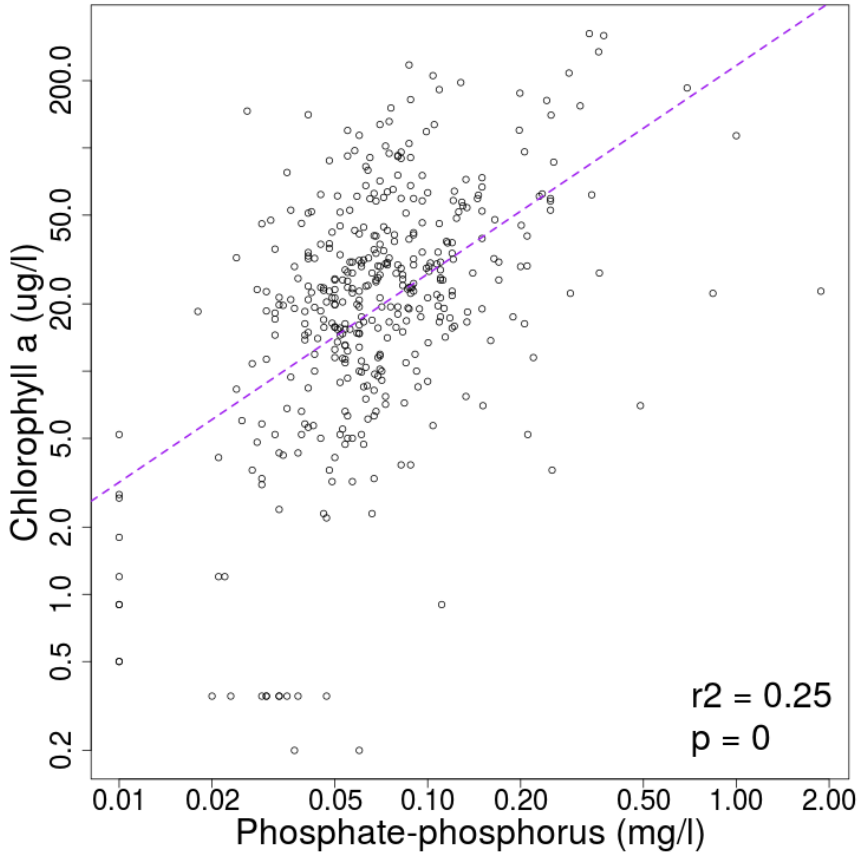
Data Characterization – Data Explorer Update

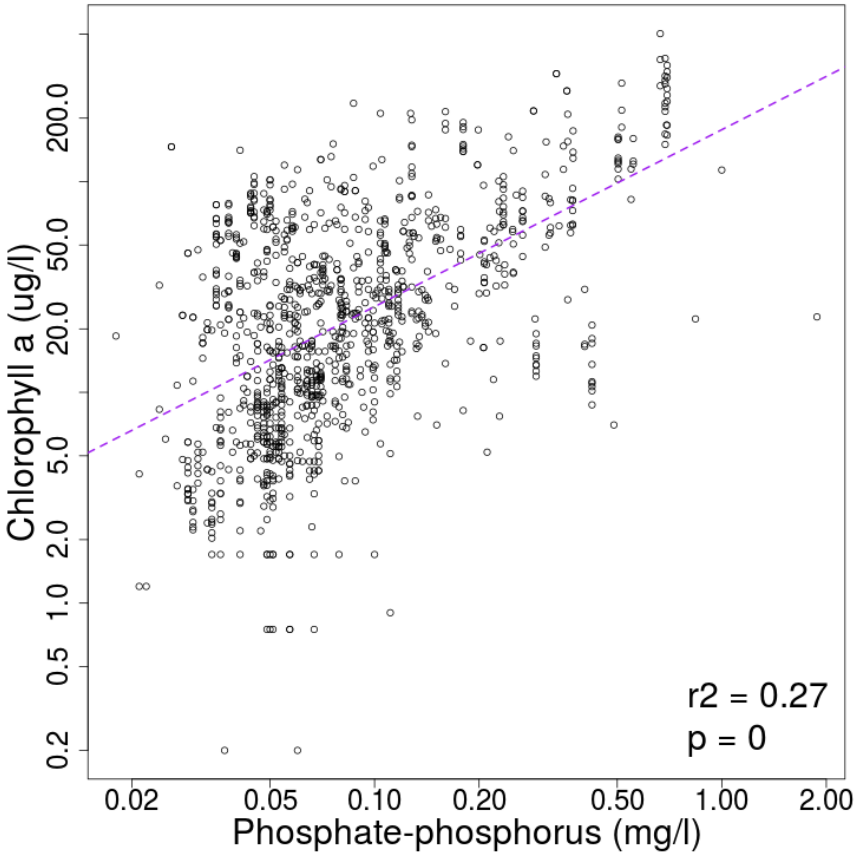
- Finalizing updated dataset (our major deliverable)
- Adding some analyses (excretion, multivariate, shear) to Explorer now that we have the new site working and Mark can load thing
- Will allow users to toggle options and review
- Continue working with Jake and Scott closely

Data Characterization – Data Explorer Update

- Major effort over past several months
- New GitHub branch is up: https://markfernandez.shinyapps.io/TEST_UtahLakeDataExplorer2/
- Allowing us to update analyses with the most recent dataset from multiple data sources as well as most recent UDWQ datasets

Data Characterization – Data Explorer Update





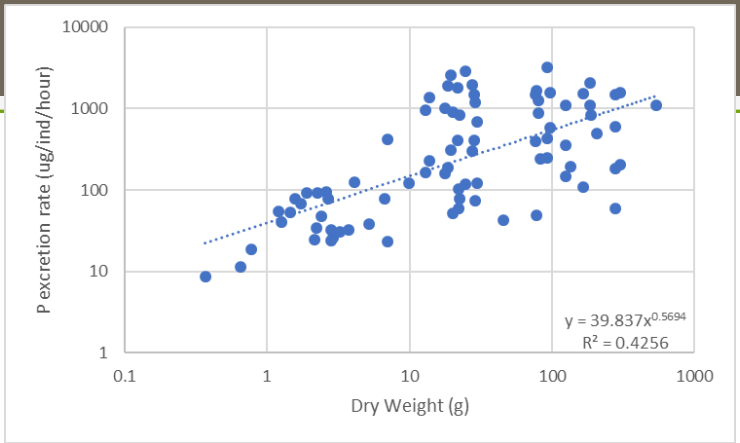
Data Analysis

- Eight Main Areas: Each tied to specific charge questions
  1. Carp excretion
  2. Algal cell count, and pigment relationships
  3. Sonde data analysis
  4. Plankton spatial and temporal analysis* (6 subareas)
  5. Diatom and macrophyte autecology
  6. Wind and turbidity
  7. Turbidity and macrophytes
  8. Light extinction

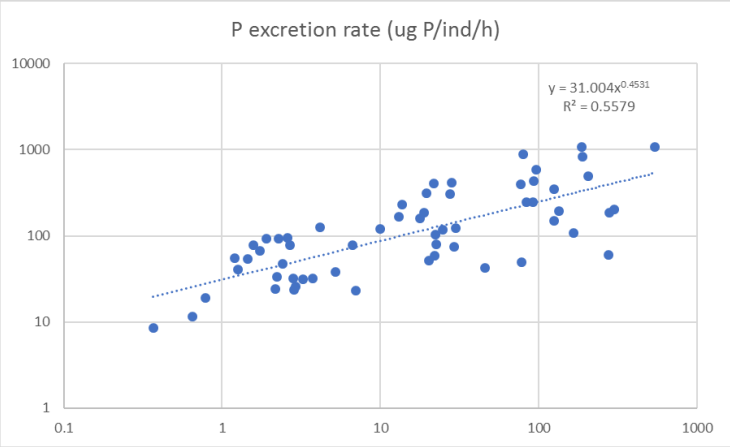
Task 1. Carp Excretion

- Role of Carp – moving potentially a lot of nutrients
- Identified that excretion data differed (SRP or TP)
- Update data with very recent draft carp survey data report from Gaeta et al. (Oct. 2019)

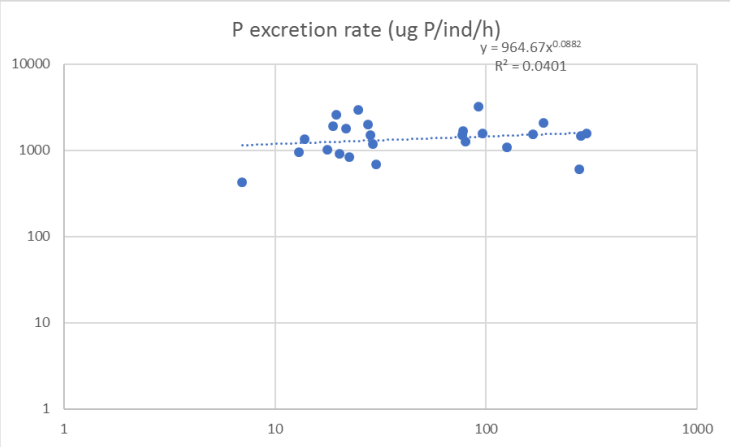
- Excretion
  - Actual 2018 individuals and weight survey
  - SRP: 16,700 to 38,500 kg/y
    - 6% to 28% of Total P Inputs
  - TP: 51,000 to 117,000 kg/y
    - 19% to 85% of Total P Inputs



Original



SRP

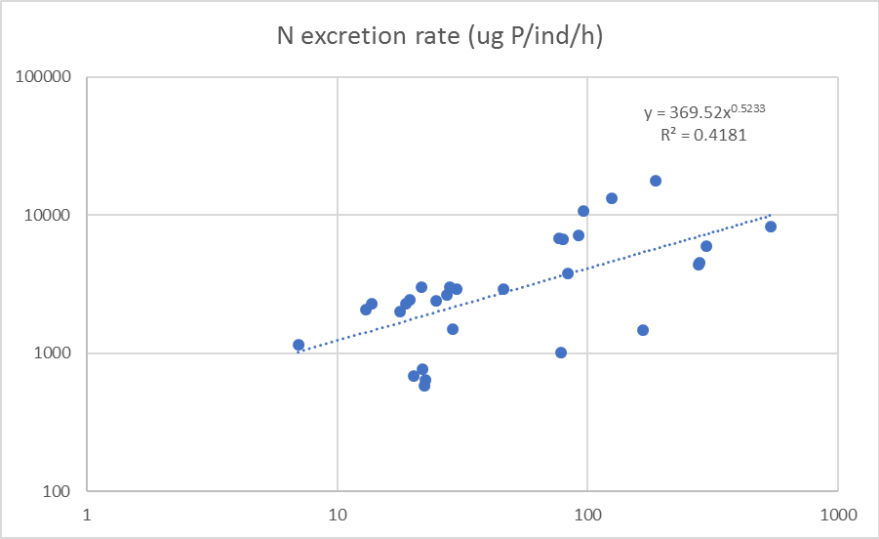


TP

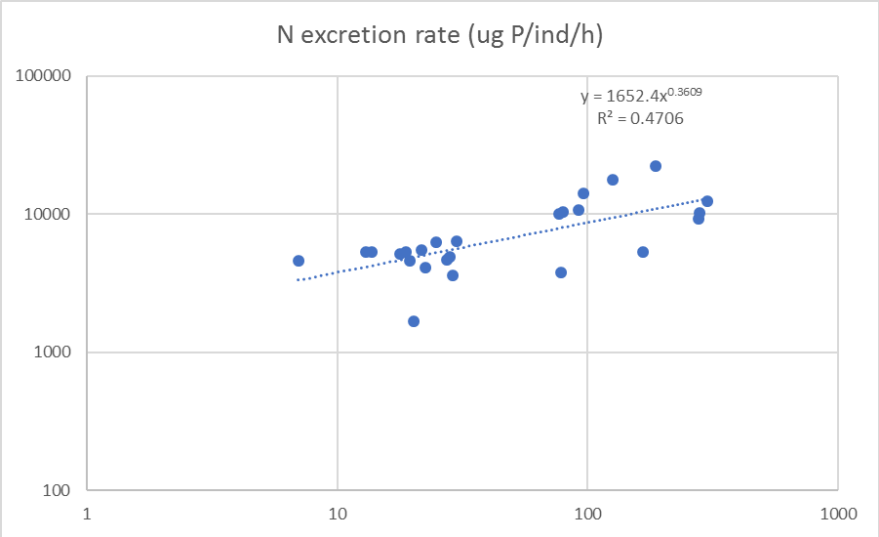
Task 1. Carp Excretion

- You also asked for Nitrogen
- Excretion data differed using NH4 or TN

- N Excretion
  - 2018 Survey data (2019 report)
  - NH4: 312,000 to 717,000 kg/y
  - TN: 496,000 to 1,100,000 kg/y



NH4



TN

Task 1. Carp Excretion

- Questions:
  - This is recycling, not new inputs
    - No idea what the translocation is from sediment via fish
    - What portion of P is making multiple cycles through food web in a year
  - And how to attack the question of bioturbation?
    - Still struggling with this one – but we have papers to read….
  - Phytoplankton and zooplankton
    - In progress
  - Other fish?
  - Both will simply raise portion of inputs moving through food web – so how much more to follow?

Task 2. Algal Cell Count and Pigment Relationship

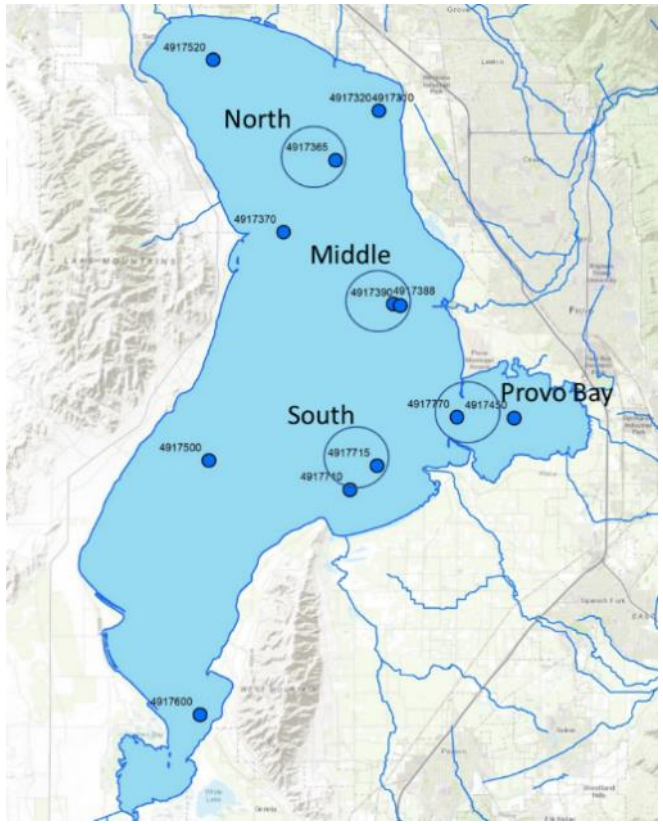
- Goal: Estimate relationships between cell count, biovolume, and pigment concentrations
- We showed you these, thanks for review, no comments or changes requested

Task 3. Sonde Data Analysis

- Goal: Extract sonde data and examine relationships among sonde variables
- We have 4 sonde locations (Phycocyanin, Chlorophyll, DO, pH, Conductivity, Temperature, Turbidity)
- Methods: Run descriptive stats (tables in report), correlation matrices, time series
- Explore relationship between chlorophyll, turbidity and lab chlorophyll and sonde chlorophyll

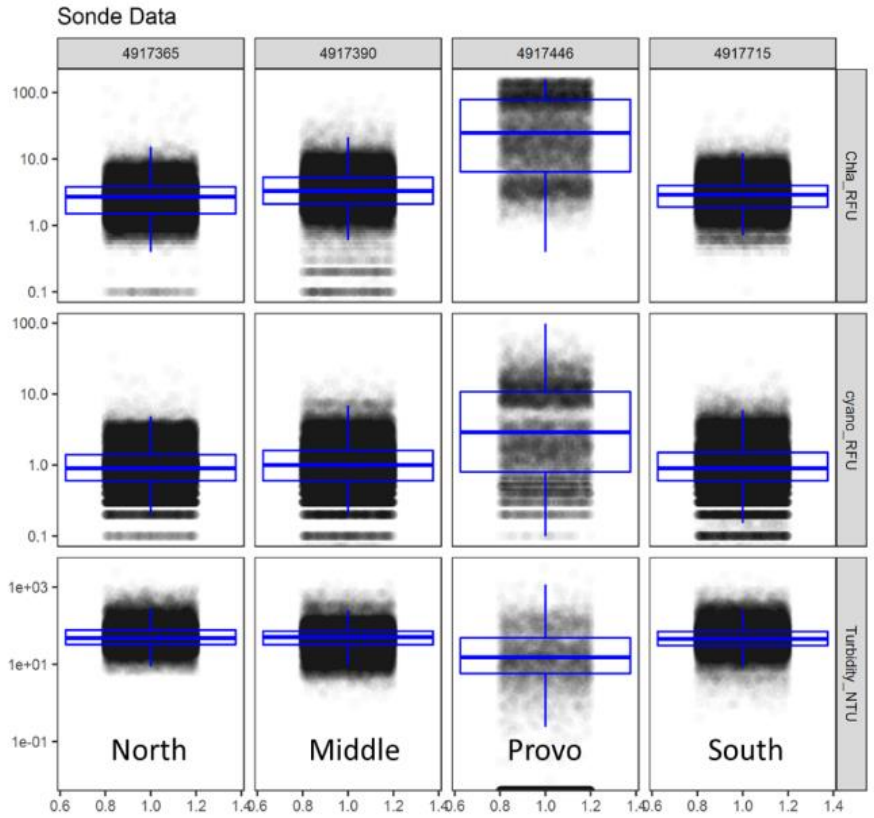
Task 3. Sonde Data Analysis

- Locations:
  - North (~Aug 2016 – Oct 2018)
  - Middle (~Aug 2016 – Oct 2018)
  - *Provo Bay (July 2018 – Oct 2018
  - South (~Aug 2016 – Oct 2018)

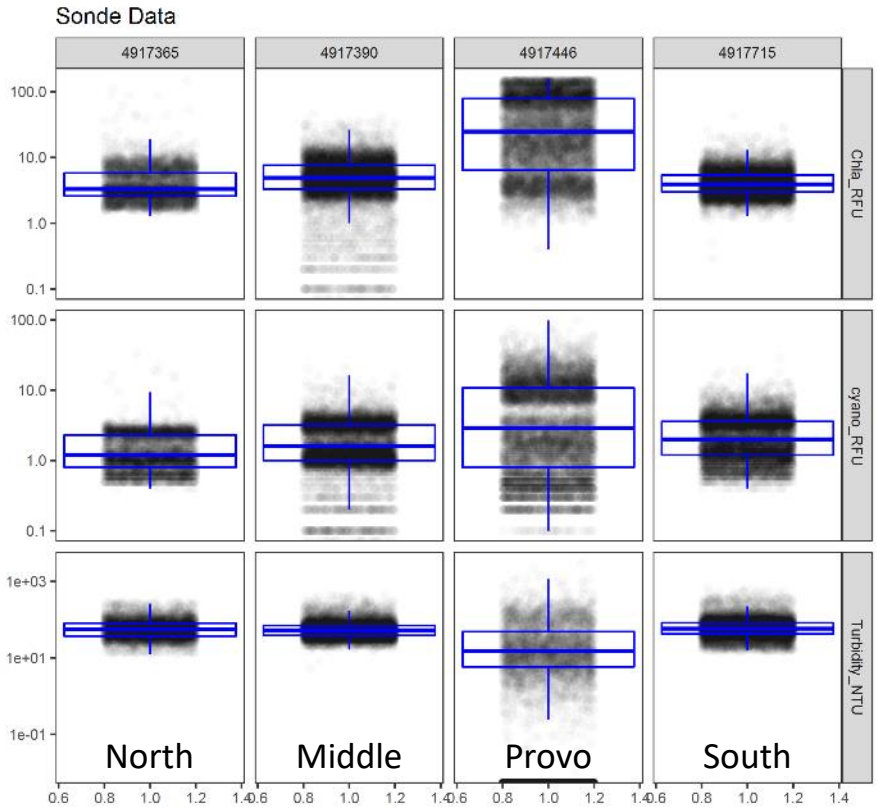


Task 3. Sonde Data Analysis

- Box and whiskers with jittered data
- Provo bay (third column) stands out
- Wanted to check if date difference mattered – maybe for Cyanos..



All Dates



Provo Bay Dates

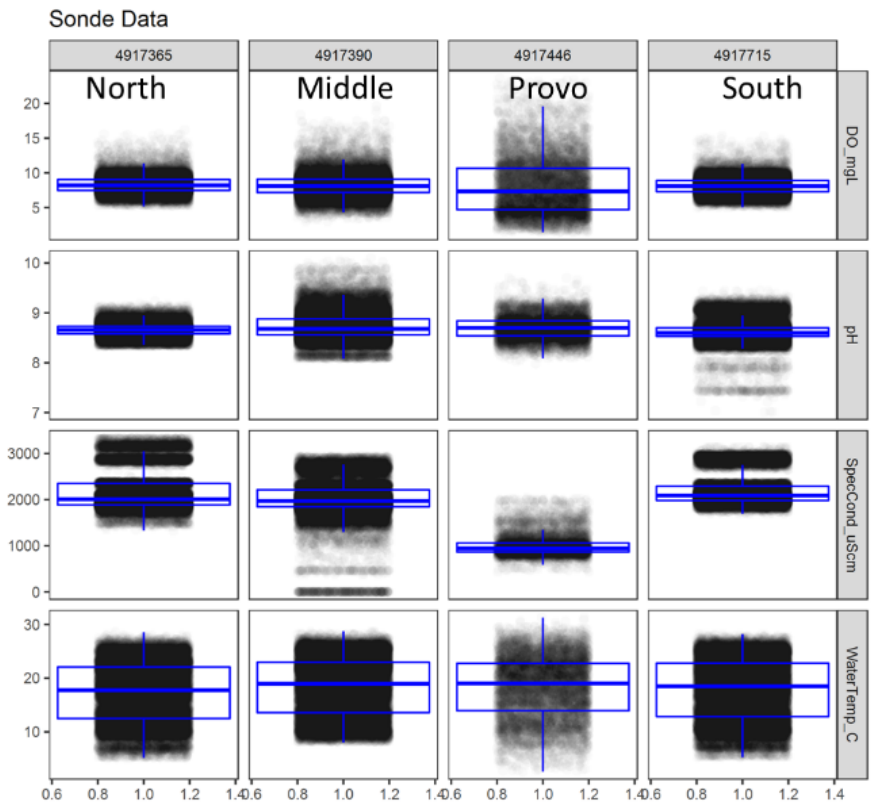
Chl

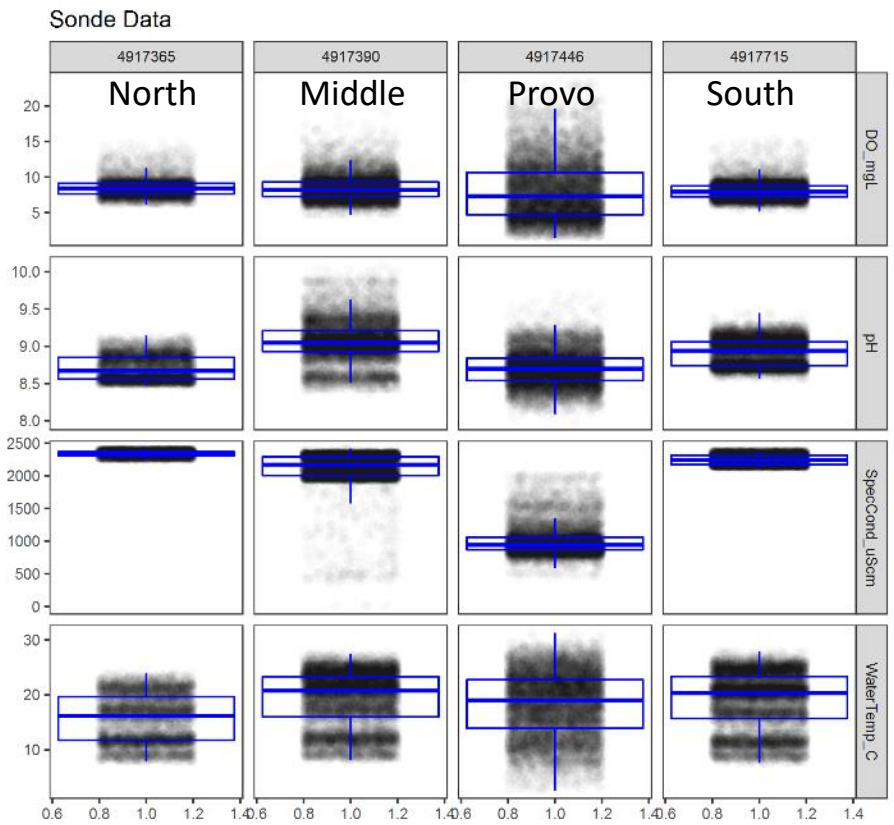
Cyano

Turbidity

Task 3. Sonde Data Analysis

- Box and whiskers with jittered data
- Provo bay (third column) stands out
- Wanted to check if date difference mattered – it did not





DO

pH

Conduct.

Temp

Task 3. Sonde Data Analysis

- Box and whiskers with jittered data
- Provo bay (third column) stands out
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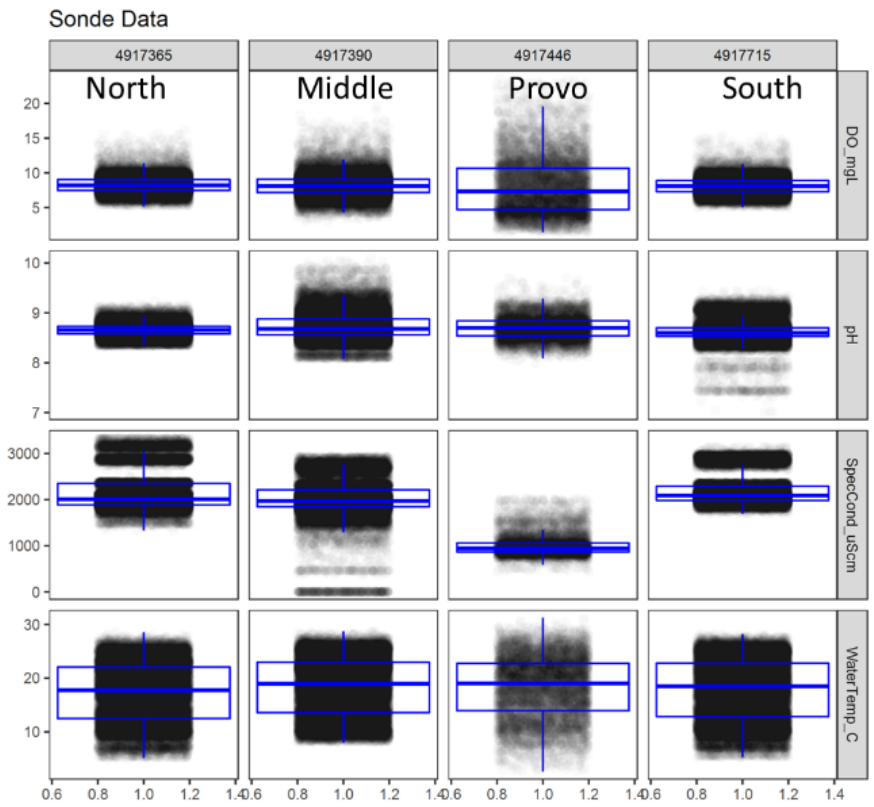
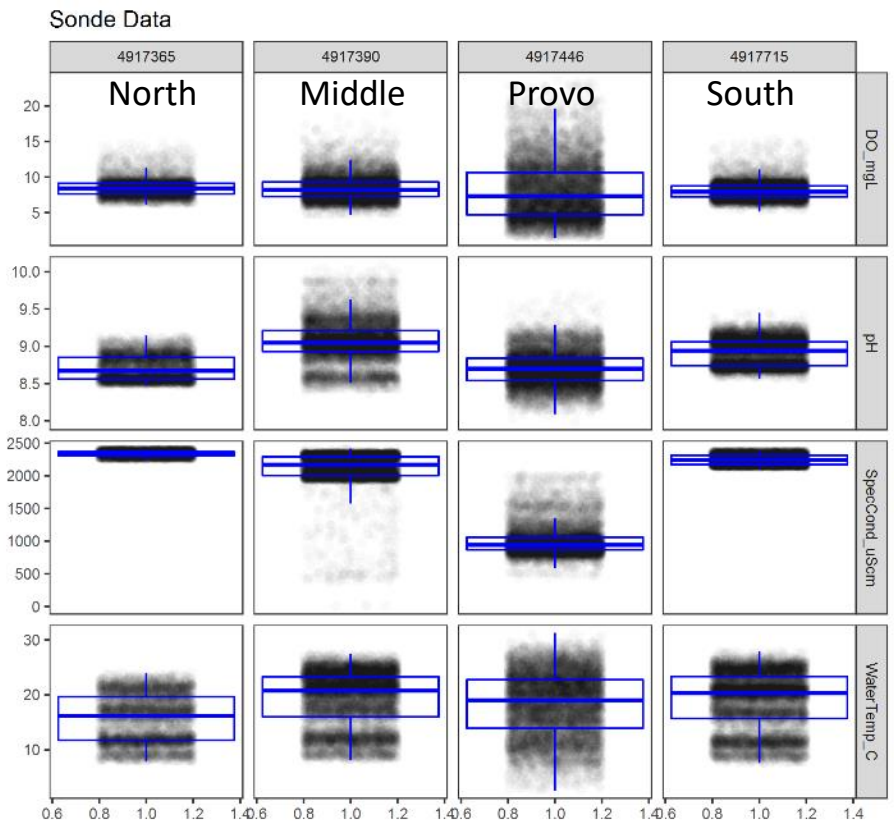




DO

pH

Conduct.

Temp

Task 3. Sonde Data Analysis

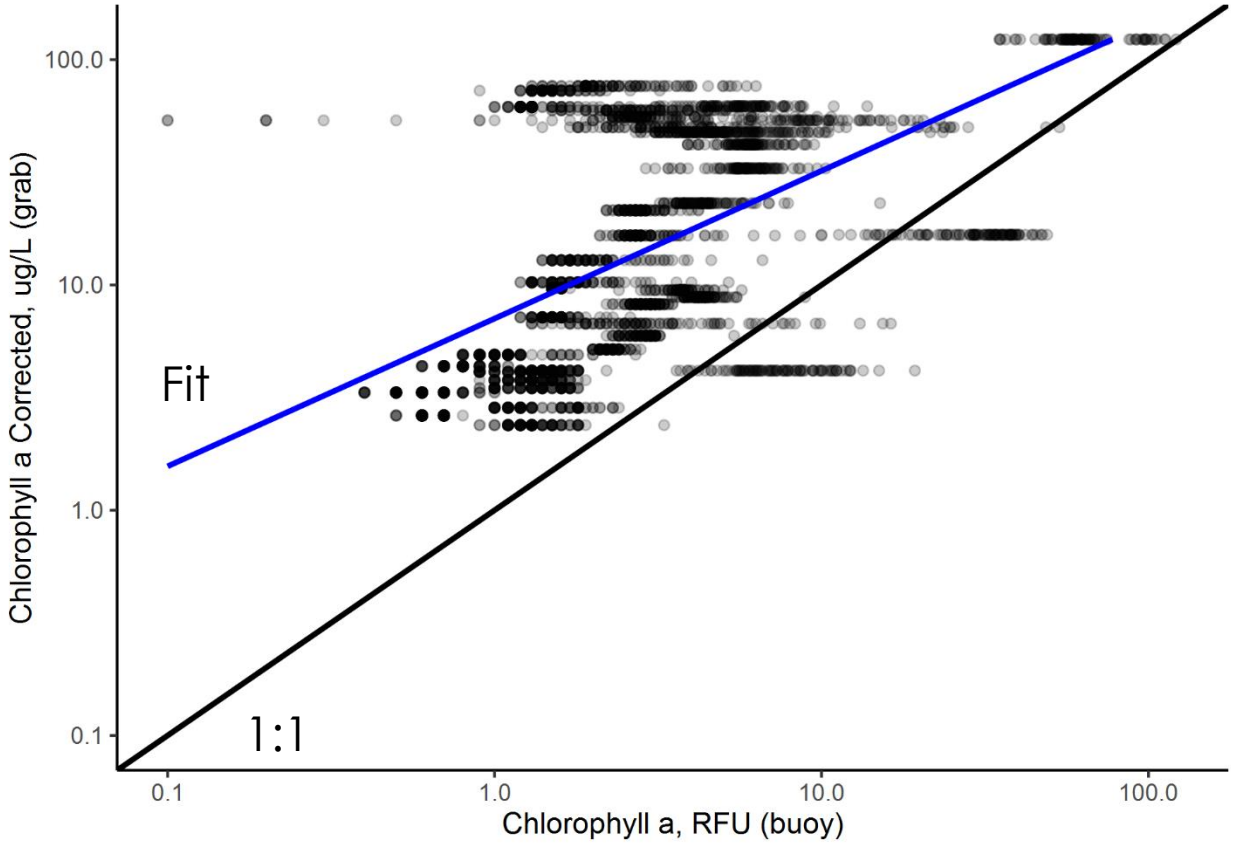
- **Matching Sites.** There are 4 buoy sites. Only 1 buoy site ID matched to the grab data.
  - We matched following nearby sites based on lat/long:

- **Buoy ID Grab ID**
  - 4917365 4917370
  - 4917390 4917390 (match)
  - 4917446 4917450
  - 4917715 4917710

- **Units.** Buoy chlorophyll units are RFU, ranging from 0 to 157.
  - Assume equivalence to ug/L for now.

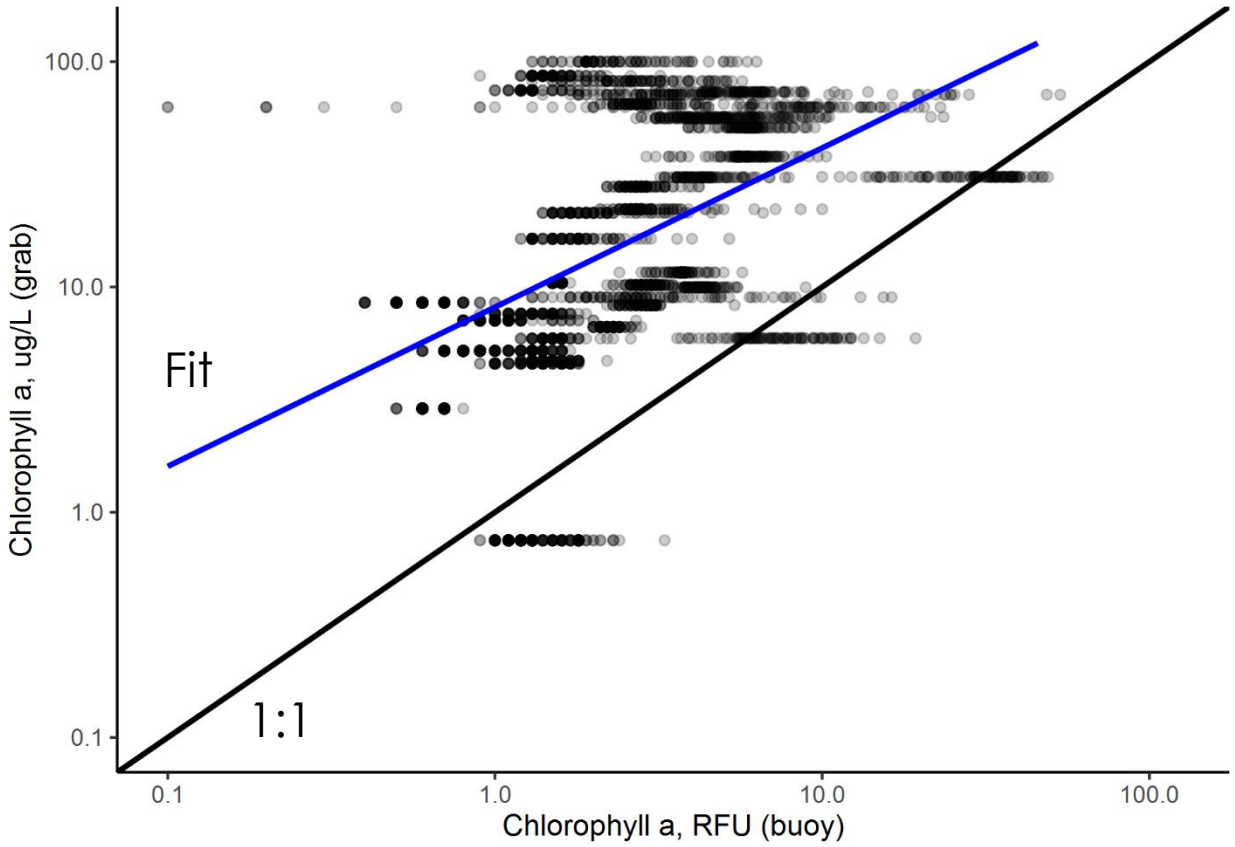
- **Joining Buoy and Grab Data.** When joining grab data to the buoy data, used a window of 24 hr.
  - ~3,600 paired chlorophyll samples
  - Can adjust as needed

- **Clearly some cleaning to do…**



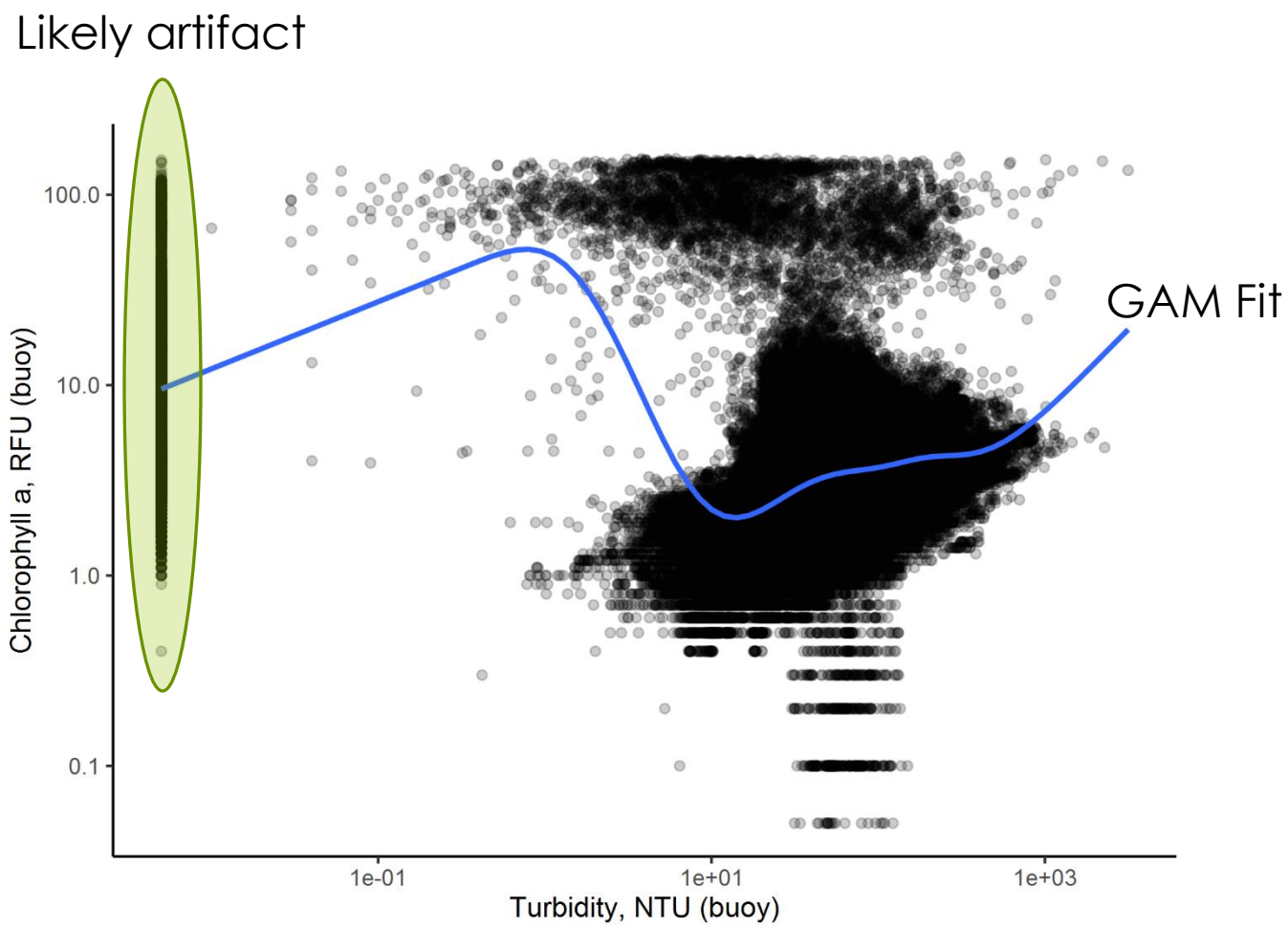
Task 3. Sonde Data Analysis

- Same with chlorophyll a listed without "correction"
- Also needs some cleaning



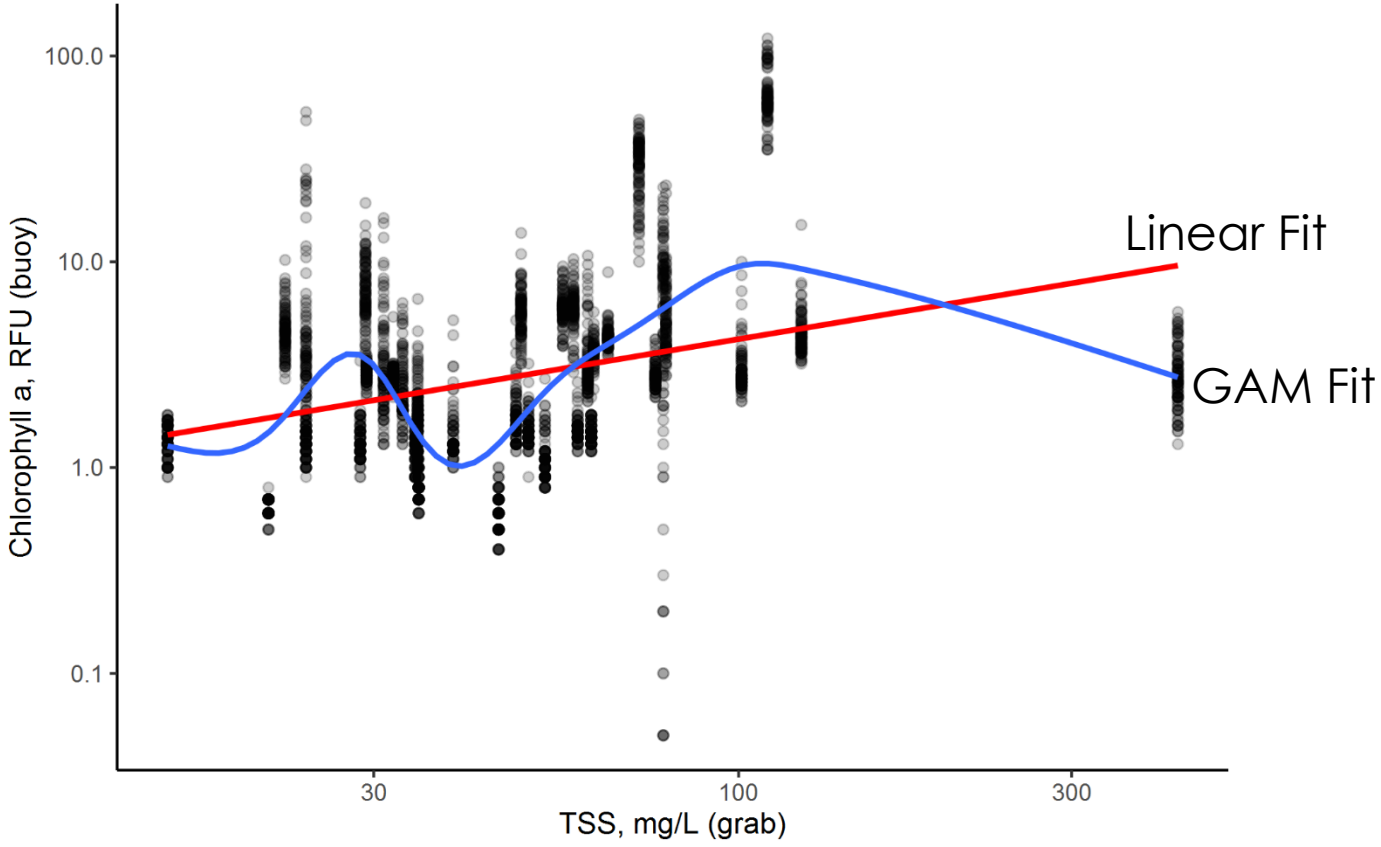
Task 3. Sonde Data Analysis

- Also looking at chlorophyll a and turbidity
- Lot of noise in this that needs addressing
- Any help appreciated for those with similar experience



Task 3. Sonde Data Analysis

- Also looking at chlorophyll a and TSS (grab)
- Little more sense
- Odd end member



Task 3. Sonde Data Analysis

- Big Picture:
  - You have the descriptive stats you requested
  - Provo looks different, but less data; this holds up even filtering all to Provo dates
  - The rest look similar
  - Promising things with chlorophyll, but need more data preparation/filtering work

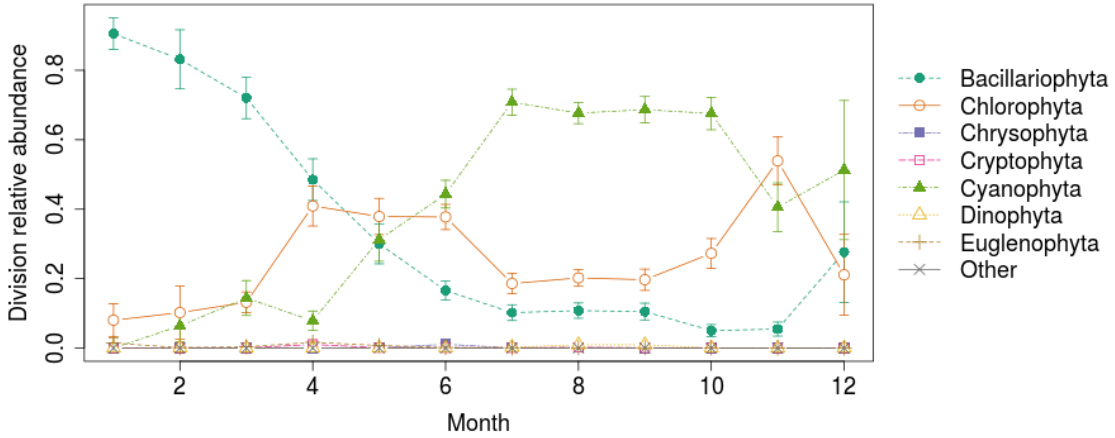
- Questions:
  - Does this get us what we need?

Task 4. Plankton Temporal and Spatial Analysis

- Question: When do HABs most frequently start/occur? (Charge question 2.3.i) What are the temporal patterns in phytoplankton and zooplankton? What is the seasonal succession of phytoplankton and zooplankton? What is the typical pattern of phytoplankton and zooplankton, how do they wax and wane? (Attachment A ULWQS Science Panel Ideas for Studies, Experiments, and Literature Reviews question).

- Long-term averaged data
- They start in April/May
- Temporal patterns paradigmatic

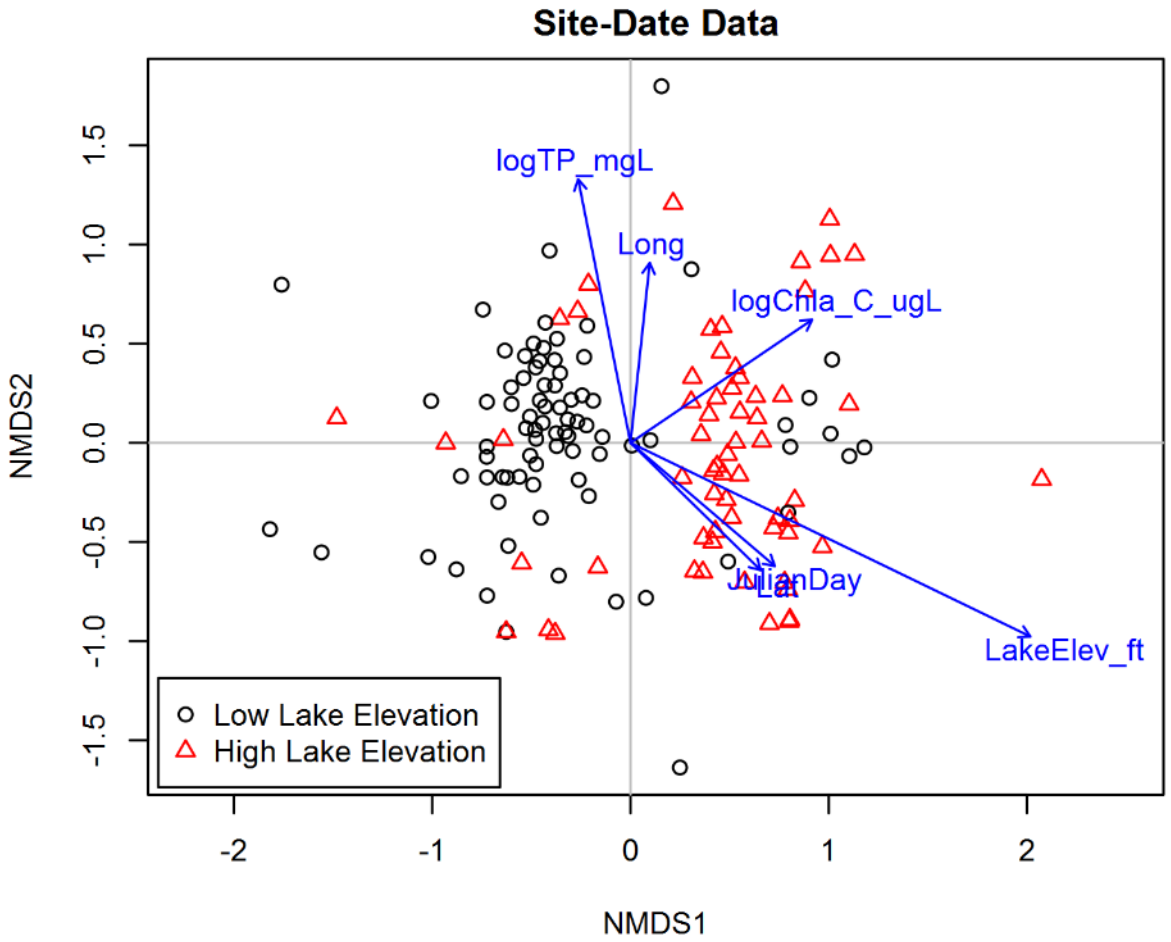
- Basically cleaning up these analyses



Task 4. Plankton Temporal Analysis

- Results: Temporal – reflects the monthly patterns – algae change

- Julian Day
- Northly locations
- Higher lake levels



Task 4. Plankton Spatial Analysis

- Question: Are there hotspots and do they tend to occur near major nutrient sources? (Charge question 2.3.i) Do HABs generally begin near POTW outfalls? (Attachment A ULWQS Science Panel Ideas for Studies, Experiments, and Literature Reviews question).

- NMDS plots were confusing – cleared those up
- Scales were off on these plots – Jake has included a way to fix scales for comparison

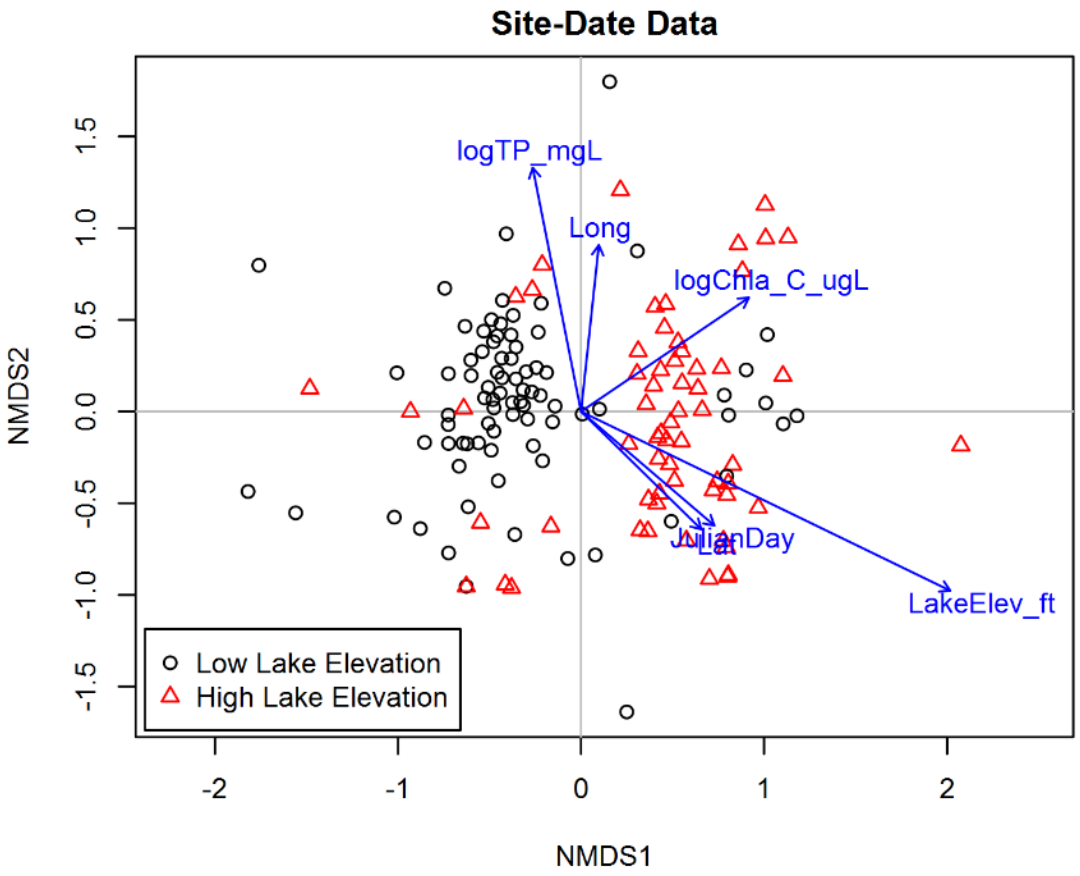
Task 4. Plankton Spatial Analysis

- Results: Spatial
- Lat/Long are important

- Higher Lake P
- Easterly locations

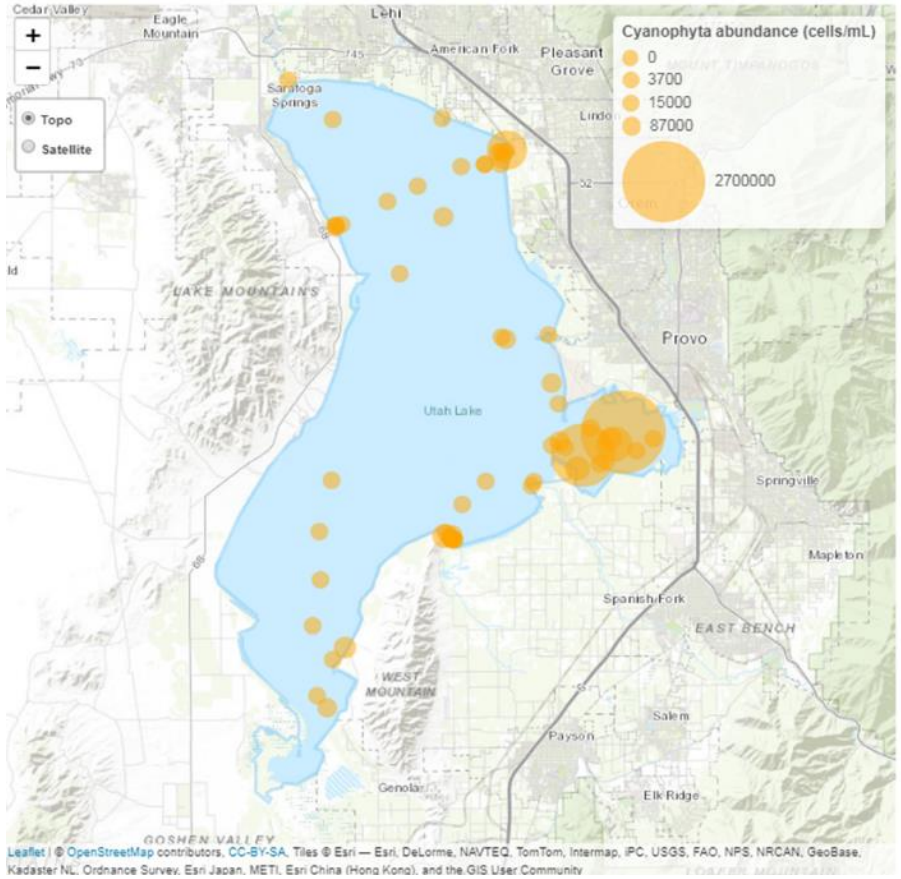
Orthogonal to

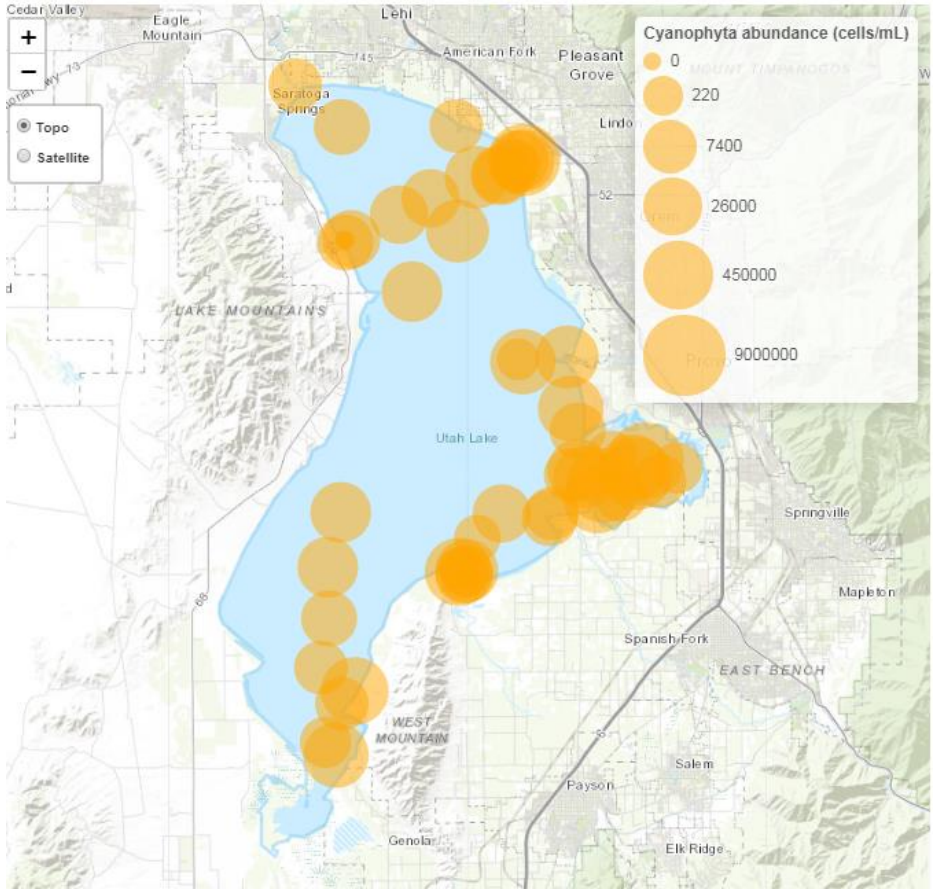
- Julian Day
- Northerly locations
- Higher lake levels



Task 4. Plankton Spatial Analysis

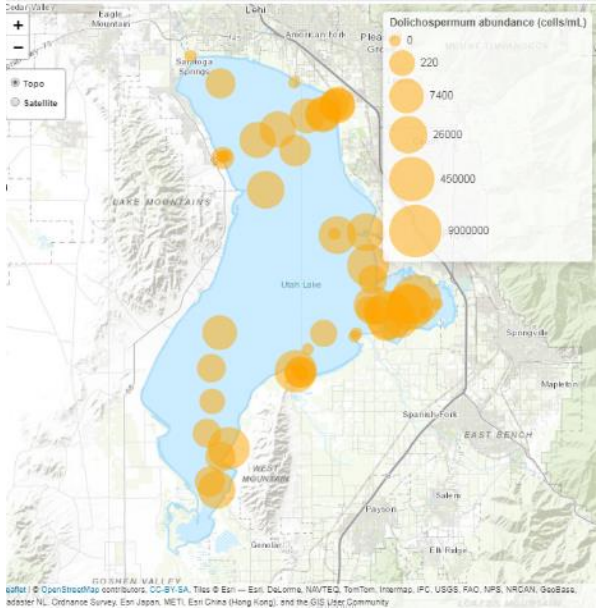
- Cyanophytes combined
- Eastern hot spots



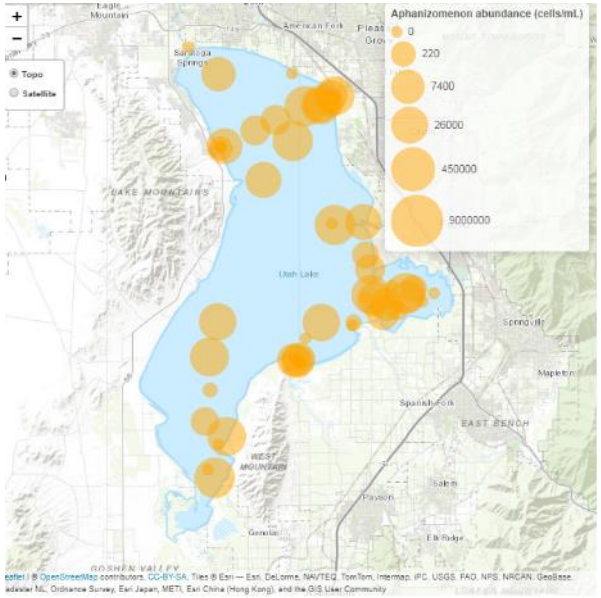


Task 4. Plankton Spatial Analysis

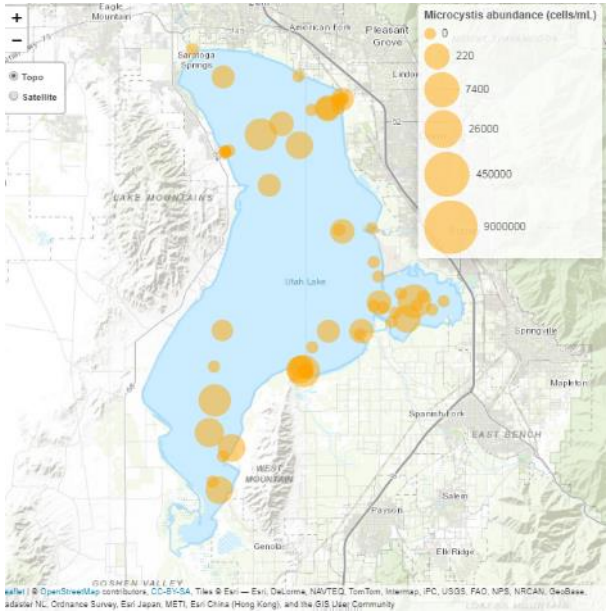
- Comparing Taxa
- Big spot in Provo Bay, but generally quite high



Dolichospermum
(Was Anabaena)



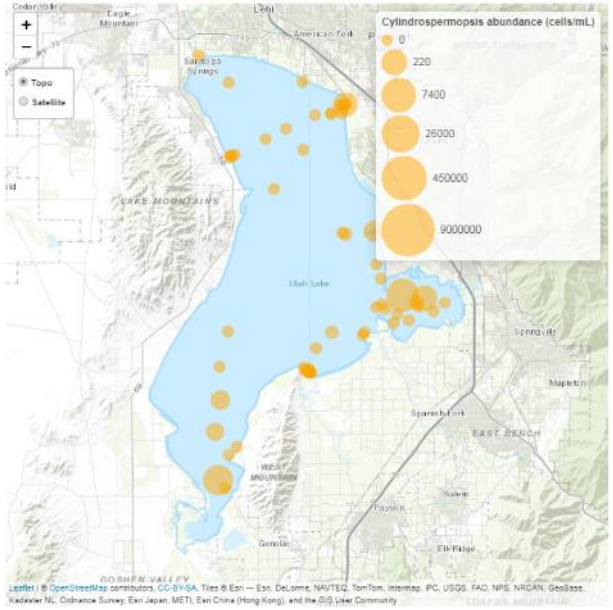
Aphanizomenon



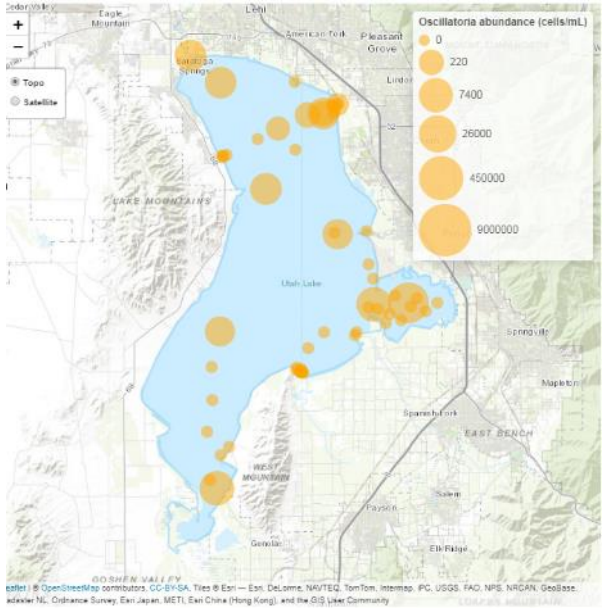
Microcystis

Task 4. Plankton Spatial Analysis

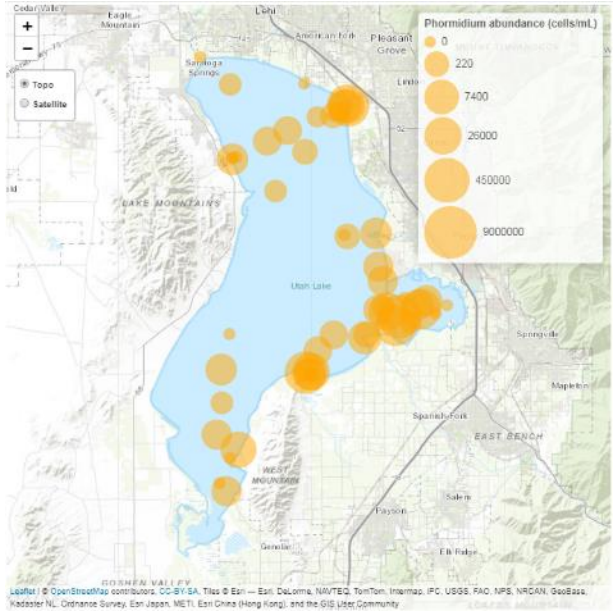
- Comparing Taxa
- Big spot in Provo Bay, but generally quite high



Cylindrospermopsis



Oscillatoria



Phromdium

Task 4. Plankton Spatial Analysis

- Question: Are there hotspots and do they tend to occur near major nutrient sources? (Charge question 2.3.i) Do HABs generally begin near POTW outfalls? (Attachment A ULWQS Science Panel Ideas for Studies, Experiments, and Literature Reviews question).
  - Yes, there are hot spots
  - We do not know their relation to POTWs – but we can find it out

- To Do:
  - Relation to POTW needs a POTW map and distance to each sampling location
  - We can then run HAB abundance (mean, max) versus distance to POTW outfall.

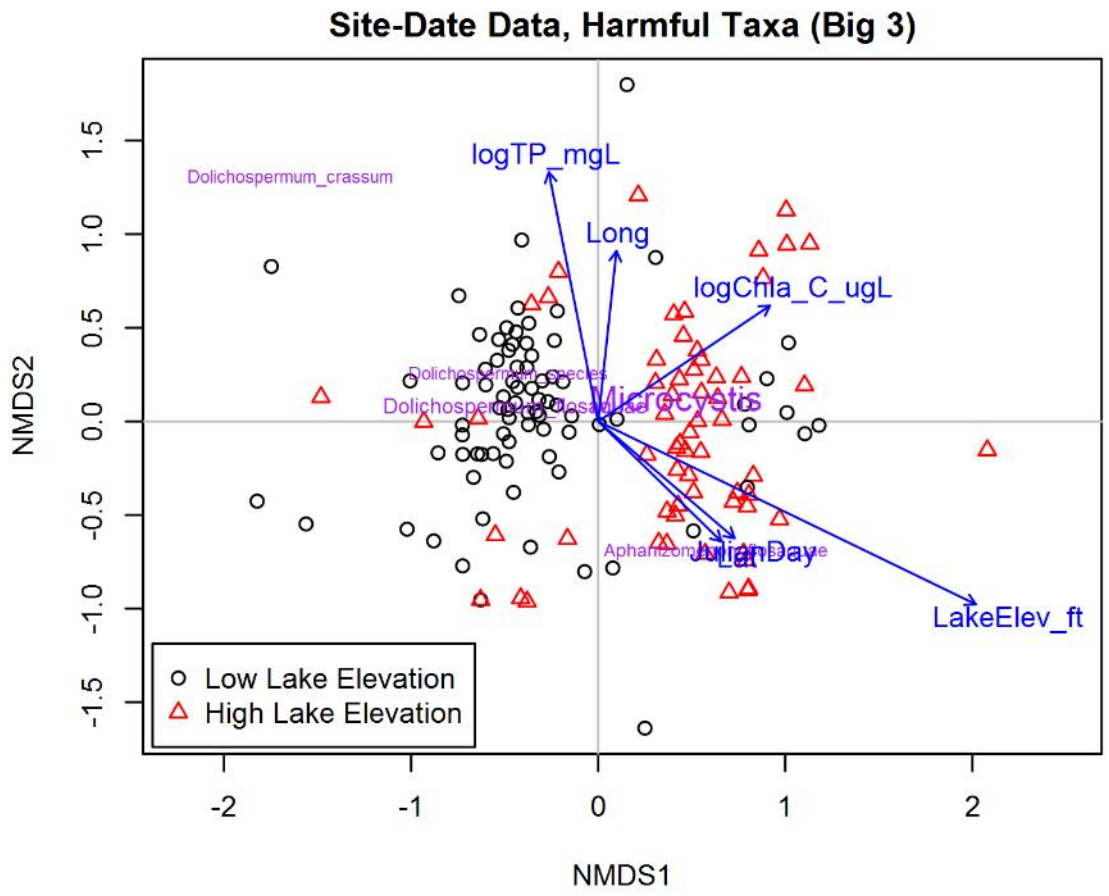
Task 4. Plankton Spatial Analysis – To Nutrients

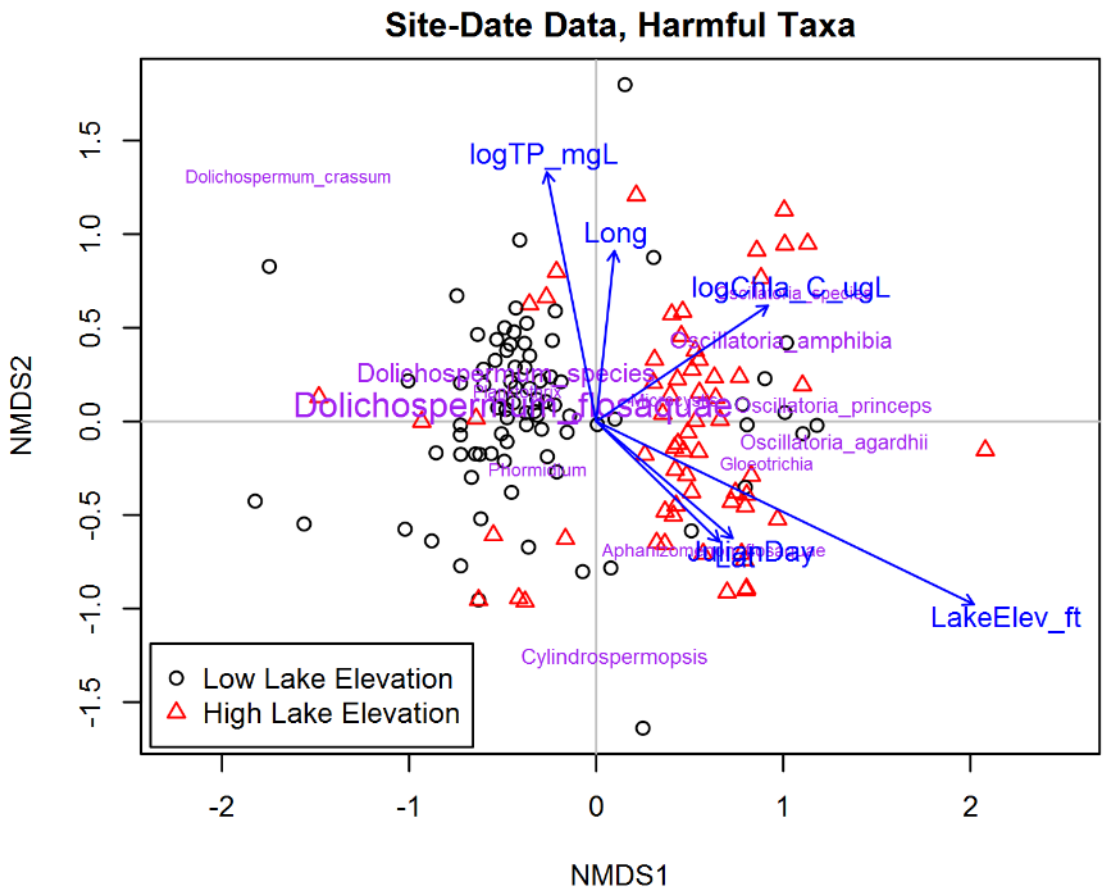
- Question: Which nutrients are actually controlling primary production and HABs and when? (Charge question 2.3.ii) If there are linkages between changes in nutrient regime and HABs?? (Charge question 2.3.iii)

- Cleaned NMS Plots
- You asked to add focus on harmful taxa

Task 4. Plankton Spatial Analysis – Nutrients

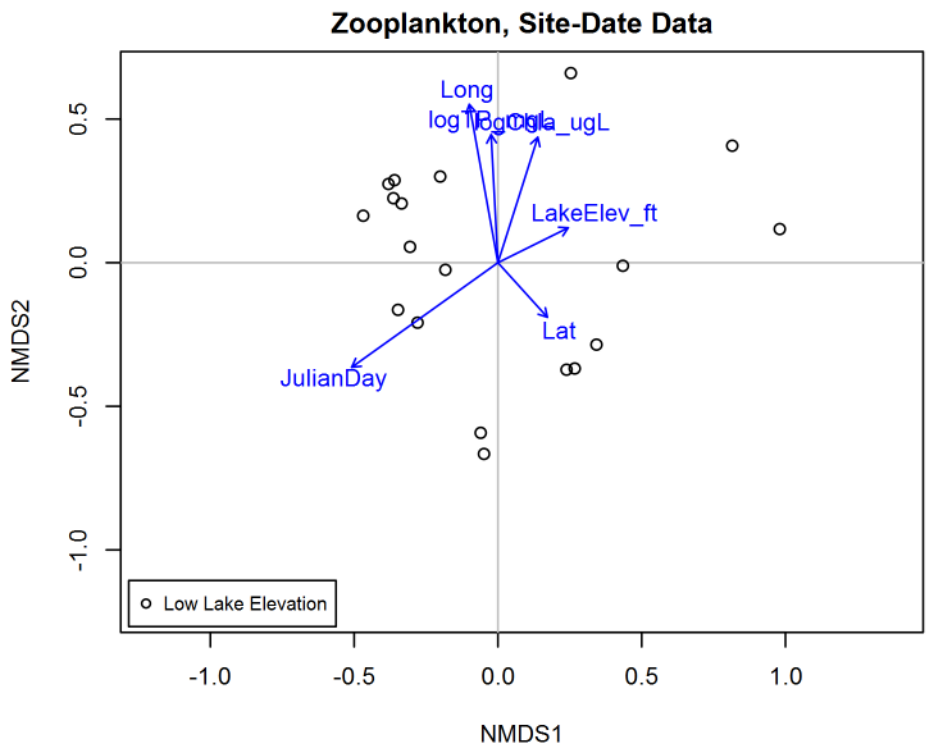
- TP tracks differences, aligned with Dolly (+) and Fanny (-)

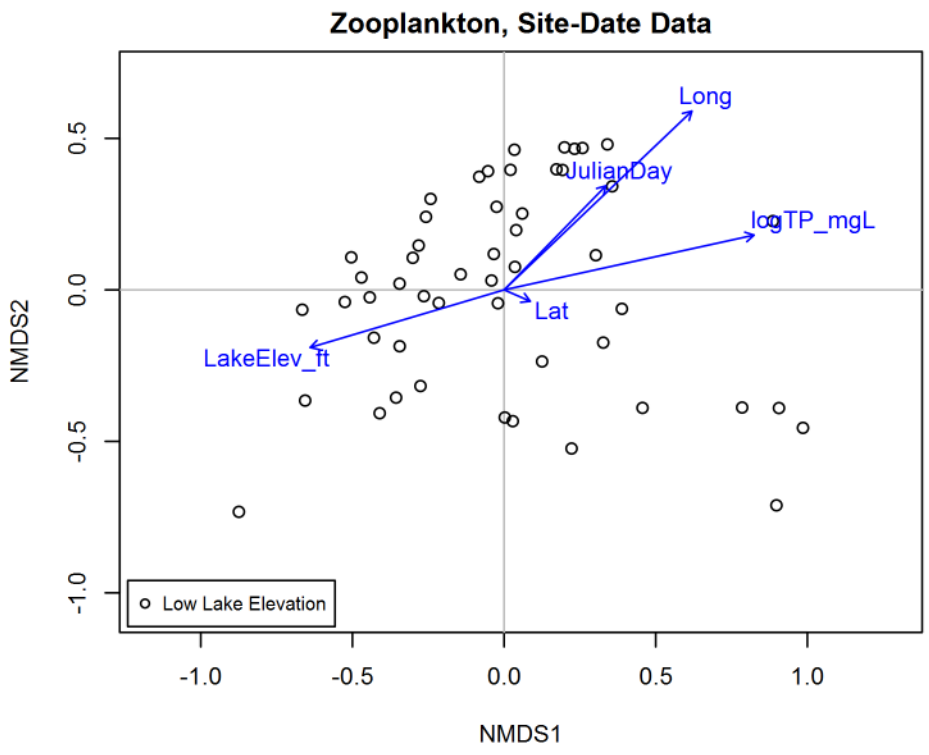




Task 4. Plankton Spatial Analysis – Nutrients

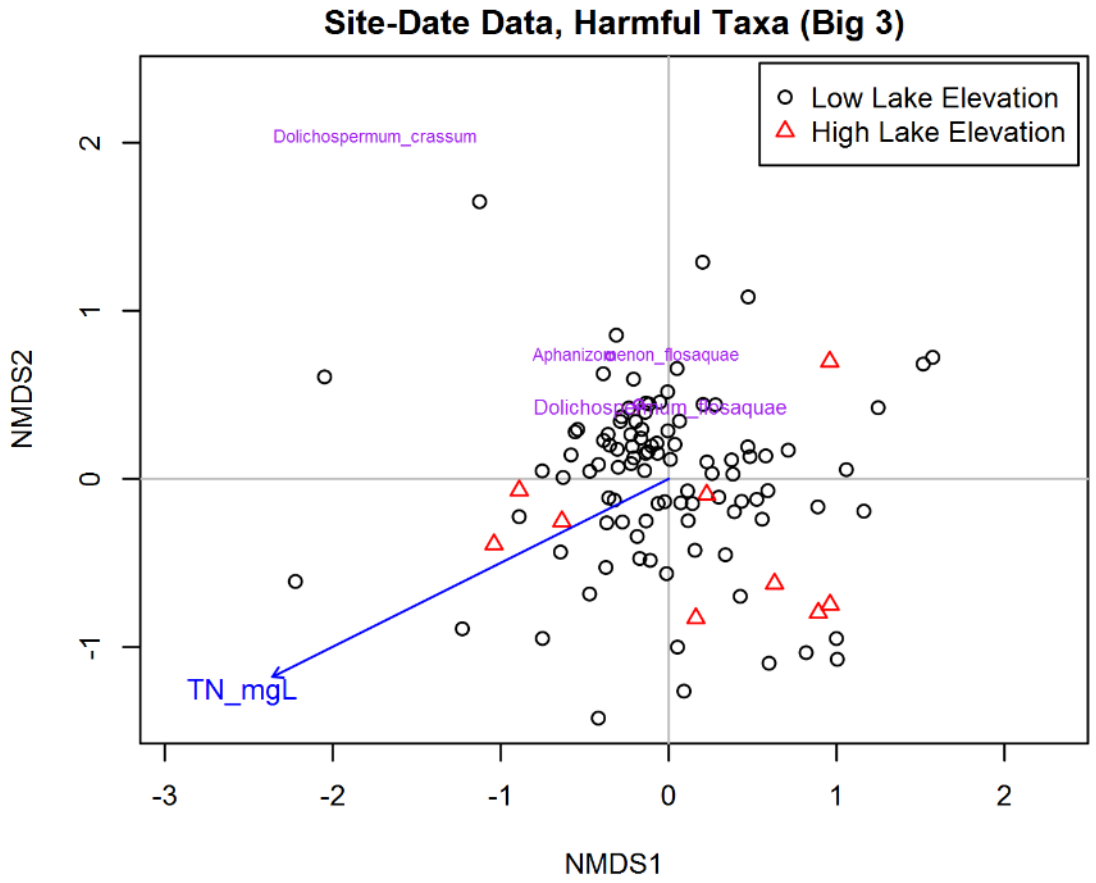
- Spatial structure to zooplankton too
- Related to nutrients, but just starting to tease apart

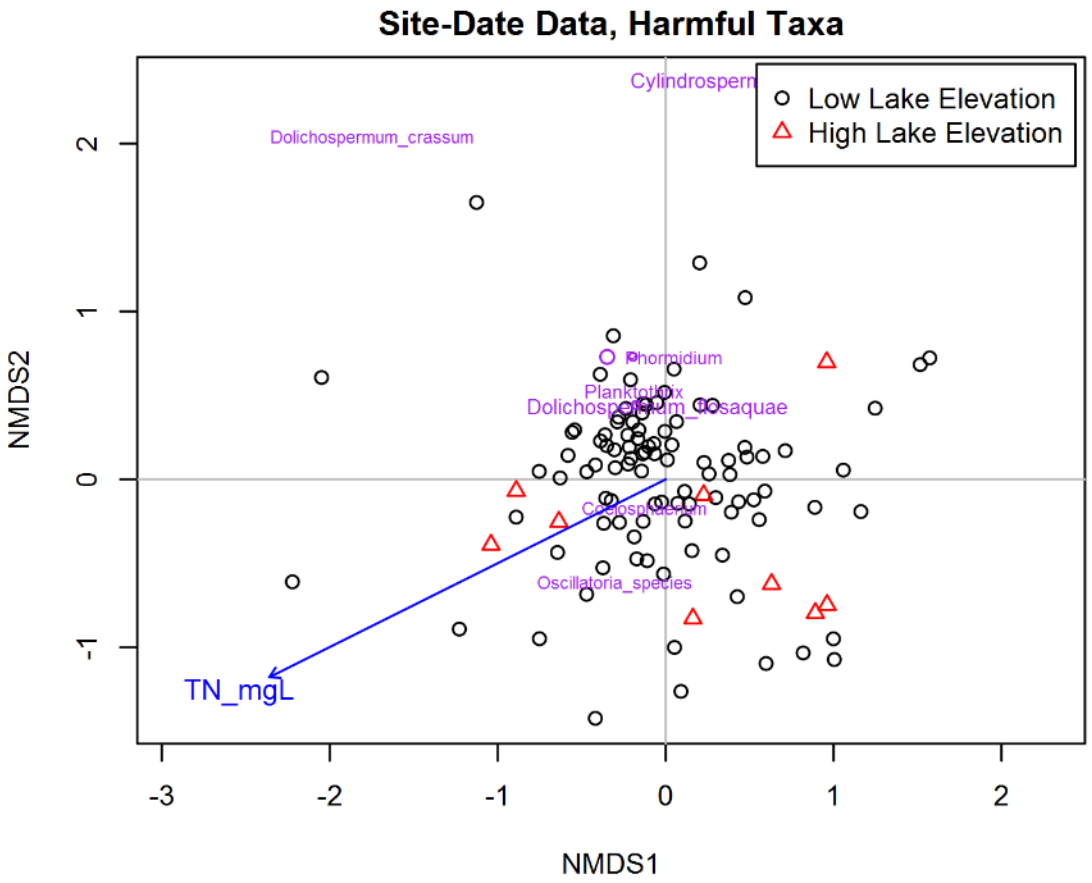




Task 4. Plankton Spatial Analysis – Nutrients

- TN tracks differences (different paired data population)
- Orthogonal to Dolly and Fanny





Task 4. Plankton Spatial Analysis – To Nutrients

- Question: Which nutrients are actually controlling primary production and HABs and when? (Charge question 2.3.ii) If there are linkages between changes in nutrient regime and HABs?? (Charge question 2.3.iii)
  - Can't answer "control" with this, but there are linkages between abundance of HABs and nutrients

To do:

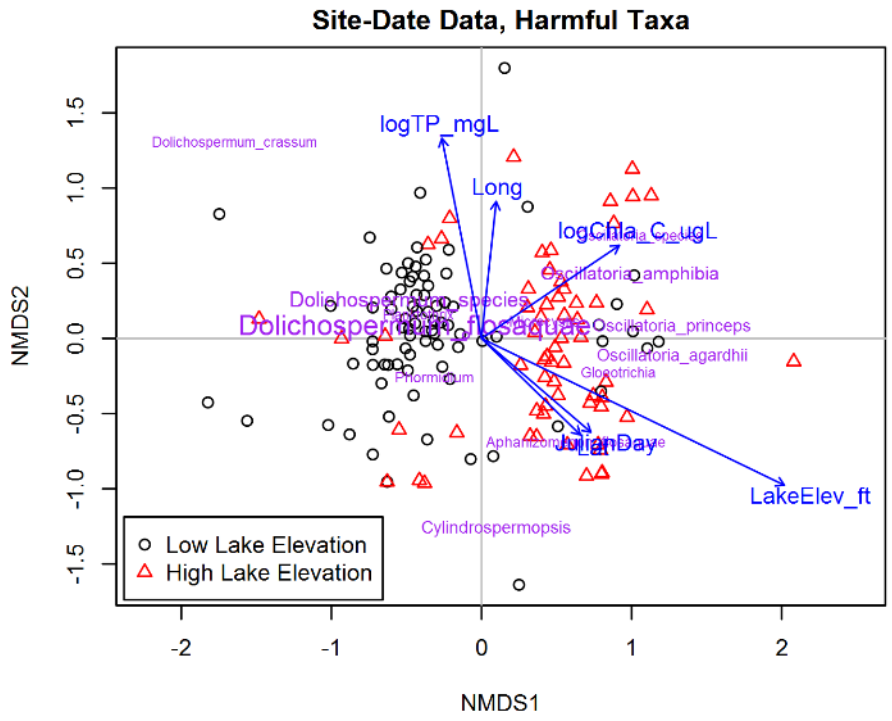
- "Nutrient regime" – what does this mean? How can it be quantified into a predictor?

Task 4. Plankton Spatial Analysis – Role of Lake Level

- Question: If there are linkages between changes in nutrient regime and HABs, what role if any does lake elevation change play? (Charge question 2.3.iii)

- Lake level did matter
- Composition changed under higher levels
- Dolly more abundant – low elevation
- Fanny – higher elevation
- Others a mix/agnostic

- Question about motile taxa
- Asked to look at HAB taxa too

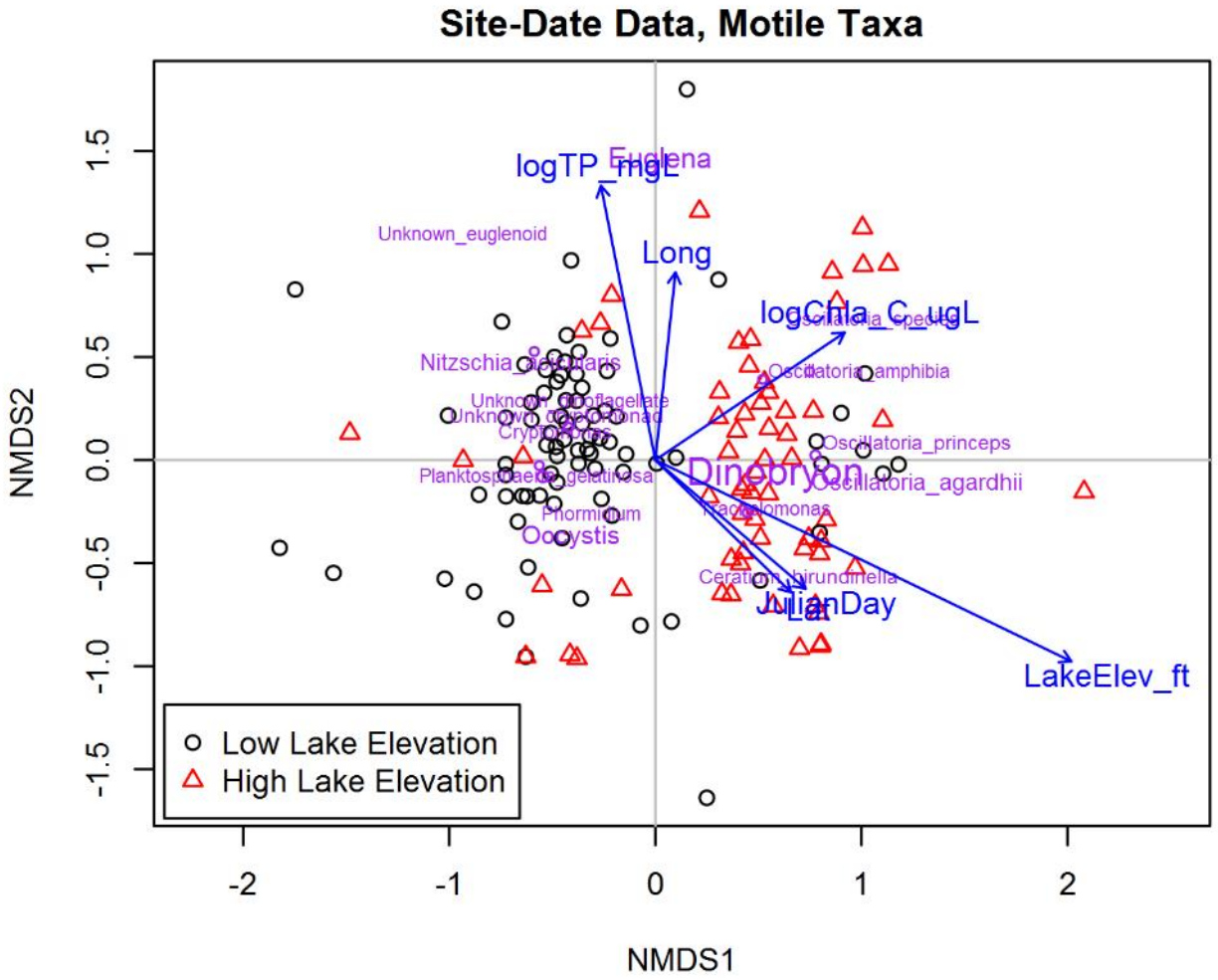


Task 4. Plankton Spatial Analysis – Role of Lake Level

- Motile taxa
- An interesting split
- Several aligning with high
- Several with low

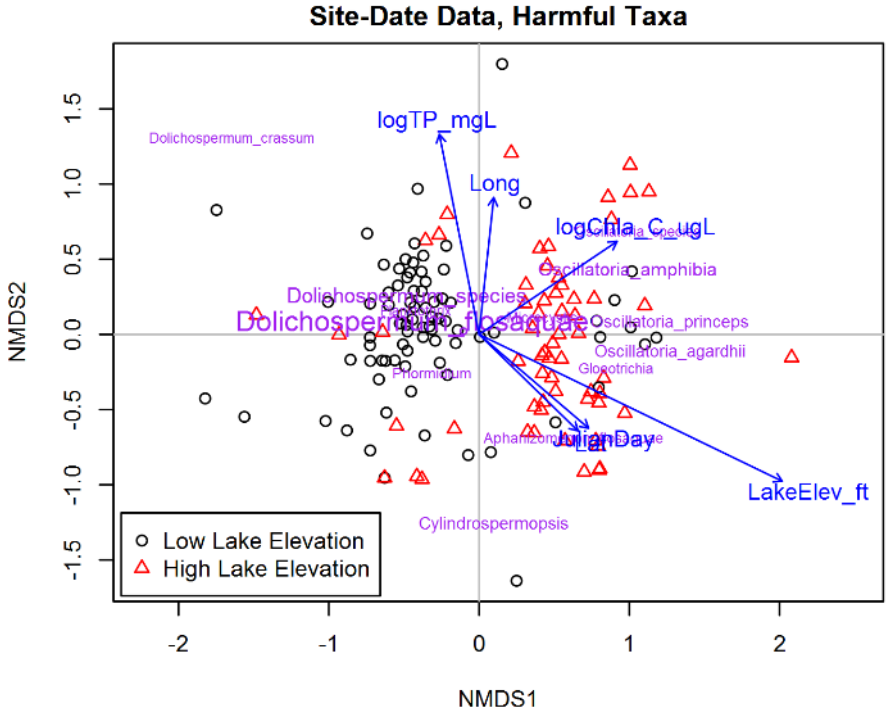
- Still not really stratified system
- Well mixed as well

- Is there more specifically to pull out regarding motility?
- What information can we provide?



Task 4. Plankton Spatial Analysis – Role of Lake Level

- Question: If there are linkages between changes in nutrient regime and HABs, what role if any does lake elevation change play? (Charge question 2.3.iii)
  - Not sure of "role", but assemblage does shift
  - Somewhat related to motility, but not universally



Task 5. Diatom and Macrophyte Autecology

- Questions:
  - Working on this
  - Getting input/feedback from Janice on diatoms
  - Recently received draft macrophyte study from Kevin Landom (June Sucker Program)

Task 5. Macrophyte Autecology

- Macrophyte Study
- Discusses history
- Can look at light/nutrient needs of these taxa

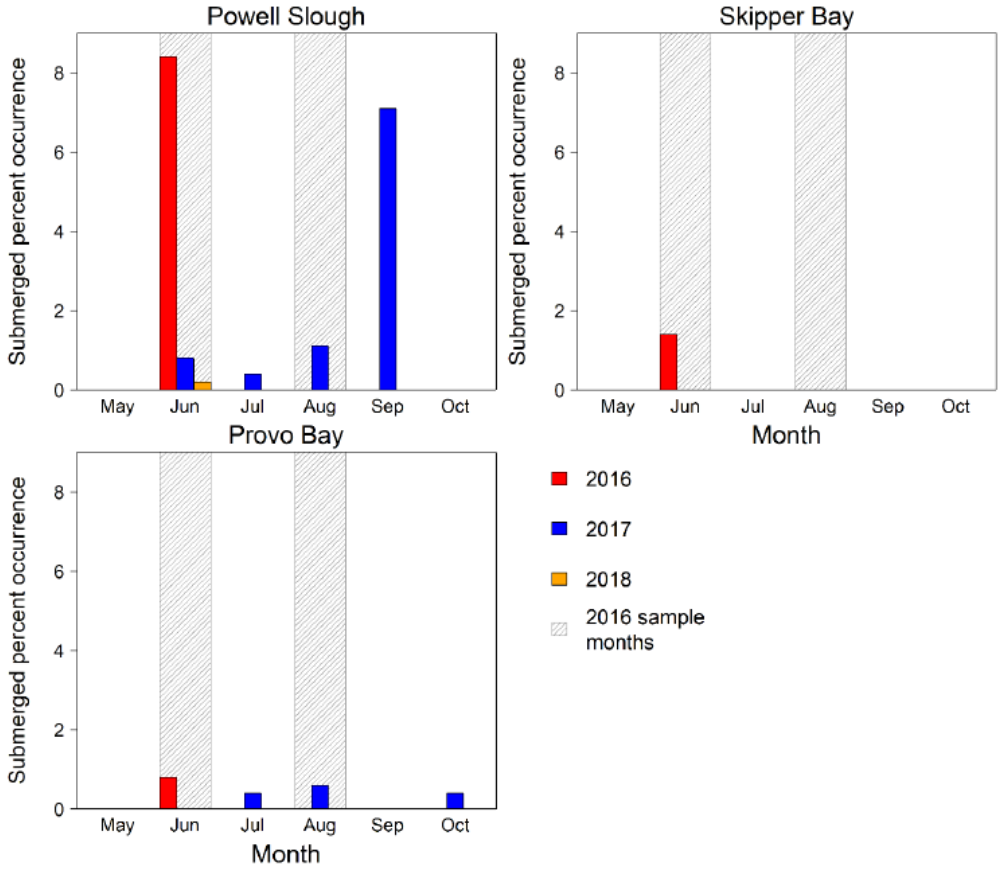
Non-native

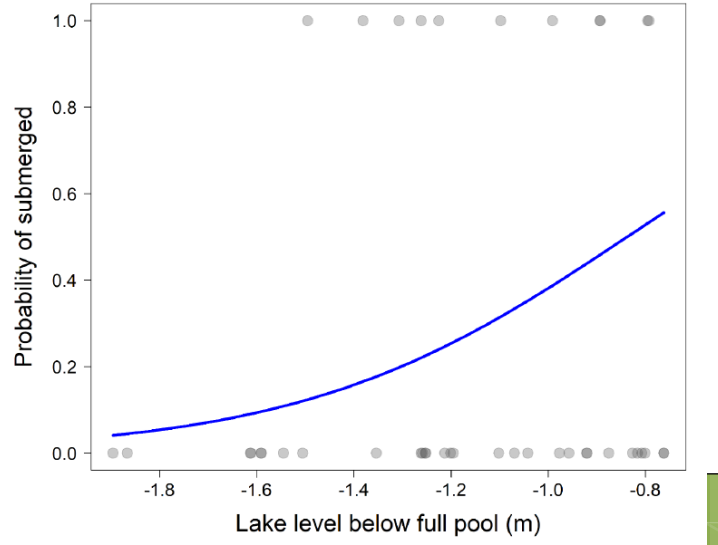
Table 1. Common and Latin names, growth form classifications, and nativity descriptions for taxa observed during Utah Lake line-intercept macrophyte transect sampling.

Common name	Latin name	Classification	Nativity
Alkali bulrush	*Bolboschoenus maritimus*	Emergent	Native
Cattail	*Typha latifolia*	Emergent	Native
Coontail	*Ceratophyllum demersum*	Submerged	Native
Cottonwood	*Populus fremontii*	Emergent-terrestrial	Native
Curly dock	*Rumex crispus*	Emergent-terrestrial	Invasive
Dead emergent	Various species	Emergent	Various species
Duckweed	*Lemna minor*	Free-floating	Native
Filamentous algae	Various species	Free-floating	Various species
Hardstem bulrush	*Scirpus acutus*	Emergent	Native
Mosquito fern	*Azolla microphylla*	Free-floating	Native
Phragmites	*Phragmites australis*	Emergent	Invasive
Sago pondweed	*Stuckenia pectinata*	Free-floating	Native
Sago pondweed	*Stuckenia pectinata*	Submerged	Native
Tamarisk	*Tamarix ramosissima*	Emergent-terrestrial	Invasive
Water plantain	*Alismataceae*	Emergent	Native
Willow	*Salicaceae*	Emergent-terrestrial	Native
Yellowcress	*Rorippa sphaerocarpa*	Emergent-terrestrial	Native

Task 5. Macrophyte Autecology

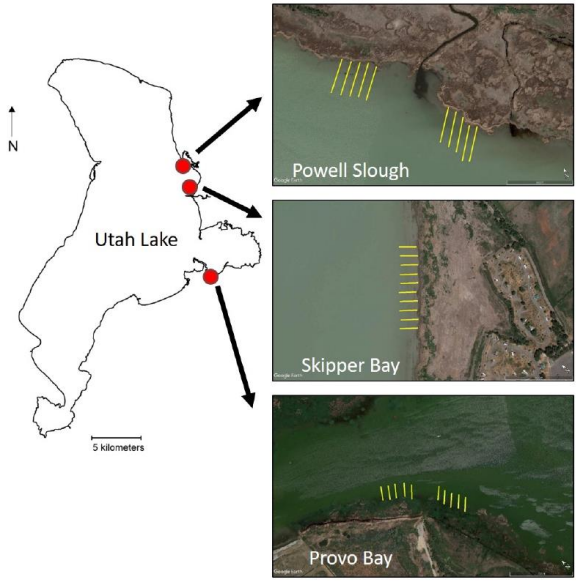
- Macrophyte Study
- Submergent taxa present but variable
- May be somewhat related to lake level fluctuations
  - 2016 – rapid lake level drop year

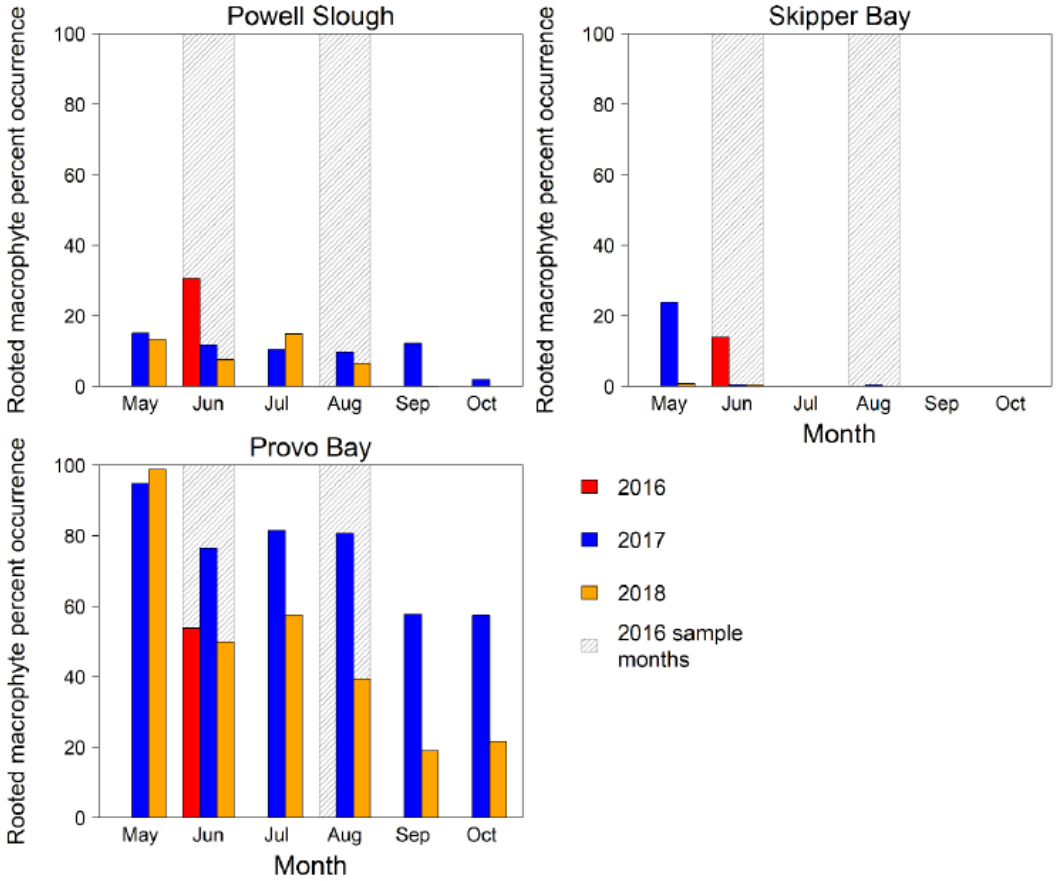




Task 5. Macrophyte Autecology

- Macrophyte Study
- Rooted macrophytes, in general, were clearly present – depending on lake level and site location





Task 5. Macrophyte Autecology

- Macrophyte Study
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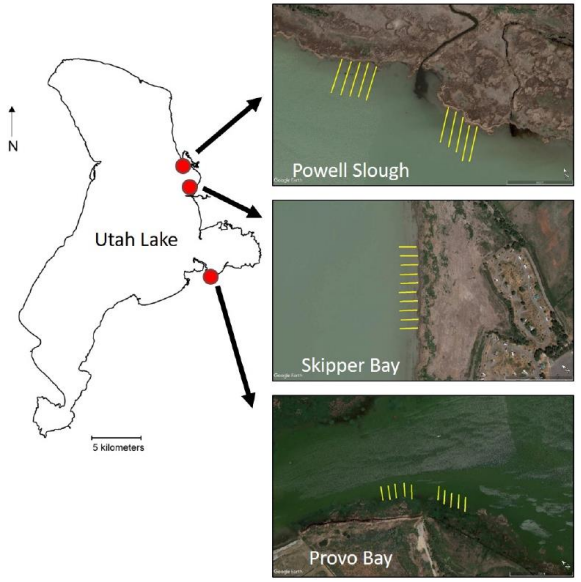
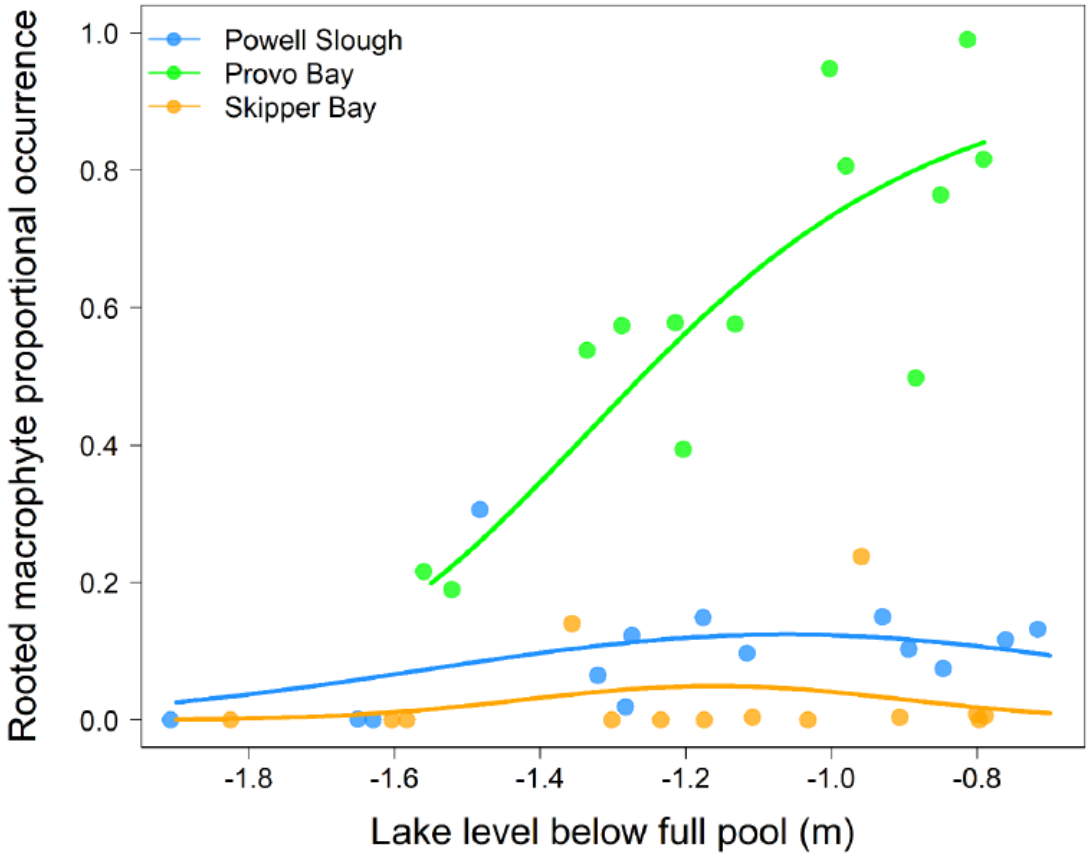
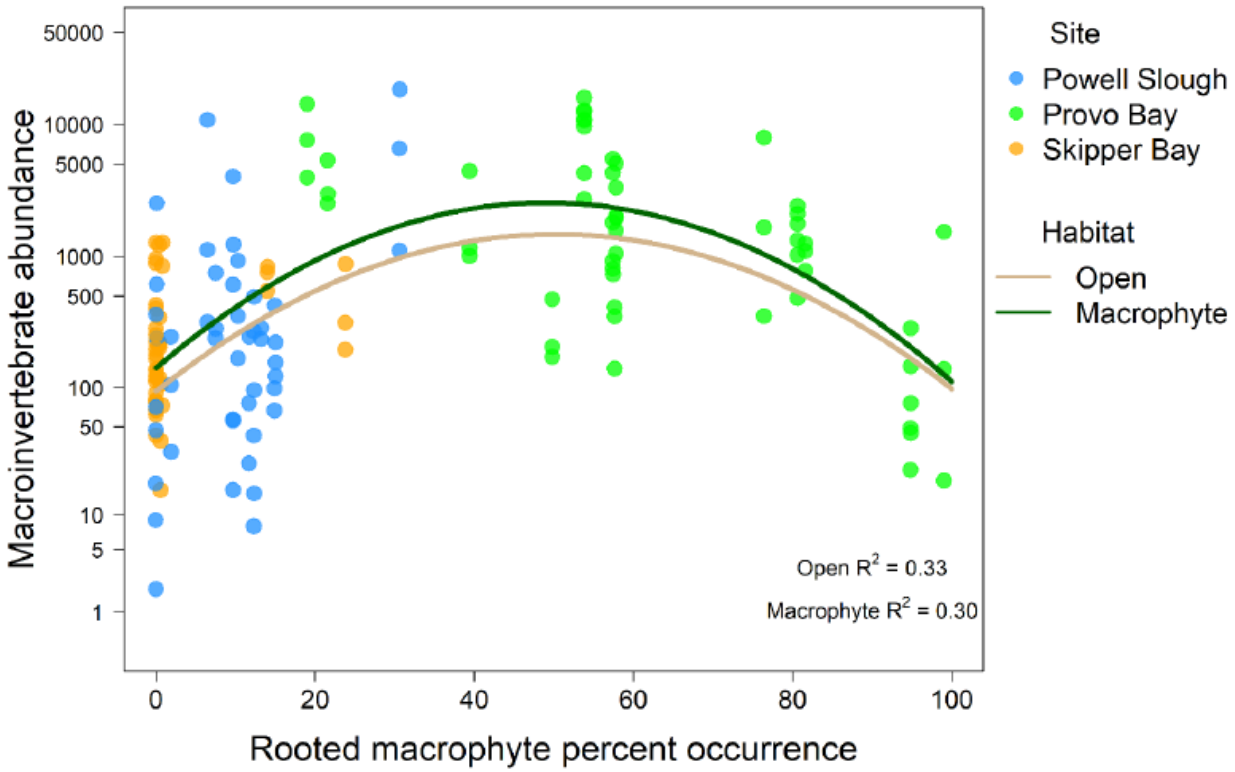




Task 5. Macrophyte Autecology

- Macrophyte Study
- Inverts prefer macrophytes until a sample effect occurs at higher macrophyte occurrences.
- Carp effect?
- Herbicide effect?
- Lake level effect?



Task 6. Wind and Turbidity

- Goal: Identify wind condition necessary to entrain bottom sediments in Utah Lake.
- THM: Lake has sufficient energy to frequently suspend sediments (wave and current shear)
  - Wind shear: 0.027 N/m^2 at average wind speed and depth and longest fetch
  - **Provo Bay Wind Shear** (WSW @ 6mph, Fetch 2.4mi, 0.5 to 1.5m depth): 0.07 to 0.18 N/m^2
  - Current shear: 0.14 to 0.23 N/m^2
  - Literature based critical shear for cohesive sediments: 0.009 to 0.25 N/m^2
- Looking to add calculator to Explorer for those interested (fetch, depth, wind speed and comparison to critical)
- WASP/EFDC will allow mapping of shear stress

Task 7. Turbidity and Macrophytes

- Goal: Identify the potential contribution of macrophytes to reducing turbidity.

- Working on this with Soren/Leighton King
- Literature suggests macrophytes have a significant effect on wind shear, even at low biomass.

Task 8. Light extinction

- Goal: Identify the potential contribution of turbidity/TSS and algal biomass to turbidity.

- Still working on this one as well – as we get PAR data

Data Analysis

- Next Steps:
  - Heads down, keep at it
  - All feedback appreciated

  - Analysis Report Draft: this spring
    - Oriented towards each specific applicable charge question
    - Will communicate uncertainty to degree analysis allows and using the guidance document