NEW YORK
STATE OF
OPPORTUNITY

Department of
Environmental
Conservation

New York State Harmful Algal Bloom Initiative: Mitigation Strategies Pilot

Stephanie June

Lake Monitoring and Assessment Section

Bureau of Water Assessment and Management, Division of Water

May 3, 2019 – New York State Federation of Lake Associations Annual Conference

Outline

2018 Statewide HABs Initiative

- Four point initiative

Point Four (Five): HABs Mitigation Strategies Pilot

- Project overview and design
- Description of strategies
- Preliminary discussion of results
- Future work and data analyses

2018 HAB Initiative

Governor Cuomo's State of the State 2018

$65 million dedicated to HABs:

- 12 Priority Waterbodies
- 4 Regional Summits
- Priority Waterbody Action Plans
- Advanced Monitoring
- Mitigation Pilot Projects

Follow up to several recent water quality initiatives

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

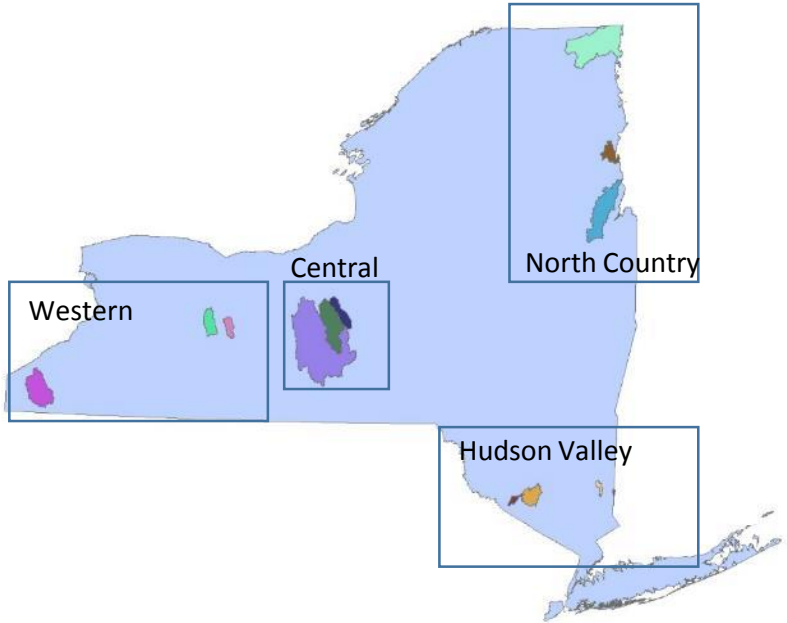
Selection of Priority Waterbodies

There are 16,000 lakes in NYS, so a difficult task

Wide variety of types, locations, sizes and vulnerabilities

All Priority Lakes are water supplies or critical tourism drivers:

- **Western Group:** Conesus; Honeoye; Chautauqua Lakes
- **Central Group:** Owasco; Skaneateles; Cayuga Lakes
- **North Country Group:** Parts of Lake Champlain; Lake George
- **Greater Hudson Valley Group:** Lake Carmel; Palmer Lake; Putnam Lake; Monhagen Brook Watershed (five reservoirs)



NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Regional HAB Summits

Organized by DEC, DOH and DAM

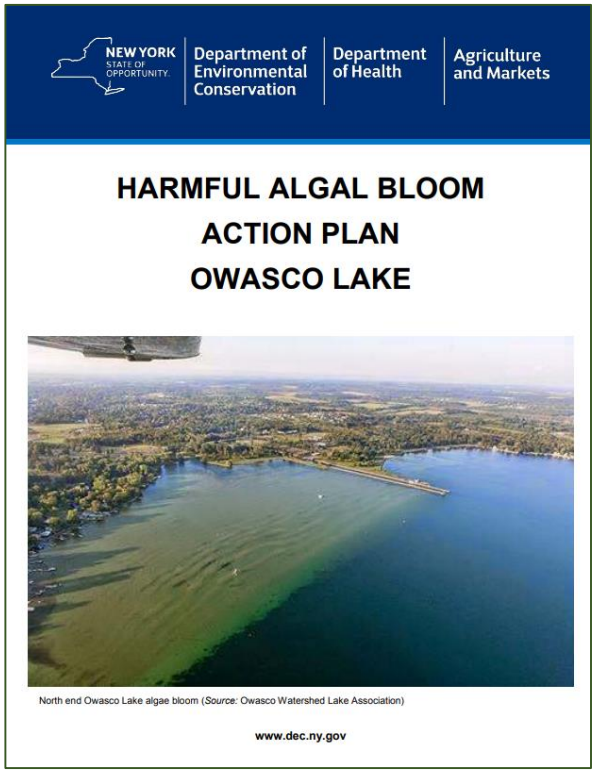
Daytime-invite

- Overview of NYS circumstances
- Expert presentations and discussions

Evening-open to public

- Presentations and keynote from an expert
- Panel with moderated Q&A
- Archived video: livestream.com/hvccstreaming/habssummits

HAB Action Plans



- Plan for each of 12 waterbodies
- Summary of lake, water quality and HABs history
- Waterbody and statewide analysis of HAB triggers
- Lake and watershed implementation projects to address HABs
- View: https://www.dec.ny.gov/chemical/113733.html

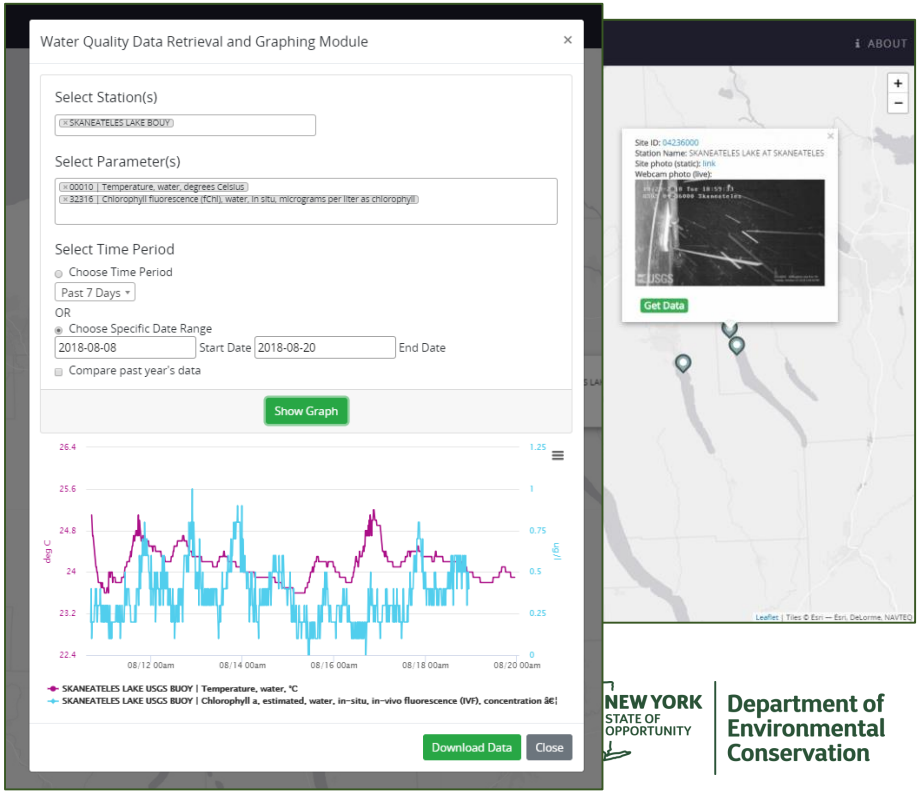
NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HAB Advanced Monitoring Pilot

DEC and USGS piloting use of advanced monitoring platforms

- Innovative HAB sensors
- Meteorological stations
- Real time reporting
- Public facing webpage:

  https://ny.water.usgs.gov/maps/habs/



HABs Mitigation Strategies Pilot

Pilot Overview

Initiated in summer 2018 on 5 waterbodies in collaboration with contractor

Piloted strategies

- Hydrogen Peroxide
- Ultrasonic Device

Evaluated strategy

- Nutrient Inactivants

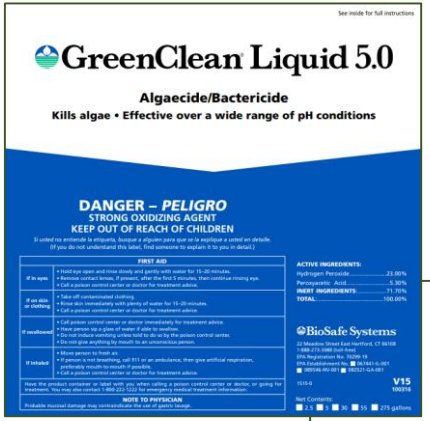
Lake	Surface Area (acres)	Max Depth (m)	Mean Depth (m)
C	192	3	2
D	38	5	2
L	25	4.5	2
M	102	5	2
P	250	9	4

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Strategies Background

Hydrogen Peroxide

- Known efficacy, infrequent use in NY
- Breaks down to water and oxygen
- Possible shift in algal community
- Possible oxidation of toxins



Ultrasonic Devices

- Unknown efficacy, some use in NY
- Emits sound waves that possibly affect gas vacuoles
- Algae prevented from moving throughout water column, sinks, dies-off
- Unknown impact to non-target organisms

NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

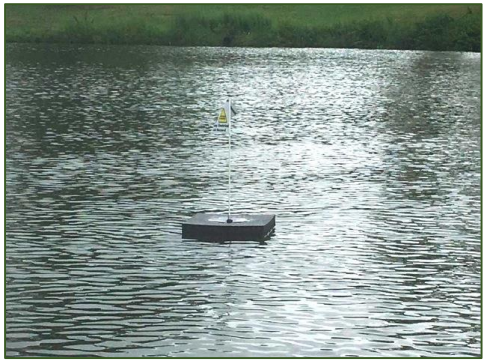
Project Design

Hydrogen Peroxide

- Alternating weeks of treatment and water quality monitoring
  - Six treatments June to September
- Two half-lake treatments (~10 acres)
- One lake with two 3-acre beach applications

Ultrasonic Device

- Installed one device for entirety of project
- In isolated cove on same lake with targeted beach hydrogen peroxide treatments



NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Data Collection

Monitoring Parameters:

Field

- Temperature
- Dissolved Oxygen
- pH
- Specific Conductance
- Water Clarity
- Aquatic Macrophyte Survey
- Benthic Algae/Macroalgae Survey

Lab

- Total Phosphorus
- Total Dissolved Phosphorus
- Soluble Reactive Phosphorus
- Nitrate + Nitrite
- Ammonia
- Total Suspended Solids
- Chlorophyll-a
- Cyanotoxins
- Phytoplankton
- Zooplankton

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Preliminary Results

2018 Review of Blooms

Lake	Pilot Treatment	Other Treatment	Blooms	Status	Weeks	Extent
C	Green Clean (Targeted), Ultrasonic	Cutrine Ultra (N=2)	Yes	Confirmed	11	Small Localized
D	Green Clean (Half Lake)	N/A	Yes	Confirmed	9	Widespread/Lakewide
L	Green Clean (Half Lake)	N/A	Yes	Confirmed	4	Small Localized
M	N/A	Cutrine Ultra (N=5), Copper Sulfate (N=1)	Yes	Confirmed	17	Widespread/Lakewide
P	N/A	N/A	Yes	Confirmed	5	Widespread/Lakewide

Preliminary Results

2018 Review of Blooms

Lake	Pilot Treatment	Other Treatment	Blooms	Status	Weeks	Extent
C	Green Clean (Targeted), Ultrasonic	Cutrine Ultra (N=2)	Yes	Confirmed	11	Small Localized
D	Green Clean (Half Lake)	N/A	Yes	Confirmed	9	Widespread/Lakewide
L	Green Clean (Half Lake)	N/A	Yes	Confirmed	4	Small Localized
M	N/A	Cutrine Ultra (N=5), Copper Sulfate (N=1)	Yes	Confirmed	17	Widespread/Lakewide
P	N/A	N/A	Yes	Confirmed	5	Widespread/Lakewide

- 2013-2015 High Toxin (Microcystin > 20ug/L) blooms: open water and shoreline
- 2013-2017 average 10 weeks of bloom listing, generally starting August through mid/late October
- 2018, two separate small localized blooms in July and August

Preliminary Results

2018 Review of Blooms

Preliminary Results

2018 Review of Blooms

Lake	Pilot Treatment	Other Treatment	Blooms	Status	Weeks	Extent
C	Green Clean (Targeted), Ultrasonic	Cutrine Ultra (N=2)	Yes	Confirmed	11	Small Localized
D	Green Clean (Half Lake)	N/A	Yes	Confirmed	9	Widespread/Lakewide
L	Green Clean (Half Lake)	N/A	Yes	Confirmed	4	Small Localized
M	N/A	Cutrine Ultra (N=5), Copper Sulfate (N=1)	Yes	Confirmed	17	Widespread/Lakewide
P	N/A	N/A	Yes	Confirmed	5	Widespread/Lakewide

- 2012-2017 High Toxin (Microcystin > 20ug/L) blooms: widespread, open water and shoreline
- 2018, persistent widespread, shoreline and open water blooms
- Low levels of toxins June-August, high toxins detected in an August skim sample

Preliminary Results

2018 Review of Blooms

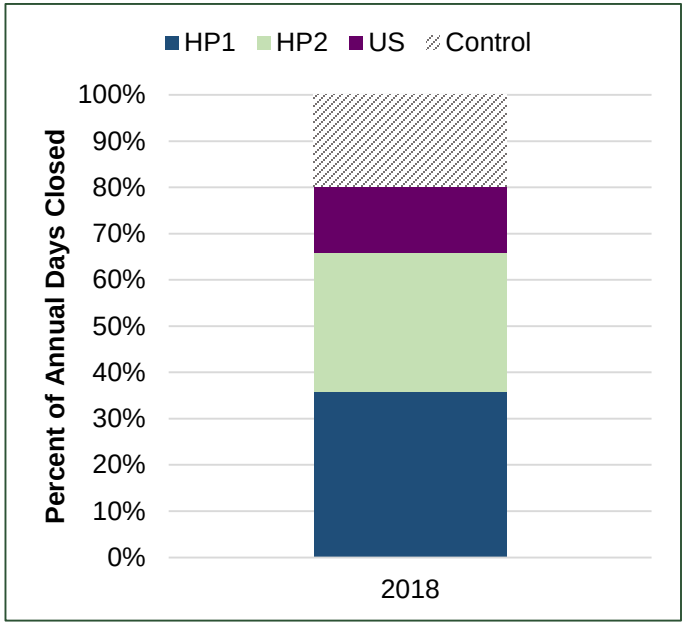
Preliminary Results

Lost Beach Days at Lake C

NYSDOH metric

2018 Observations:

- No biofouling on ultrasonic device
- No power related issues
- Apparent lower percentage lost beach days



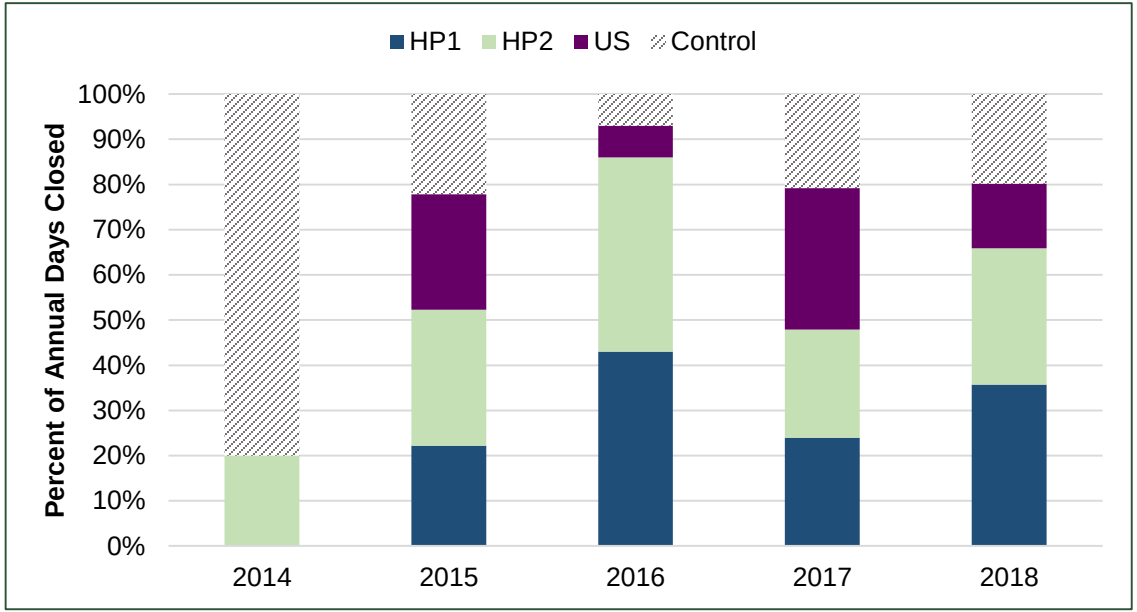
NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Lost Beach Days at Lake C

Historically:

- Lakewide slight increase in length of closures over time (p=0.027)
- No significant change in number of closures, length of closures by beach
- US beach trended better (closed less), dataset too small to detect significance

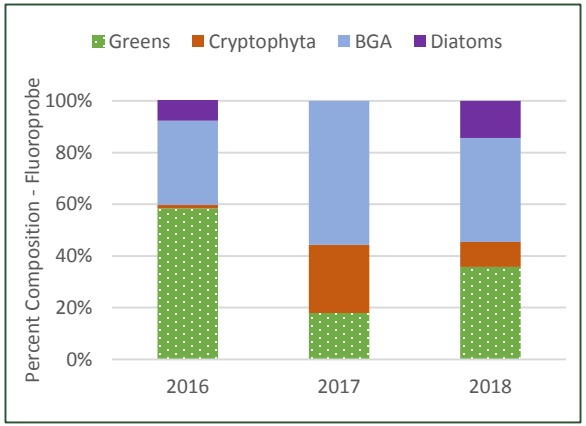


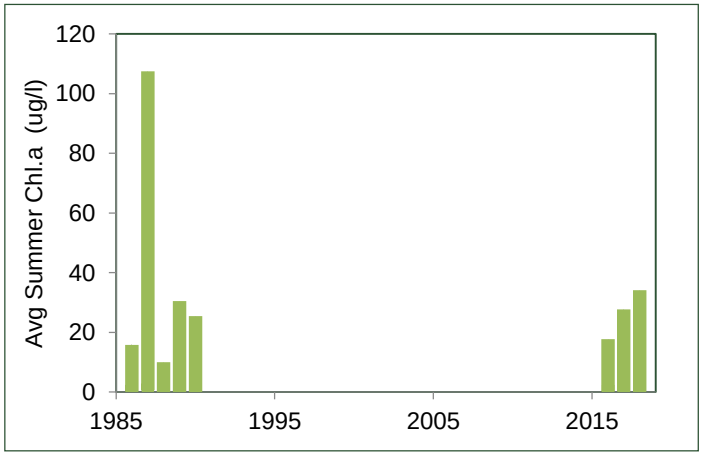
NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Lost Beach Days at Lake C

- 2016-2018 increase in open water extracted chlorophyll a
- Fluoroprobe results suggest cyanobacteria not as dominant as last year
- No significant change, other concurrent treatments

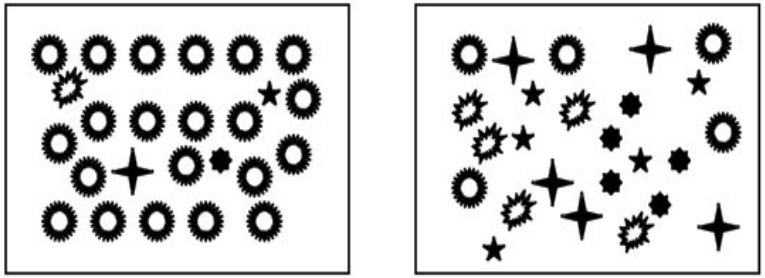




NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Diversity Evaluation



Pyron, M. (2010) Characterizing Communities. *Nature Education Knowledge* 3(10):39

Species Richness

Number of different species present

Species Evenness

The relative abundance of each species present

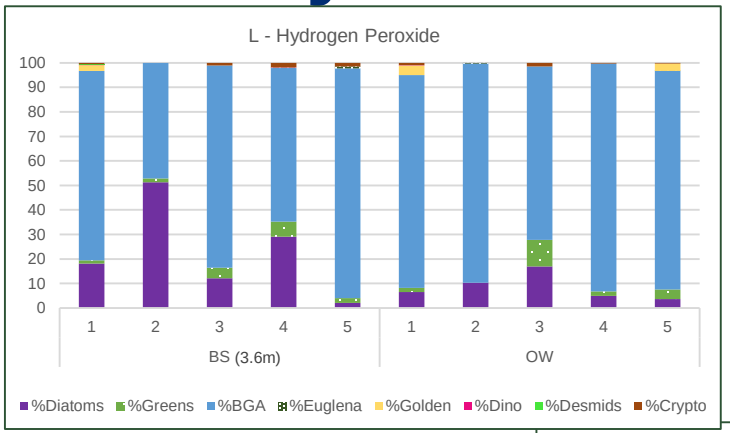
Shannon Diversity Index

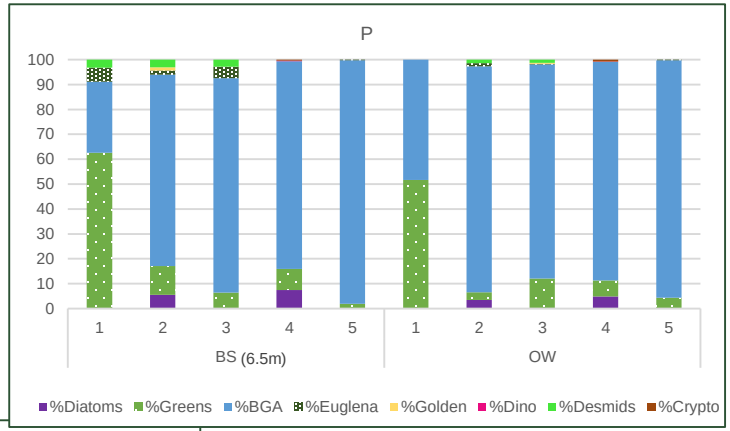
Combines richness and evenness to evaluate how the species abundance is distributed among the community

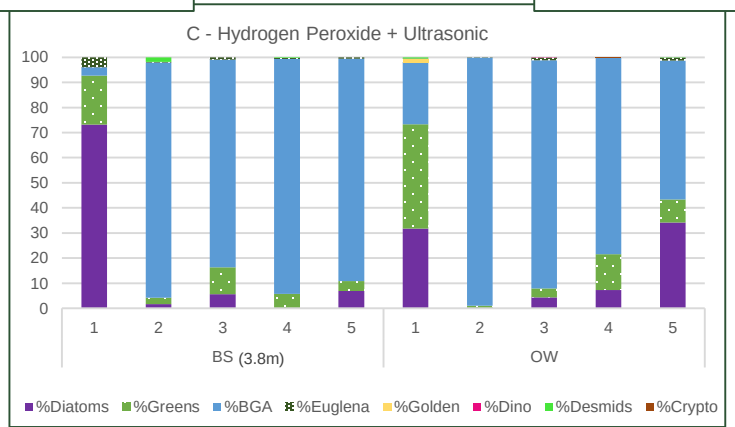
$$H = \sum_{i=1}^{S} - (P_i * \ln P_i)$$

Preliminary Results

Diversity Evaluation







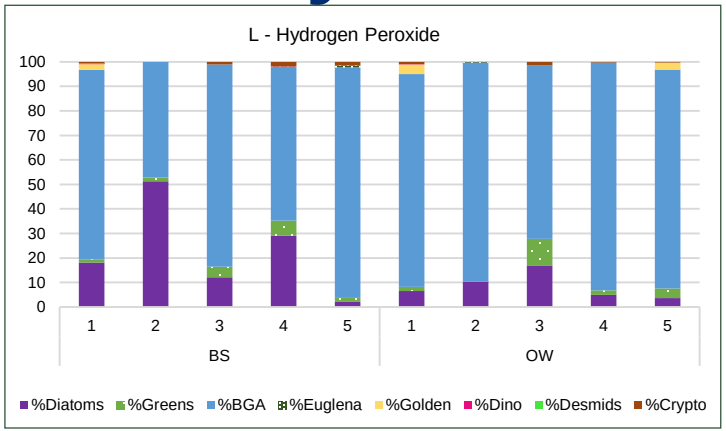
- Significantly greater phytoplankton richness and diversity in three lakes
- Season average <80% community made up of cyanobacteria

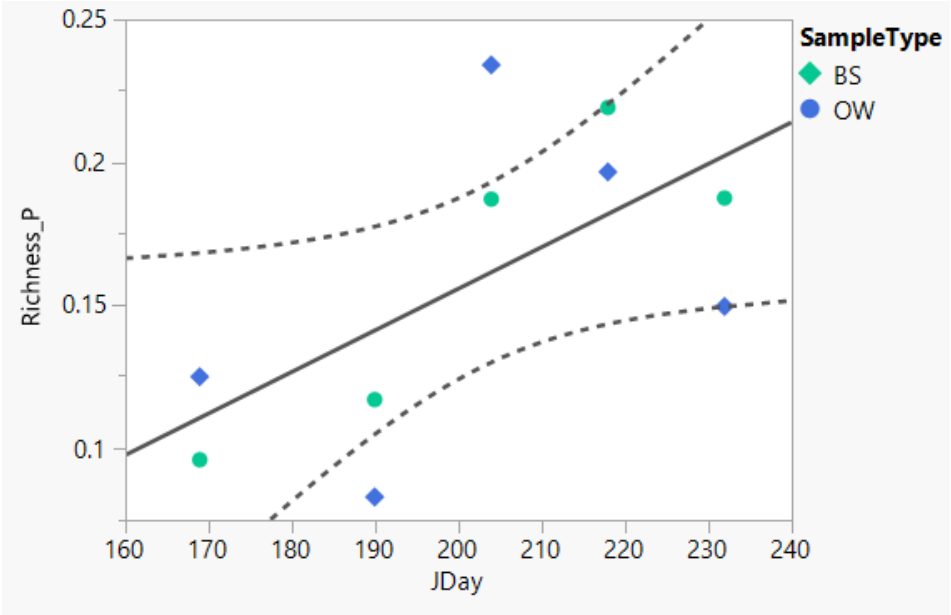
- Diversity greatest at start of project, session 2 least diversity, no detectable change sessions 3-5

NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Diversity Evaluation



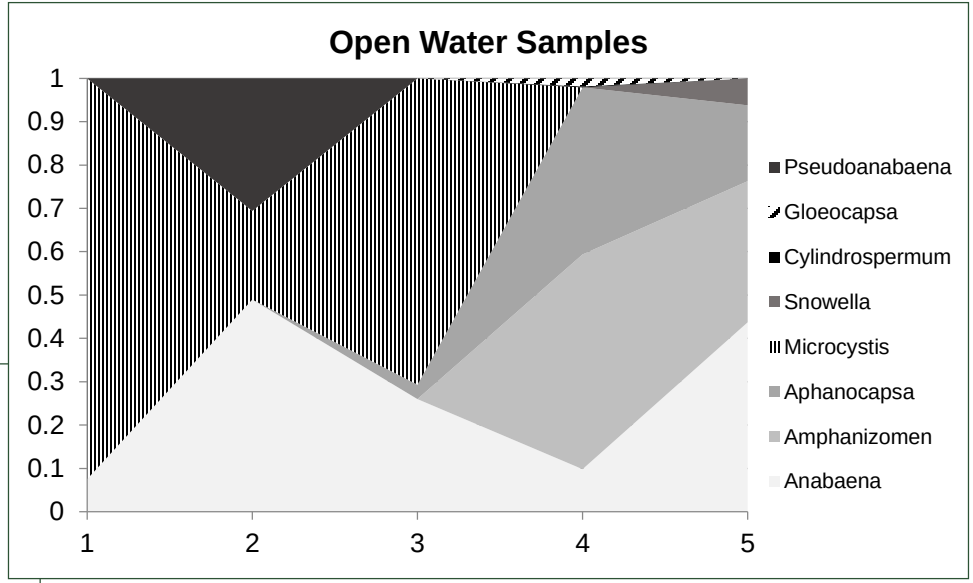


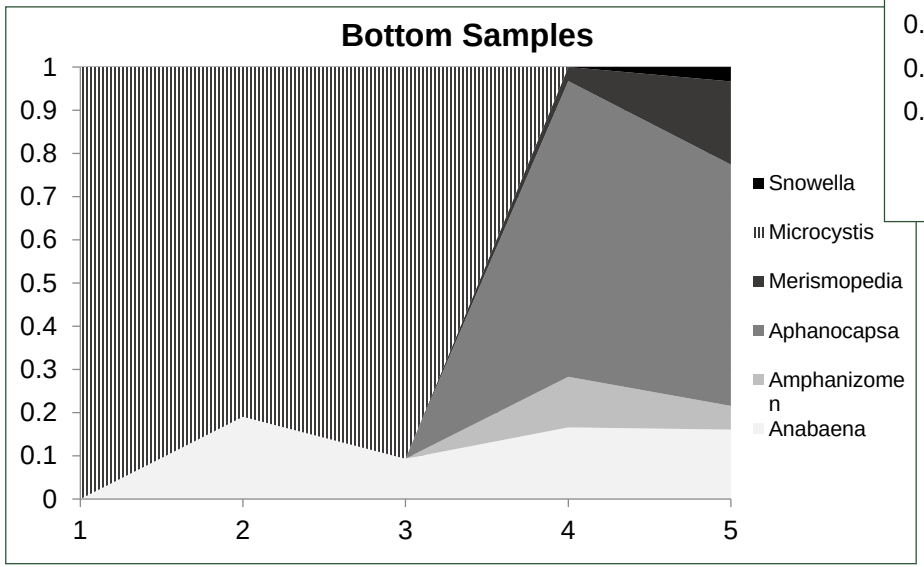
- 2015 Poorer community composition
- 2018 No trend in diversity over time
- Significant increase in species richness over time (p=0.038), primarily driven by changes at depth (95% increase BS, 20% increase OW)

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Preliminary Results

Diversity Evaluation

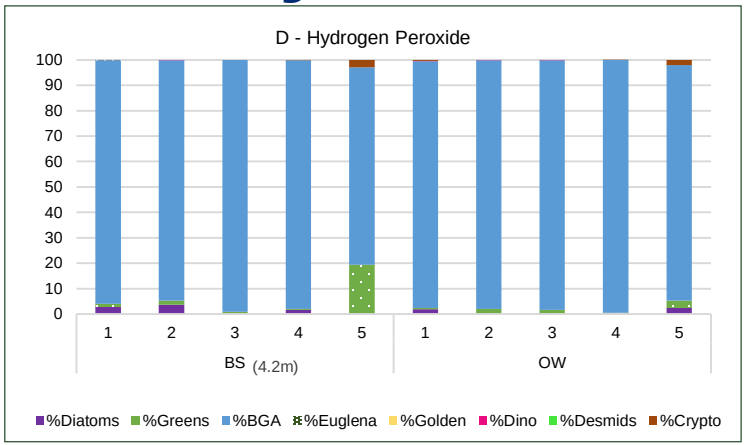


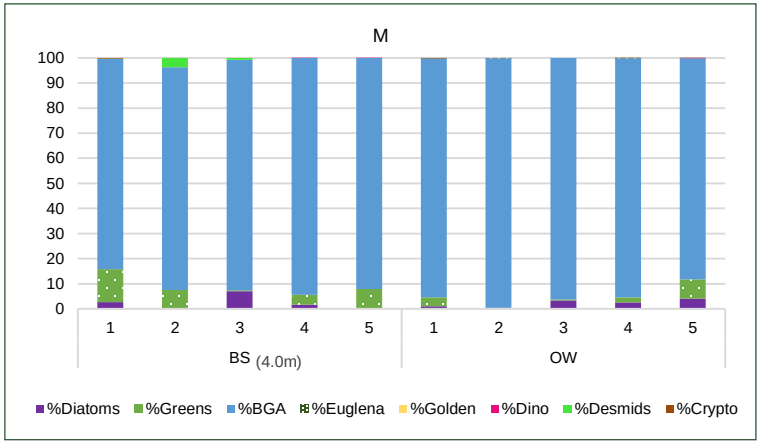


NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Diversity Evaluation





- Significantly lower phytoplankton richness and diversity in two lakes
- Season average >90% community made up of cyanobacteria
  - Lakes with persistent blooms

NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Preliminary Results

Nonmetric Multidimensional Scaling

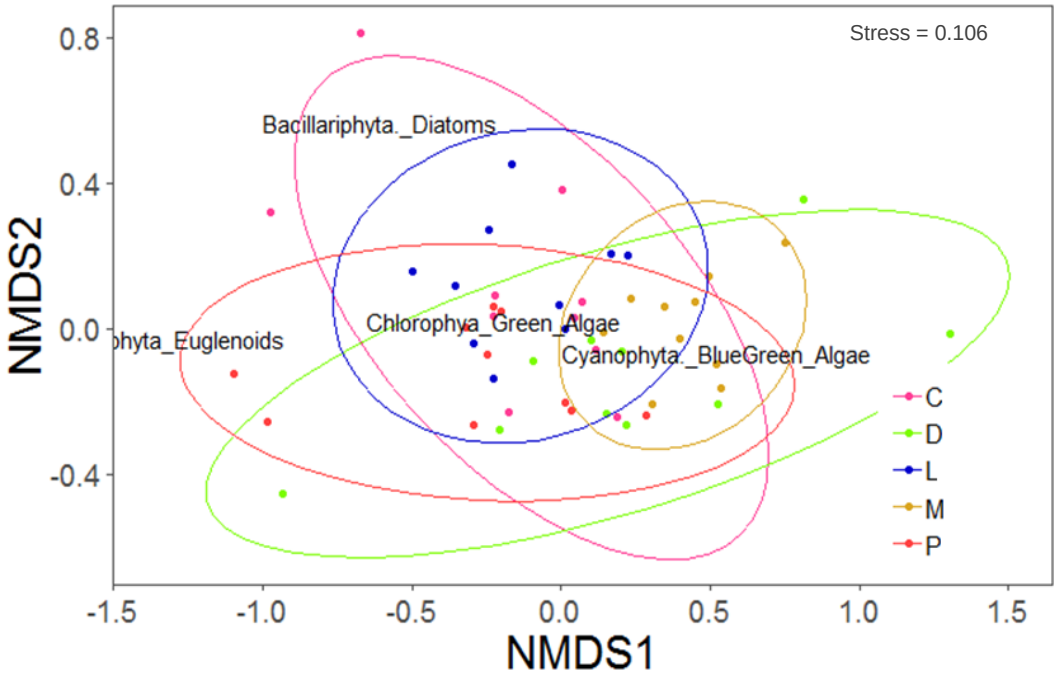
Community assemblage dissimilarities - aggregation and rotation

NMDS Results

- NMDS1 Axis: Euglena
- NMDS2 Axis: Diatoms

PerMANOVA (*Lakes*) p=0.001

Phytoplankton NMDS by Lake



Preliminary Results

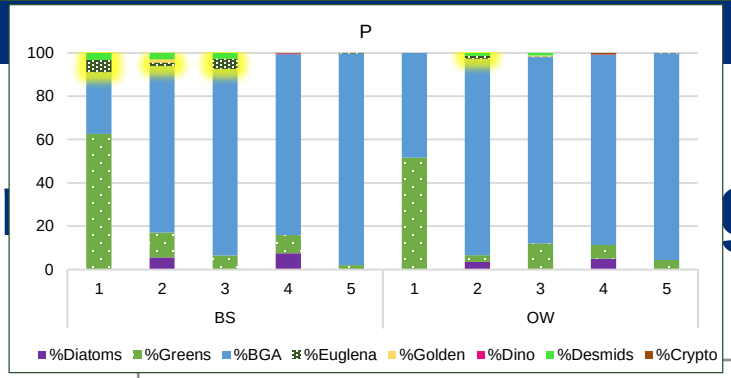
Nonmetric Multidi g

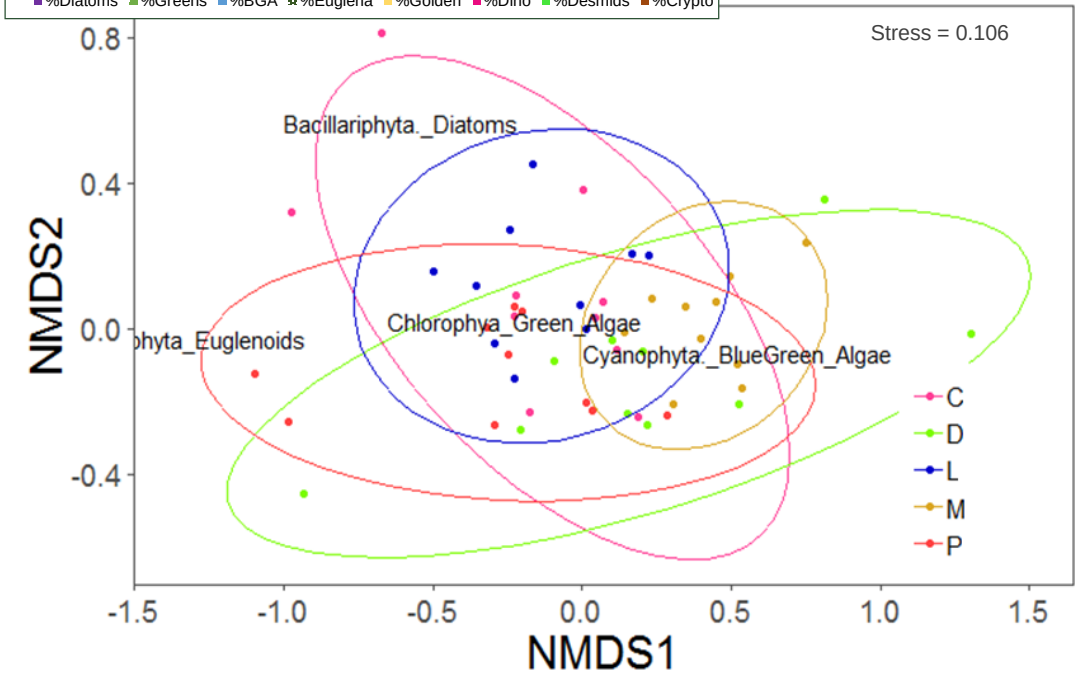
Community assemblage dissimilarities - aggregation and rotation

NMDS Results

- NMDS1 Axis: Euglena
- NMDS2 Axis: Diatoms

PerMANOVA (*Lakes*) p=0.001





Preliminary Results

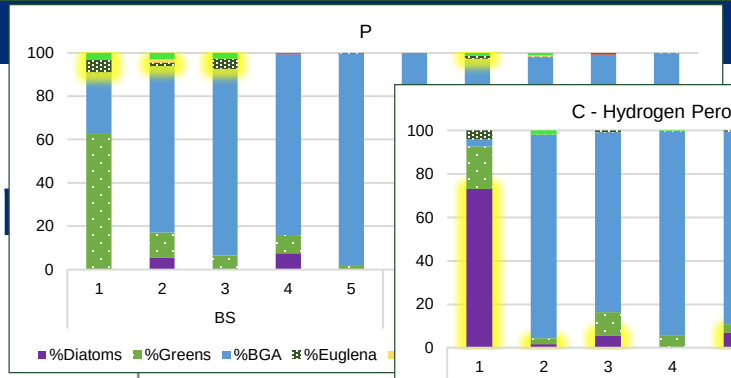
Nonmetric Multidi

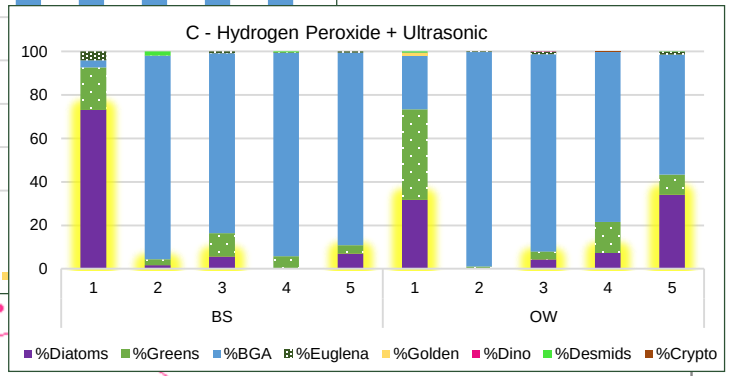
Community assemblage dissimilarities - aggregation and rotation

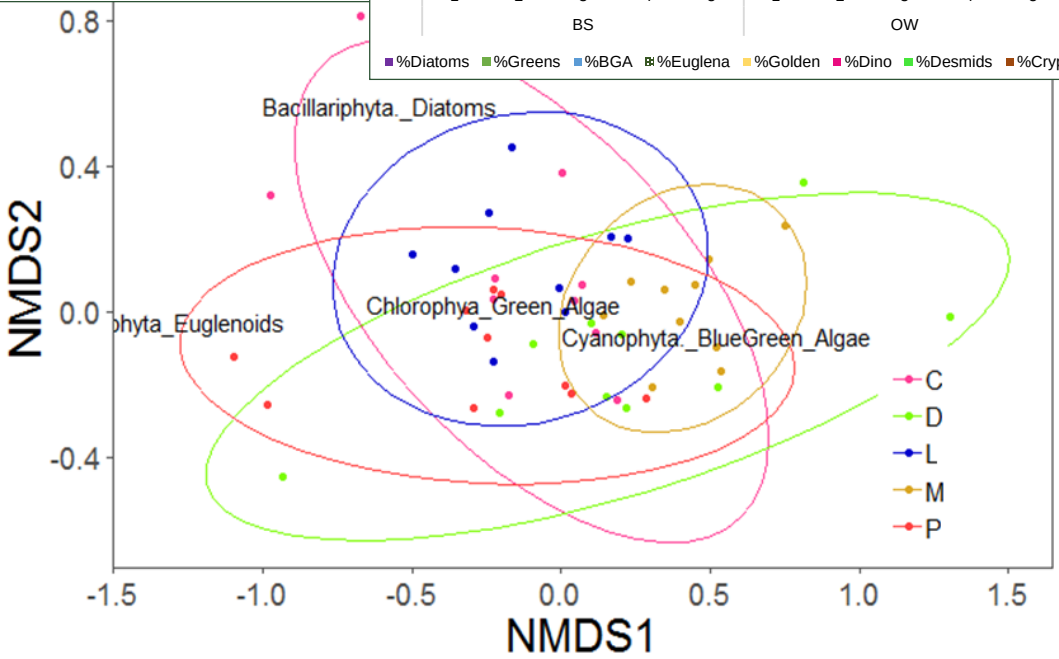
NMDS Results

- NMDS1 Axis: Euglena
- NMDS2 Axis: Diatoms

PerMANOVA (*Lakes*) p=0.001



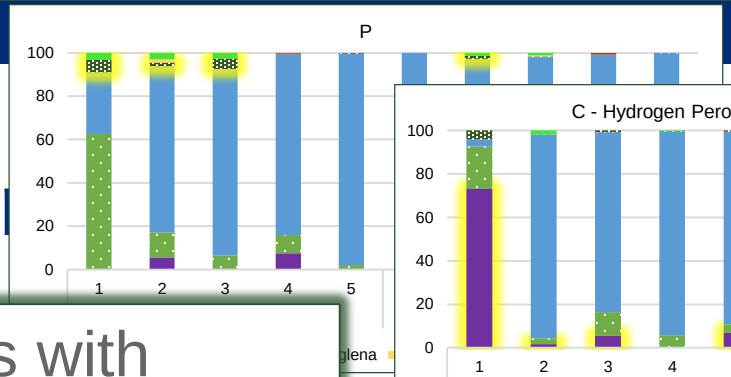


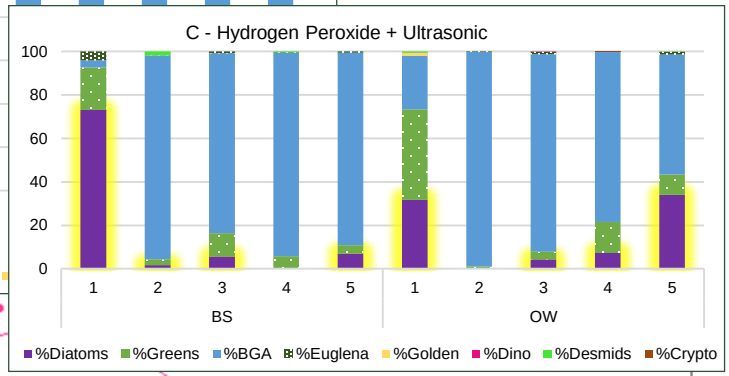


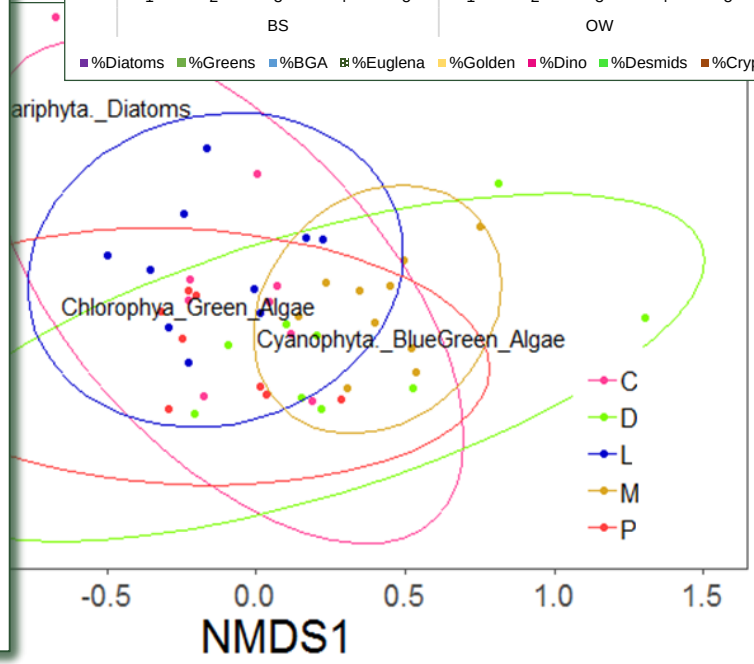
Preliminary Results

Nonmetric Multidi

Suspect that waterbodies with greater phytoplankton diversity prior to hydrogen peroxide application will experience more favorable treatment response, as they have a more stable community potentially resistant to significant shifts and dominance by single species or group







Preliminary Results

Nonmetric Multidimensional Scaling

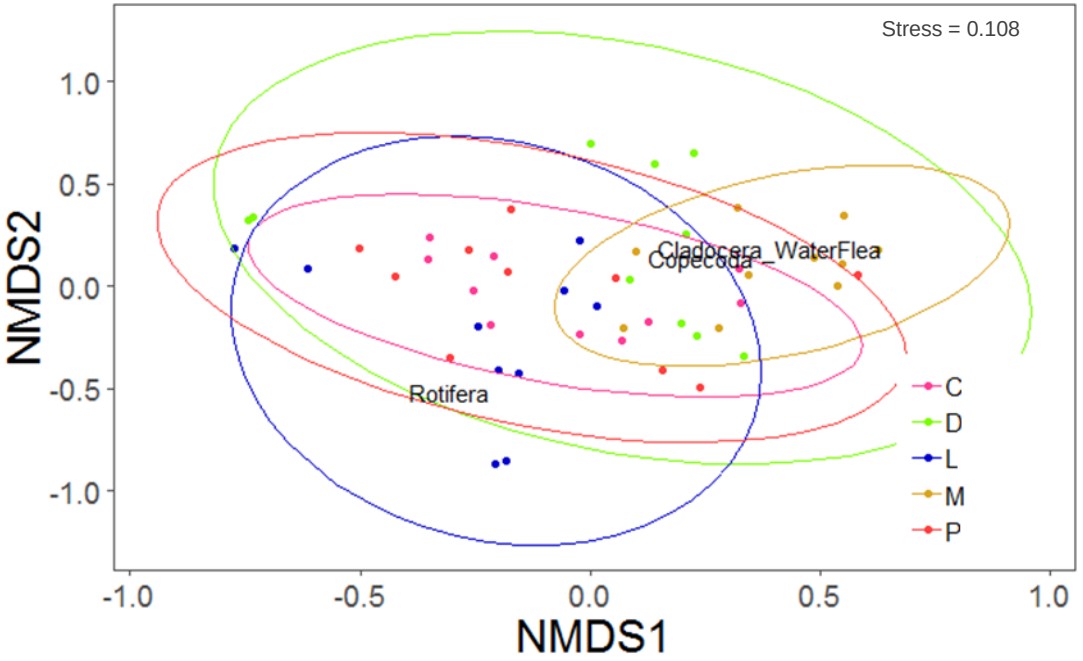
Most lakes similar richness and diversity, Lake L significantly less ($p<0.0001$), dominated by Rotifers 60% samples

NMDS Results

- NMDS1 Axis: Water Flea
- NMDS2 Axis: Rotifers

PerMANOVA (*Lakes*) p=0.001

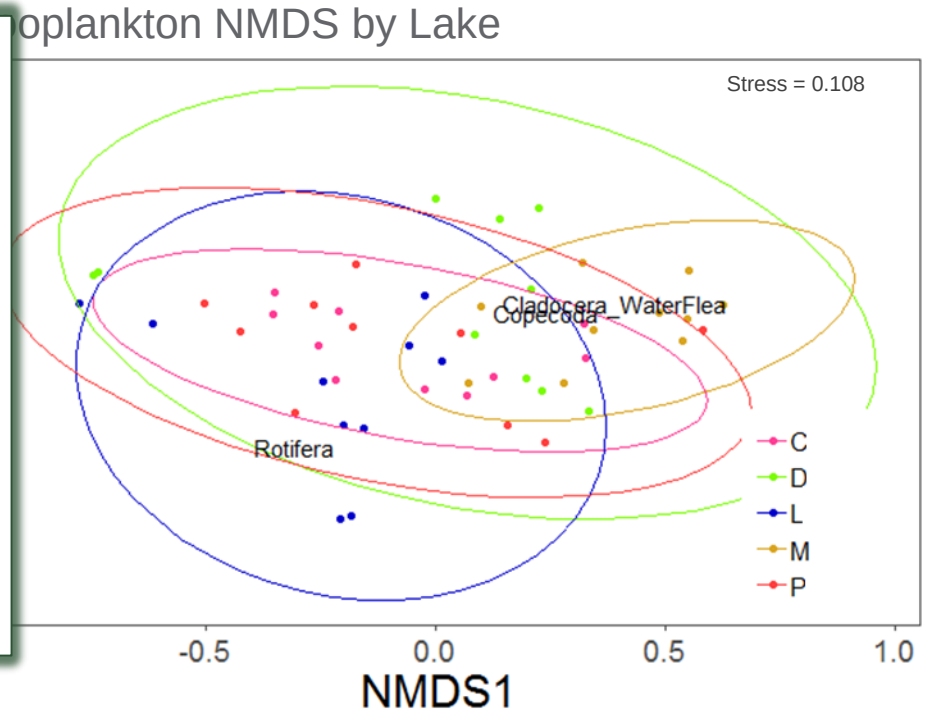
Zooplankton NMDS by Lake



Preliminary Results

Nonmetric Multidimensional Scaling

Given dominance of rotifers and greater diversity of phytoplankton observed in Lake L, next steps will be to assess the potential interaction between zooplankton and phytoplankton assemblages



Preliminary Findings and Future Outcomes

How effective were these strategies in deterring HABs or lessening their impact?

- *At first glance, what didn't work (Hydrogen Peroxide):*
  - Targeted applications in areas susceptible to wind blown accumulations;
  - Half lake applications where external load and internal load not addressed – hypereutrophic (TP: OW=97ug/L, BS=1023ug/L; SRP=844ug/L) – too low a dose or too infrequent treatments
- *What did work (Hydrogen Peroxide):*
  - Half lake treatments, **high phytoplankton diversity prior to treatment and maintained throughout**, external/internal loads not expected to be contributing significant nutrients

What additional work is needed to assess these and other innovative strategies?

- Toxicity comparison - shifts within season, compared to previous years
- Water chemistry analyses
- Phytoplankton-Zooplankton interactions
- Fish Response Study - Ultrasonic Devices

To be continued…
Nutrient Inactivant Evaluation

Nutrient Inactivation

- Flocculation, precipitation, reduction in bioavailable phosphorus

Two pilot treatments on small lakes with documented internal loading

- Information collection, research in nature

To date:

- Extensive water quality monitoring every two weeks in Summer 2018
  - Eight sampling events June to early October
- Sediment core bench testing
- Inactivant product and maximum safe dose determination

To be continued…
Nutrient Inactivant Evaluation

Pilot treatments conducted late April 2019

To be continued…
Nutrient Inactivant Evaluation

To come:

- Two years post treatment water quality monitoring
- Biological impact monitoring
  - Benthic macroinvertebrates
  - Aquatic plants
- Evaluation of results for efficacy of nutrient inactivants at binding excess nutrients in lake bottom sediments in NYS
- Pilot project outcomes will be assessed and used to inform development of Department guidance on nutrient inactivant use if appropriate to proceed on a larger scale

NEW YORK
STATE OF
OPPORTUNITY

Department of
Environmental
Conservation

Questions?

Stephanie June
625 Broadway Albany, NY 12233-3502
stephanie.june@dec.ny.gov
(518) 402-8179