2021 Ball Pond Water Quality and Cyanobacteria Dynamics

Presented to

Ball Pond Advisory Committee

By

Aquatic Ecosystem Research LLC

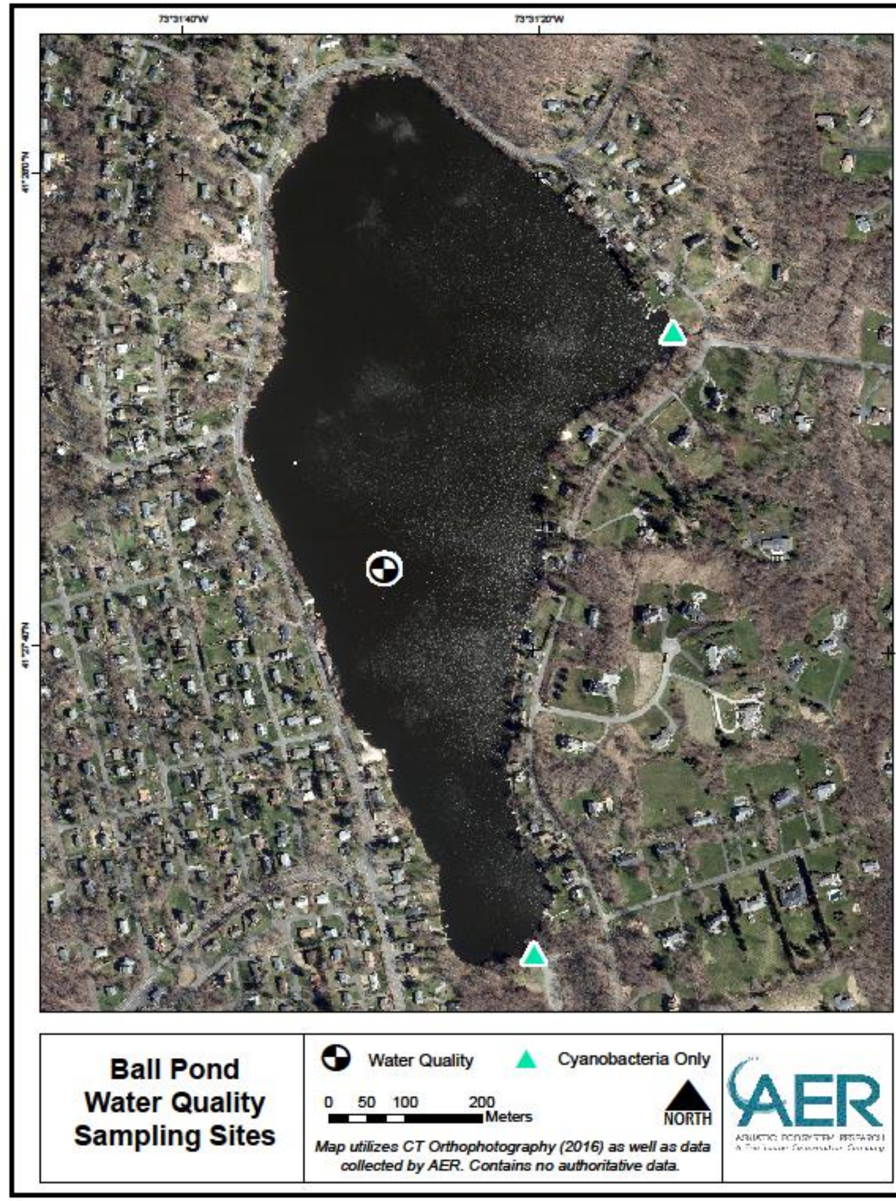
On

February 1, 2022

Photo: Maureen Dangelo

Tonight…

- Introductions
- Provide an outline to the report; how to interpret charts
- Discuss a few of the highlights
- Discuss some of the recommendations
- Answer your questions



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Mark June-Wells
Larry Marsicano
William Henley
David MacAskill

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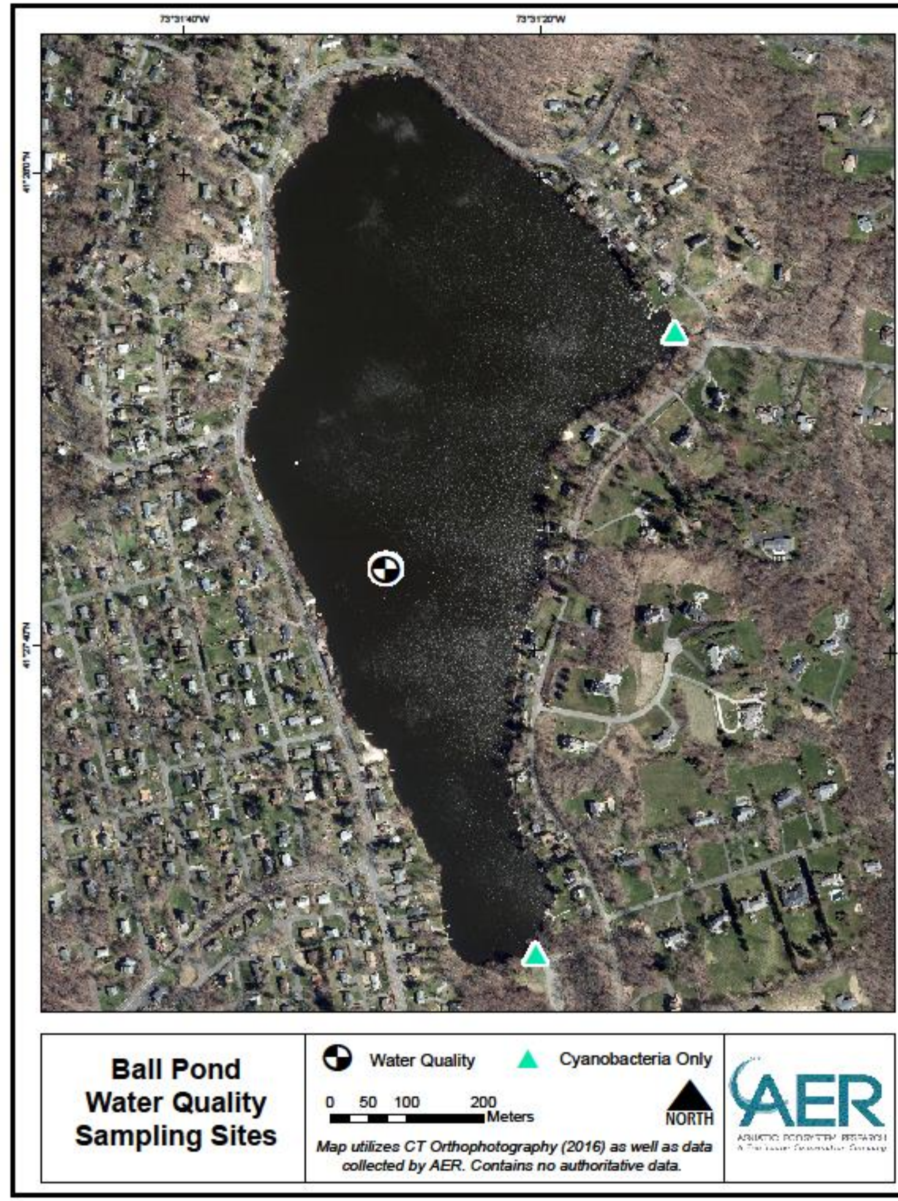
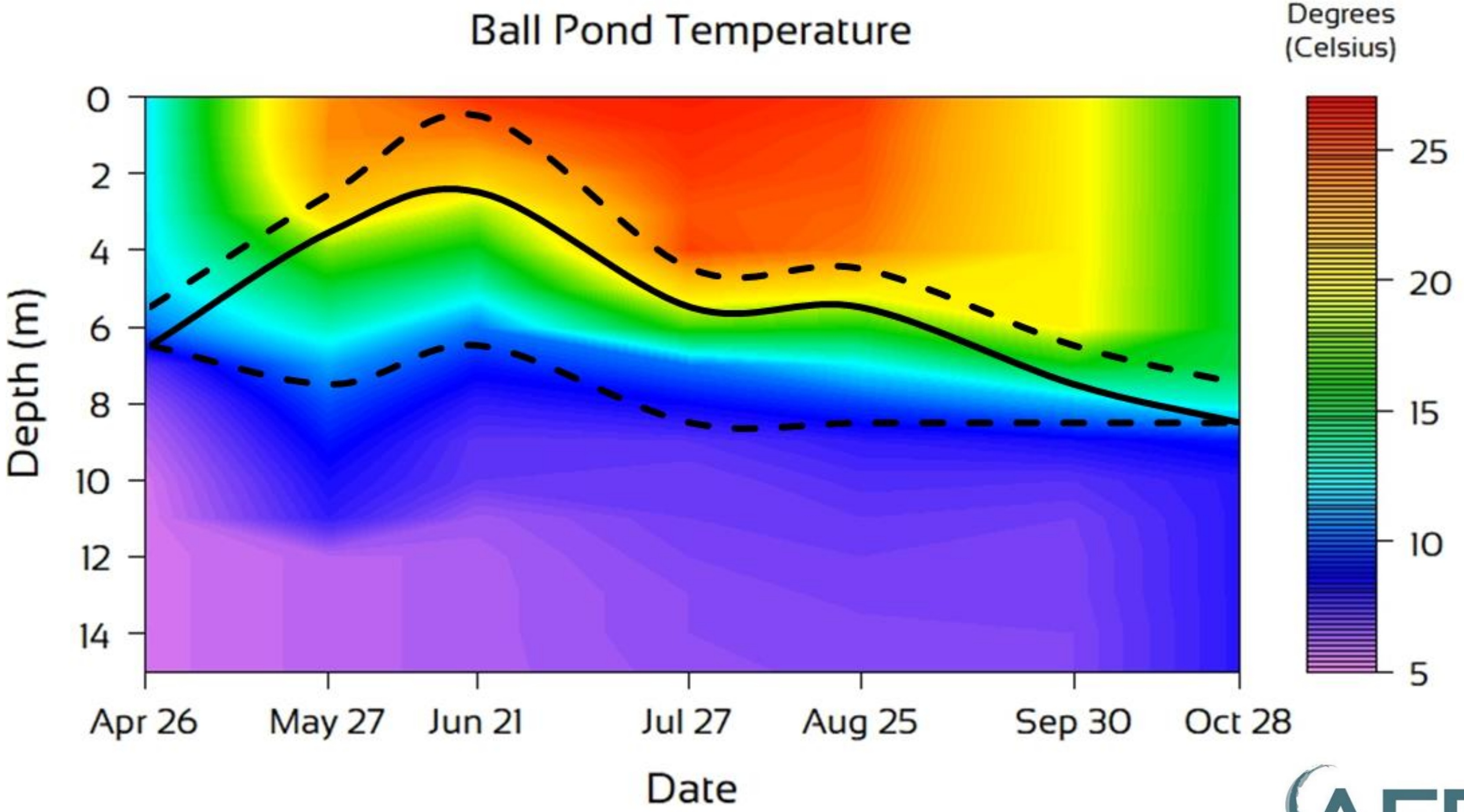
Photo: Jane Didona

Report Organization

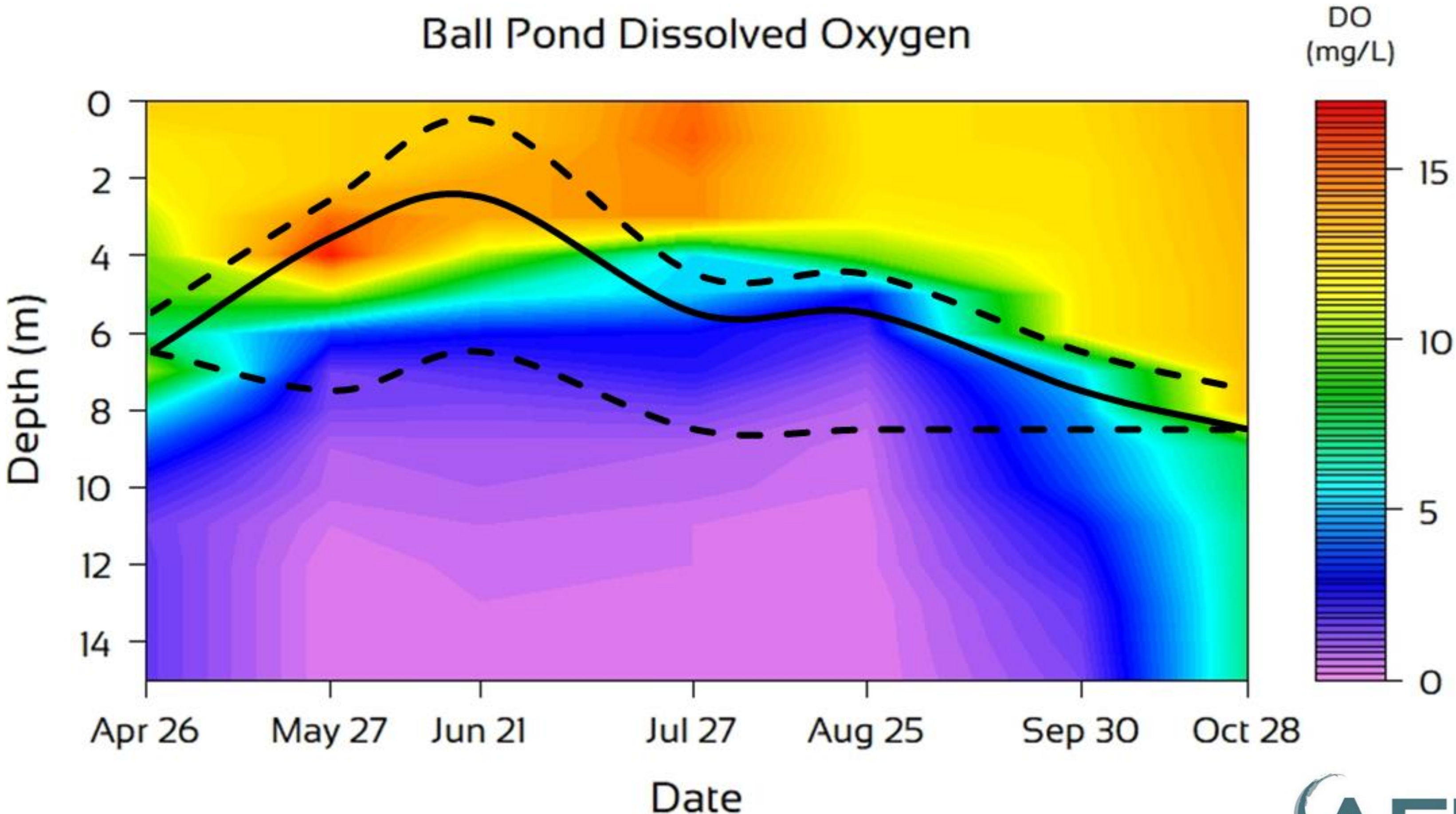
- Introduction and Methods
  - Physical, historical, geological
- Water quality monitoring
- Cyanobacteria
  - CyanoMonitoring
  - Cyanotoxins
- Recommendation



Isopleths Charts



Oxygen Dynamics



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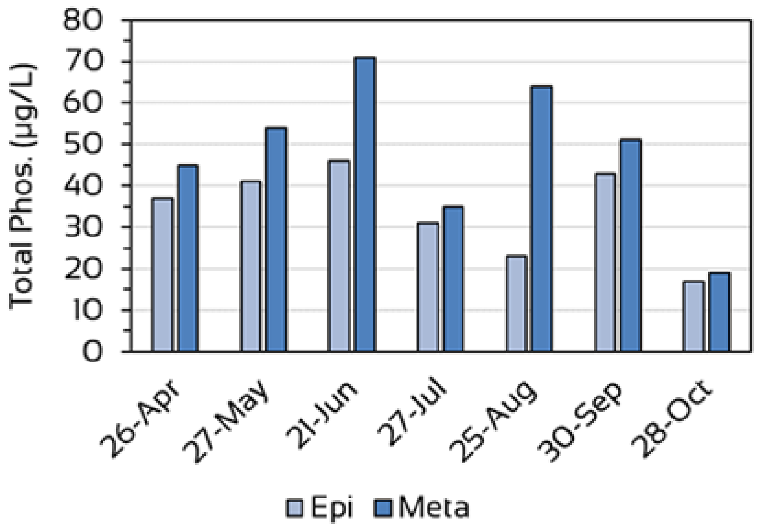
Trophic Status
(aka "How much productivity?")

Table 1. Trophic classification criteria used by the Connecticut Experimental Agricultural Station (Frink and Norvell, 1984) and the CT DEP (1991) to assess the trophic status of Connecticut lakes. The categories range from oligotrophic or least productive to highly eutrophic or most productive.

Trophic Category	Total Phosphorus (µg / L)	Total Nitrogen (µg / L)	Summer Chlorophyll-*a* (µg / L)	Summer Secchi Transparency (m)
Oligotrophic	0 - 10	0 - 200	0 - 2	>6
Early Mesotrophic	10 - 15	200 - 300	2 - 5	4 - 6
Mesotrophic	15 - 25	300 - 500	5 - 10	3 - 4
Late Mesotrophic	25 - 30	500 - 600	10 - 15	2 - 3
Eutrophic	30 - 50	600 - 1000	15 - 30	1 - 2
Highly Eutrophic	> 50	> 1000	> 30	0 - 1

Total Phosphorus

- The *limiting* nutrient
- Bound, SRP (PO_4), etc.
- Epilimnion, Metalimnion, Hypolimnion



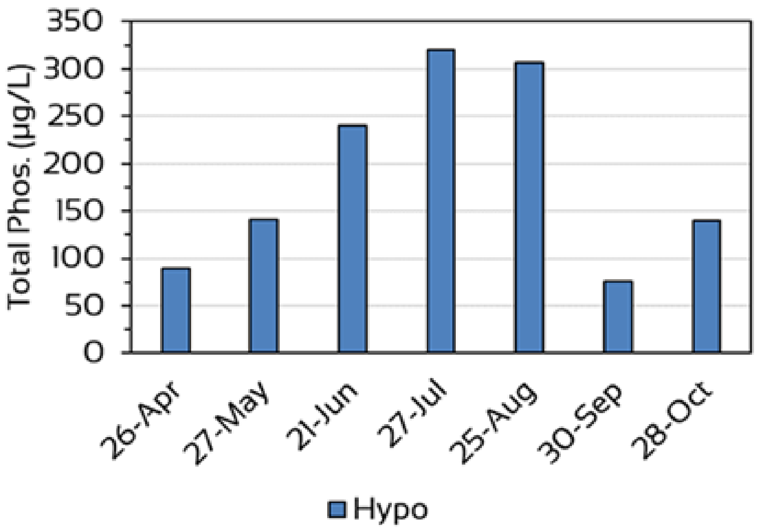
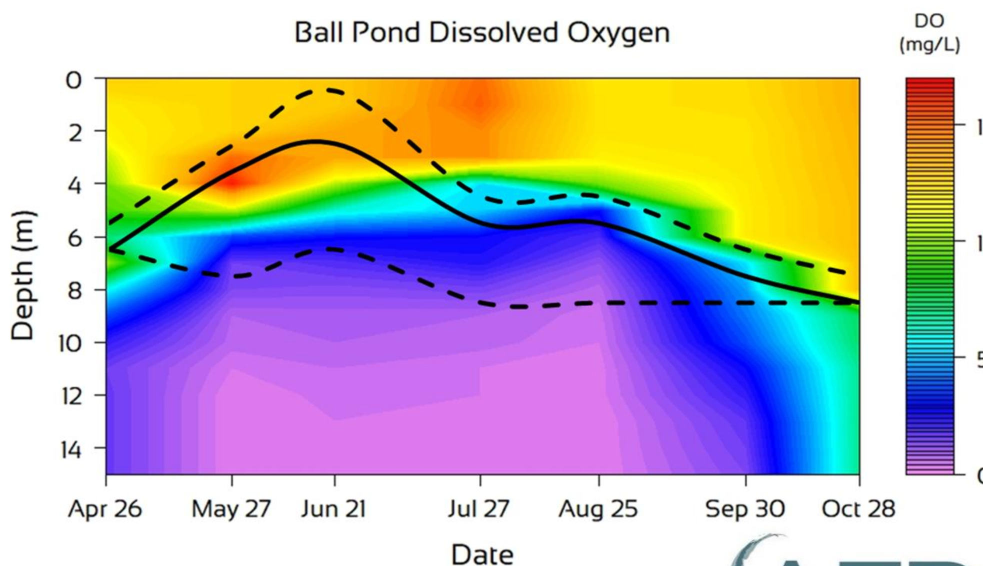


Figure 6. Total phosphorus (Phos.) concentrations in the epilimnion (Epi; top panel) and metalimnion (Meta; top panel) and hypolimnion (Hypo; bottom panel) measured in Ball Pond in the 2021 season.



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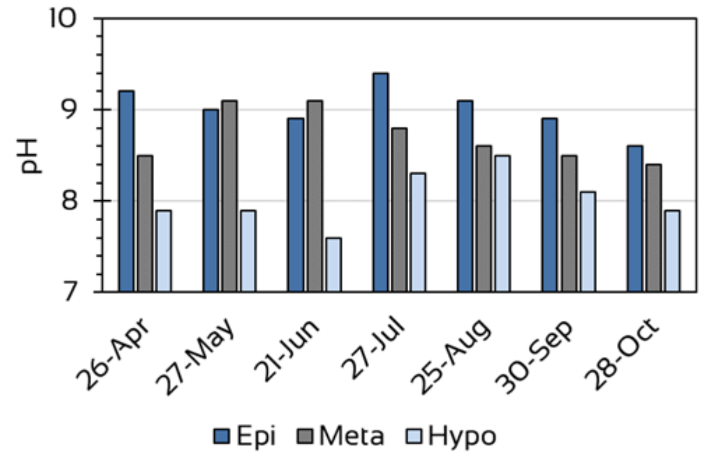
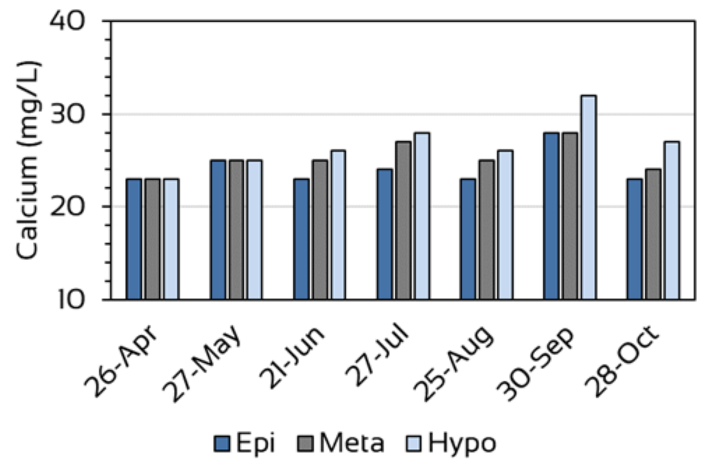
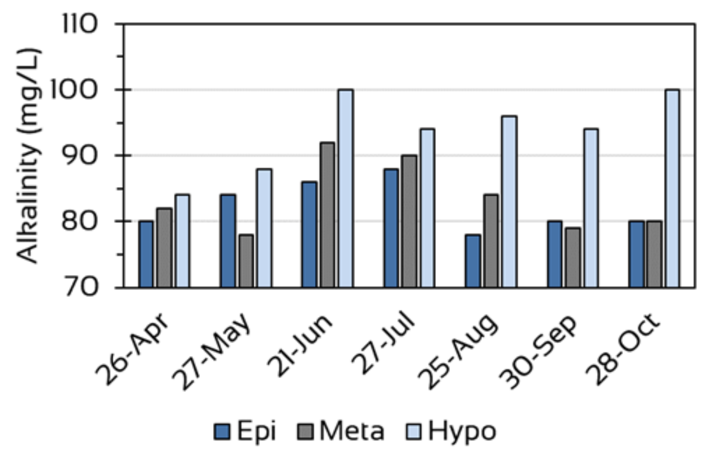
Phosphorus Co-precipitation

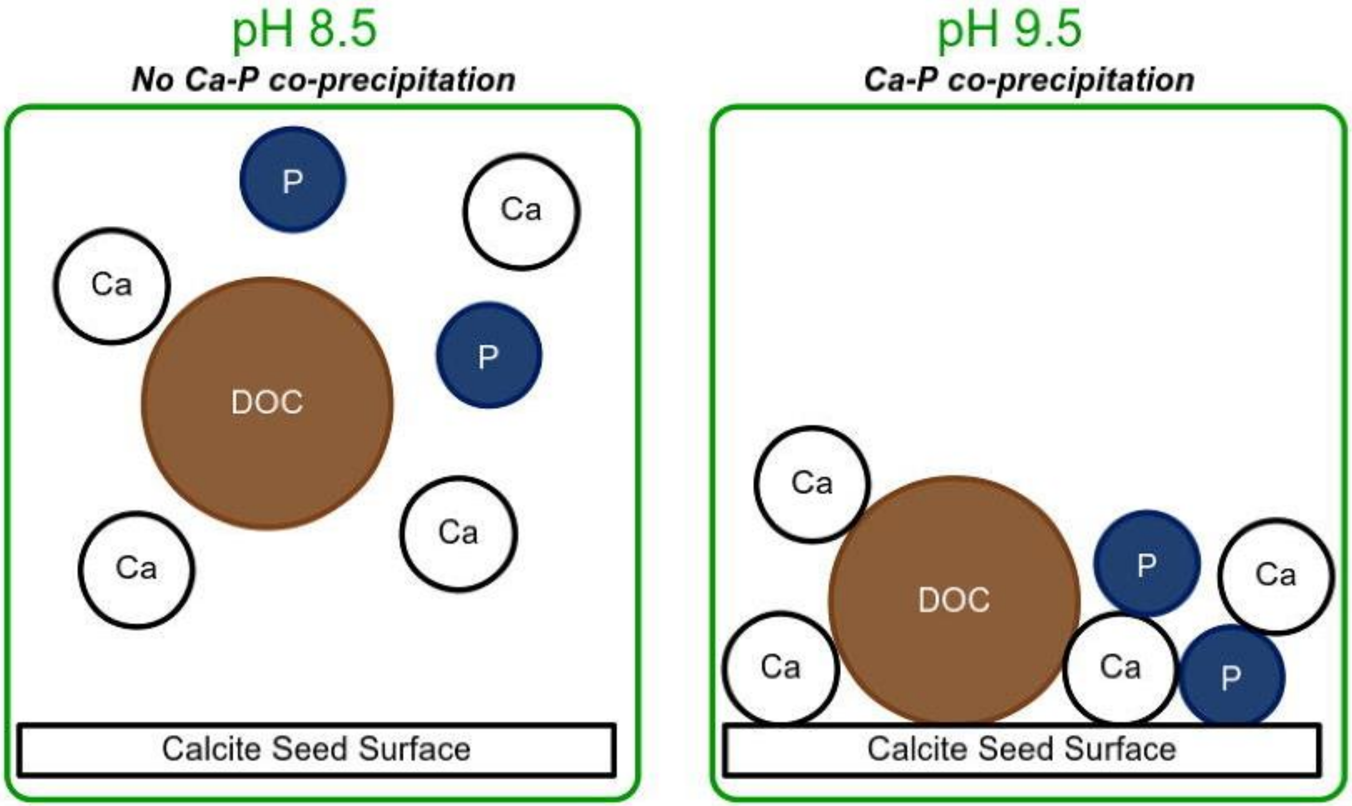
- High Calcium
- High pH
- Phosphorus and calcium bind and precipitate out as calcite
- Phosphorus that might have been in a form available to algae is no longer available… but <u>still measurable</u>
- Precipitate can reduce clarity







Phosphorus Co-precipitation



Hugo R. Sindelar, Mark T. Brown, Treavor H. Boyer. Effects of natural organic matter on calcium and phosphorus co-precipitation. Chemosphere. Volume 138, 2015, pp. 218-224

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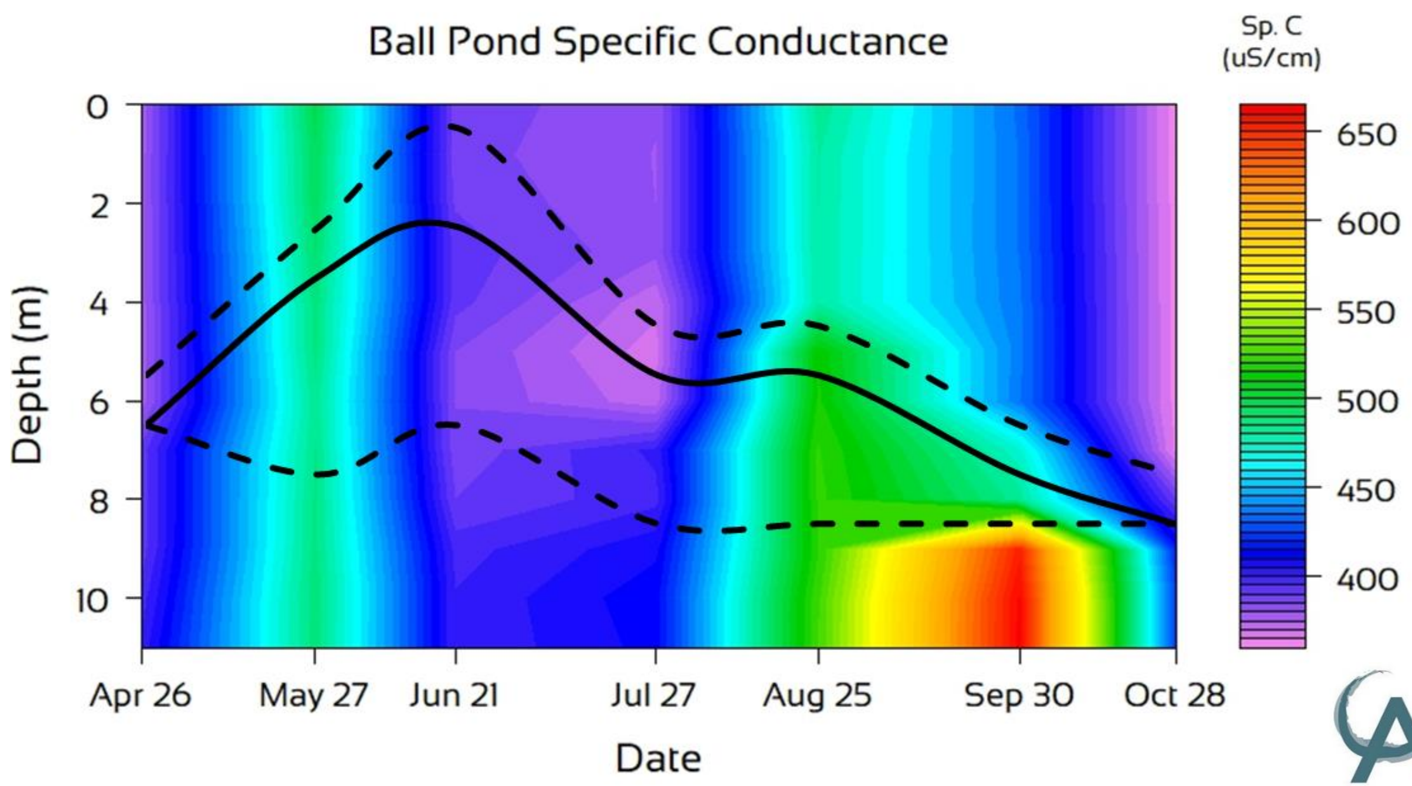
Table 4. Comparisons of the 2021 and 1993 season averaged water quality variables from Ball Pond to ranges observed in lakes located in the Marble Valley, Western Upland and in all geological regions in Connecticut from a Statewide survey of 60 lakes (Canavan and Siver 1995) conducted in the early 1990s. All measures with the exception of Secchi transparency were from samples collected at 1 meter depth.

Parameter	Units	Ball Pond		Marble Valley			Western Uplands			60 Lake Set		
		2021 Mean	1993 Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Total Nitrogen	µg/L	734	---	343	547	449	208	714	364	119	3831	439
Total Phosphorus	µg/L	34	22	27	42	31	10	57	33	9	334	33
Chlorophyll-a	µg/L	6.5	5.0	1.2	7.1	4.3	0.7	19.7	5.1	0.2	71.6	6.5
Secchi Disk	meters	2.4	2.6	2.0	4.9	3.3	1.7	7.6	3.5	0.9	7.6	3.3
pH	SU	9.0	8.7	7.8	8.3	8.2	4.6	8.1	7.2	4.6	8.8	7.1
Specific Conductance	µS/cm	417	283	180	317	258	25	188	96	24	317	102
Alkalinity	mg/L	82	64	54.5	120.5	90	23.7	44	21	0	120.5	14.5
Chloride	mg/L	---	42.2	3.2	42.2	21.3	0.7	24.1	9.2	0.7	42.2	10.3
Calcium	mg/L	24.1	19.7	16.6	28.8	22.8	2.8	11.4	6.8	1.2	28.8	7.6
Magnesium	mg/L	---	6.6	5.9	15.2	9.8	1	5.2	4.1	0.2	15.2	2.5
Sodium	mg/L	---	24.6	2.5	24.6	13.1	1.4	10.4	5.3	1.4	24.6	6.9
Potassium	mg/L	---	2.7	1.2	2.7	1.9	0.2	0.9	0.5	0.4	2.7	1.2

Specific Conductances
Dissolved Salts

"...high concentrations accumulated at the bottom of the lake can prevent complete spring turnover and prevent replenishment of oxygen to lower depths (Kelly et. al. 2019)."



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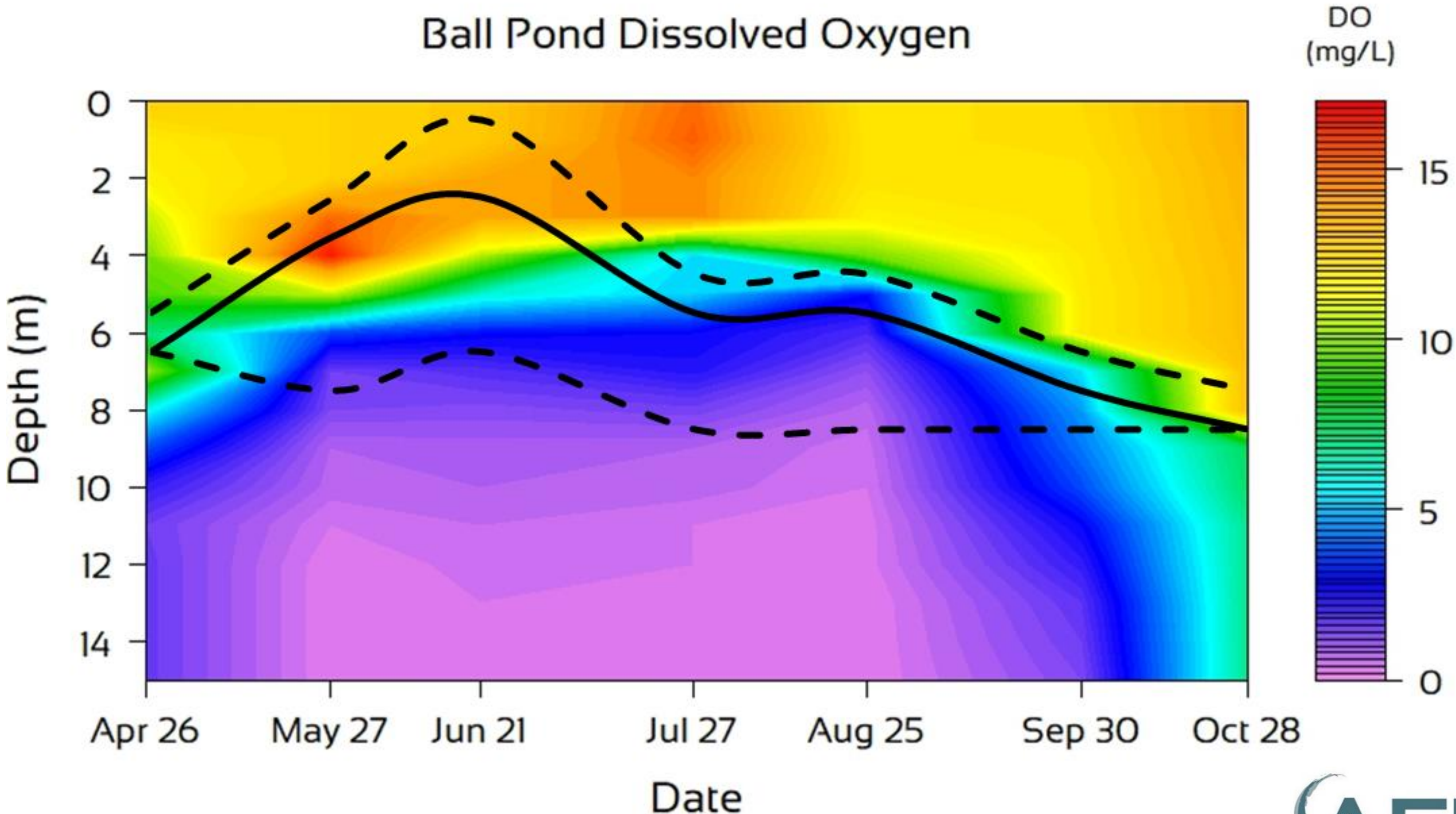
Oxygen Dynamics



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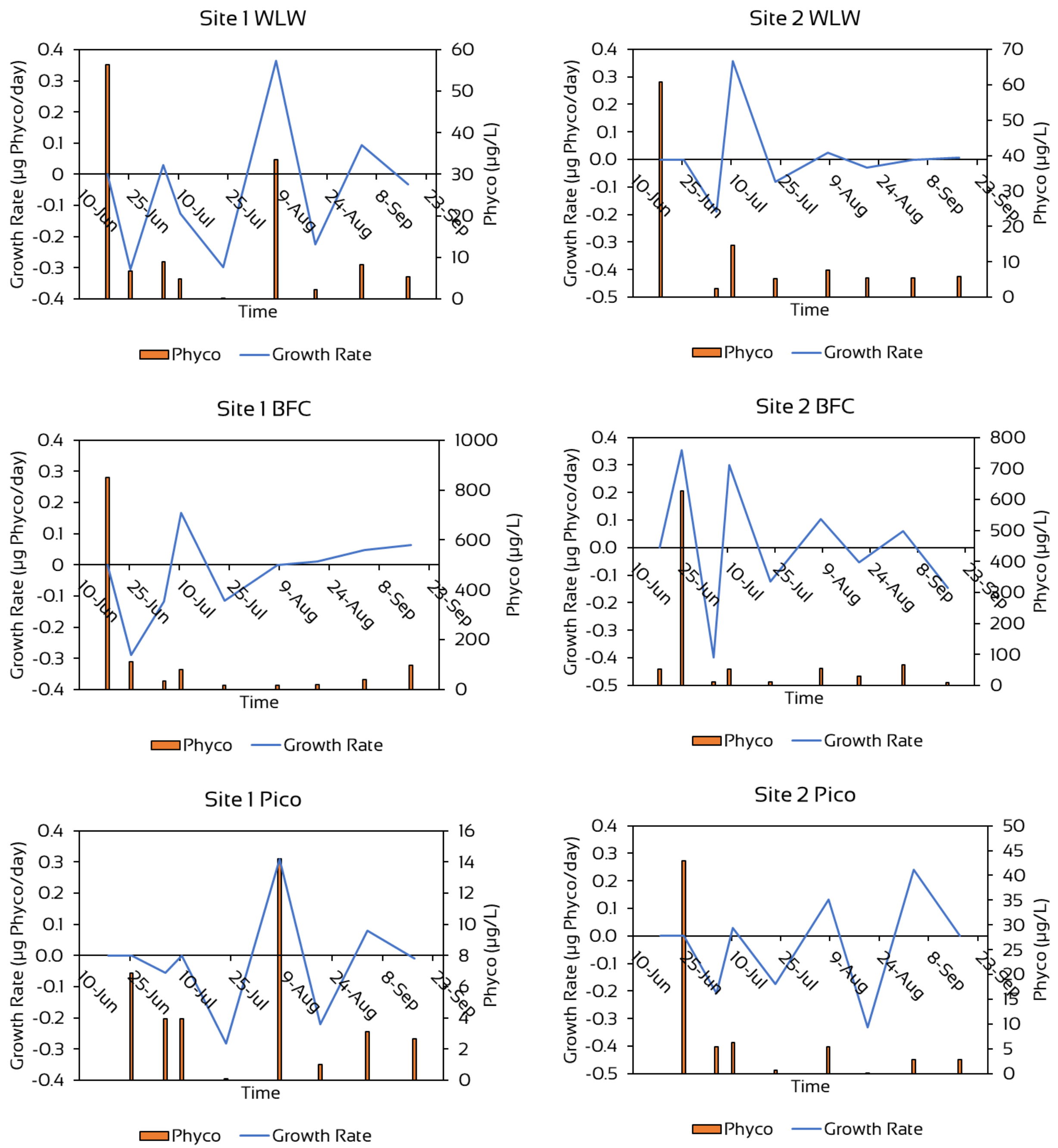
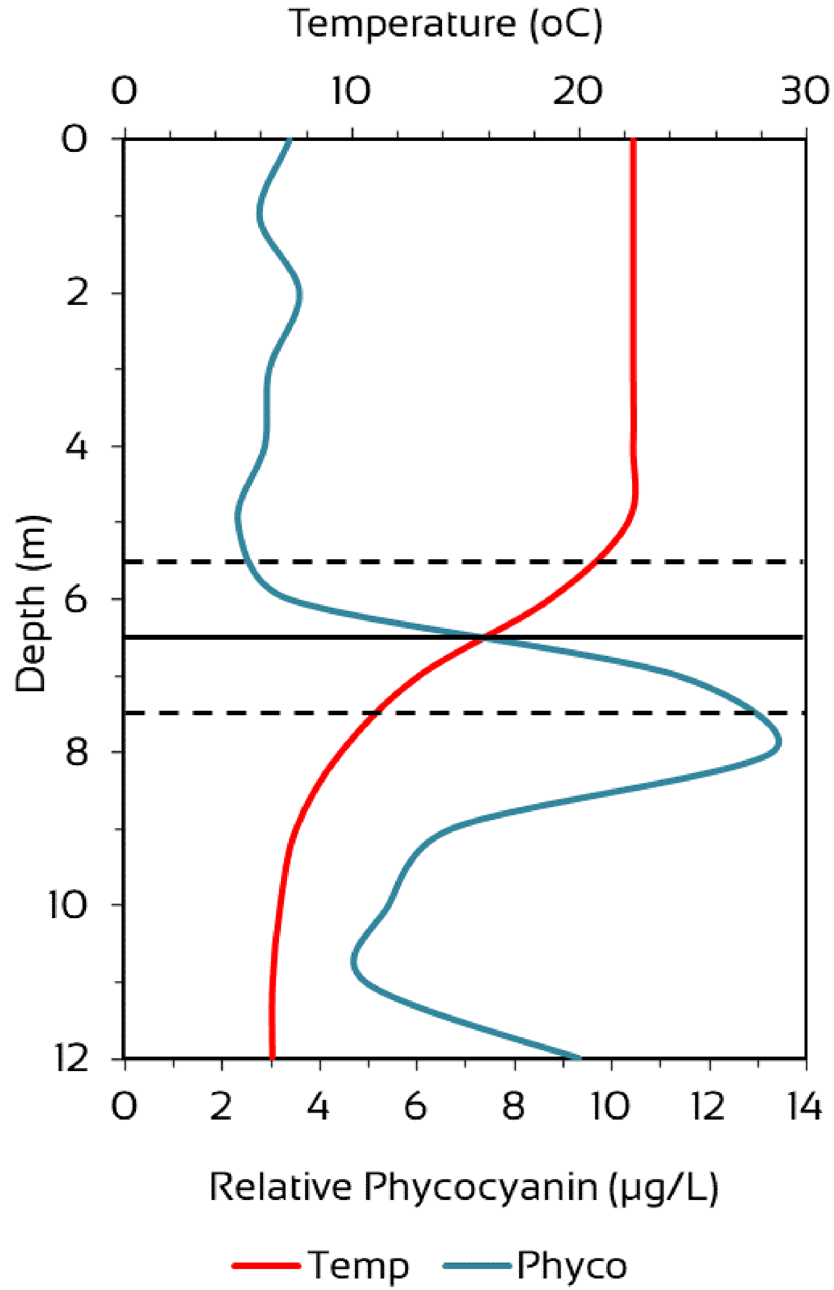
CyanoMonitoring

- Cyanobacteria Collaborative/EPA
- Examines with fluorimetry cyanobacteria based on size factions
    - BFC = bloom forming Cyanos (big)
    - Pico = pico plankton size ≤2µm dia (small)
    - WLW = whole lake water (both big and small)
- Mid-lake (Site 1) and shoreline sites (Sites 2 & 3)



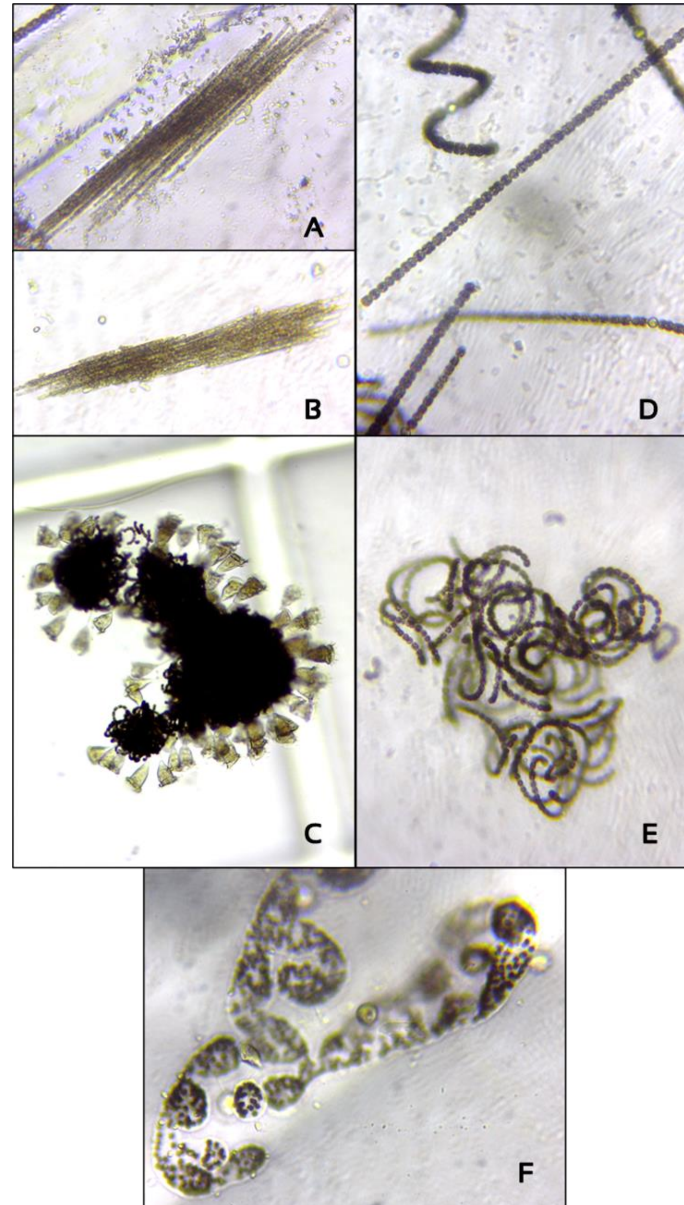
What Lurks Beneath?

- Some cyanobacteria can regulate buoyancy and position within the water column
- Maximize nutrient availability and adaptive advantages to use light
- They can and do become positively buoyant and come to surface
- Harmful cyano blooms!



September 3, 2021

Cyanobacteria (aka blue-green algae) at Ball Pond



Photos: Elissa Johnson

Cyanotoxin Monitoring

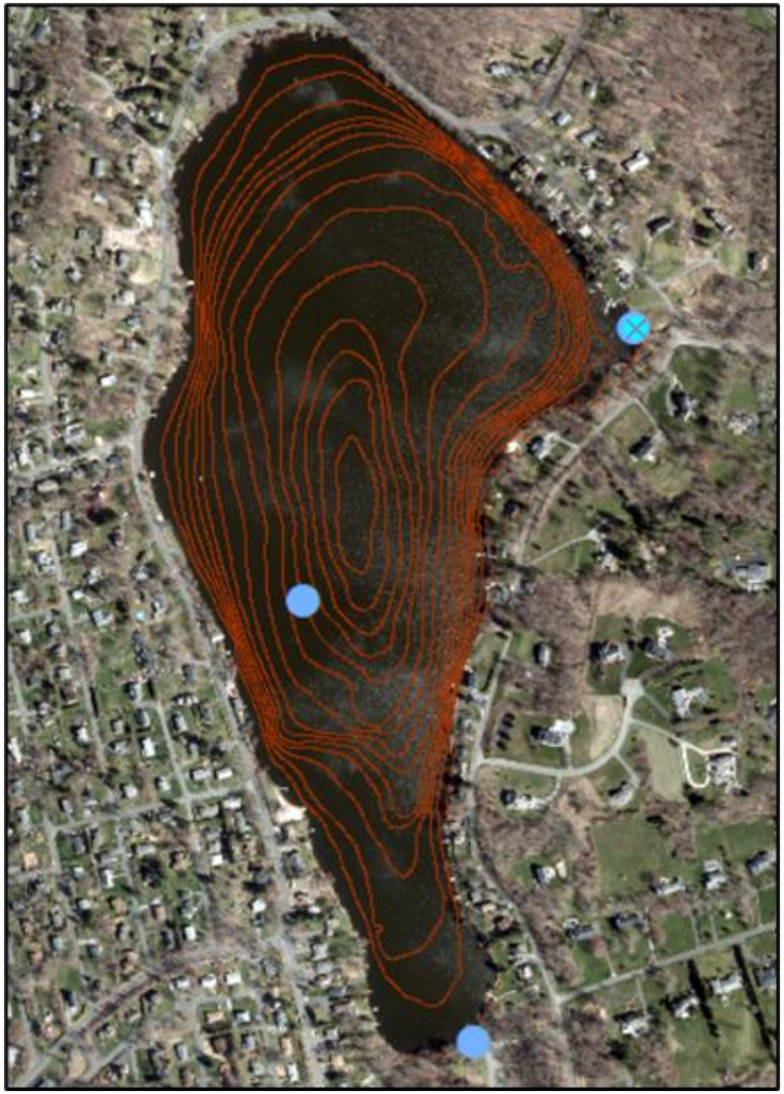
- CyanoMonitoring also encourages measuring microcystin levels
- Dr. Edwin Wong Research Lab at WCSU
- Sampled beach weekly from July 14th to Sep. 2nd.
- CT uses a threshold of 8 µg/L
- All concentrations at Ball Pond <1 µg/L.
- Caveat!

Table 3. Results of microcystin analyses of samples collected at Ball Pond in 2021.

Date	Microcystin (µg/L)
14-Jul	0.186
21-Jul	0.22
28-Jul	0.105
4-Aug	0.079
11-Aug	0.068
18-Aug	0.194
25-Aug	0.052
2-Sep	0.16

Recommendations

- Use GPS to consistently find the deep site in the lake for water quality monitoring.
- Measure down to ½ meter above the bottom
- Profiles of oxidation-reduction potential and relative phycocyanin concentrations
- Sodium, potassium, magnesium, chloride, and sulfate in epilimnetic waters
- Free phosphate (PO4-)
- Iron, and manganese from epilimnetic and hypolimnetic samples.



Recommendations

- Develop a protocol to determine if and where coprecipitation is rendering phosphorus limiting to algal growth
- Develop a plan and cost estimate to establish a nutrient budget for the lake. This will be critical for the development of a lake management plan.
- Start water quality monitoring in March, even if it is to just measure temperature, oxygen, and conductivity in the water column.
- Develop a plan and cost estimate to understand the chemistry of groundwater and spring waters entering Ball Pond.
- Get feedback from the researchers of Cyanobacteria Monitoring Collaborative on the 2021 data.

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Photo: Maureen Dangelo