2023 Ball Pond Water Quality Assessment

Presented to

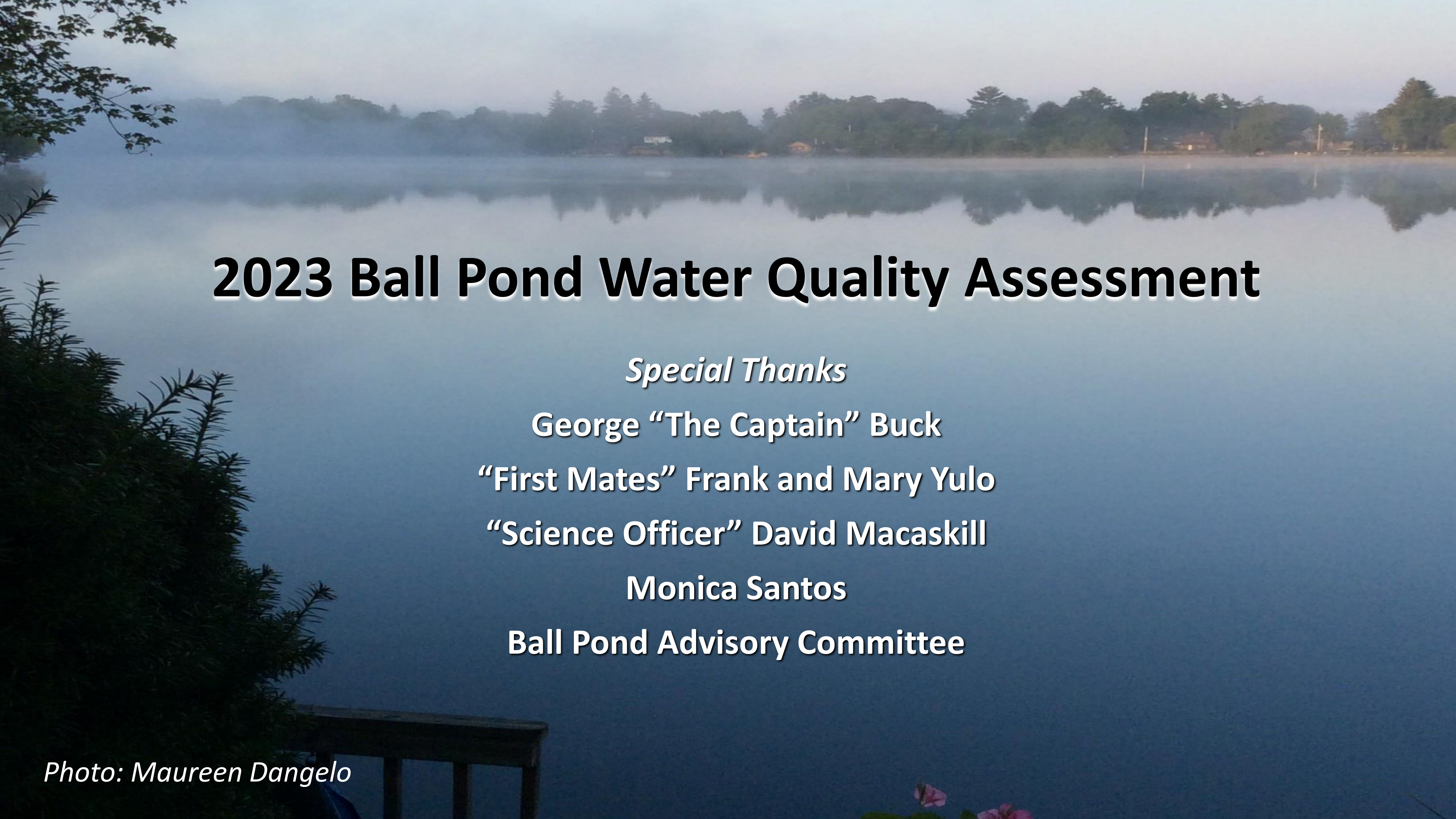
Ball Pond Advisory Committee

Larry Marsicano

Brawley Consulting Group LLC

December 6, 2023

Photo: Maureen Dangelo



2023 Ball Pond Water Quality Assessment

Special Thanks

George "The Captain" Buck

"First Mates" Frank and Mary Yulo

"Science Officer" David Macaskill

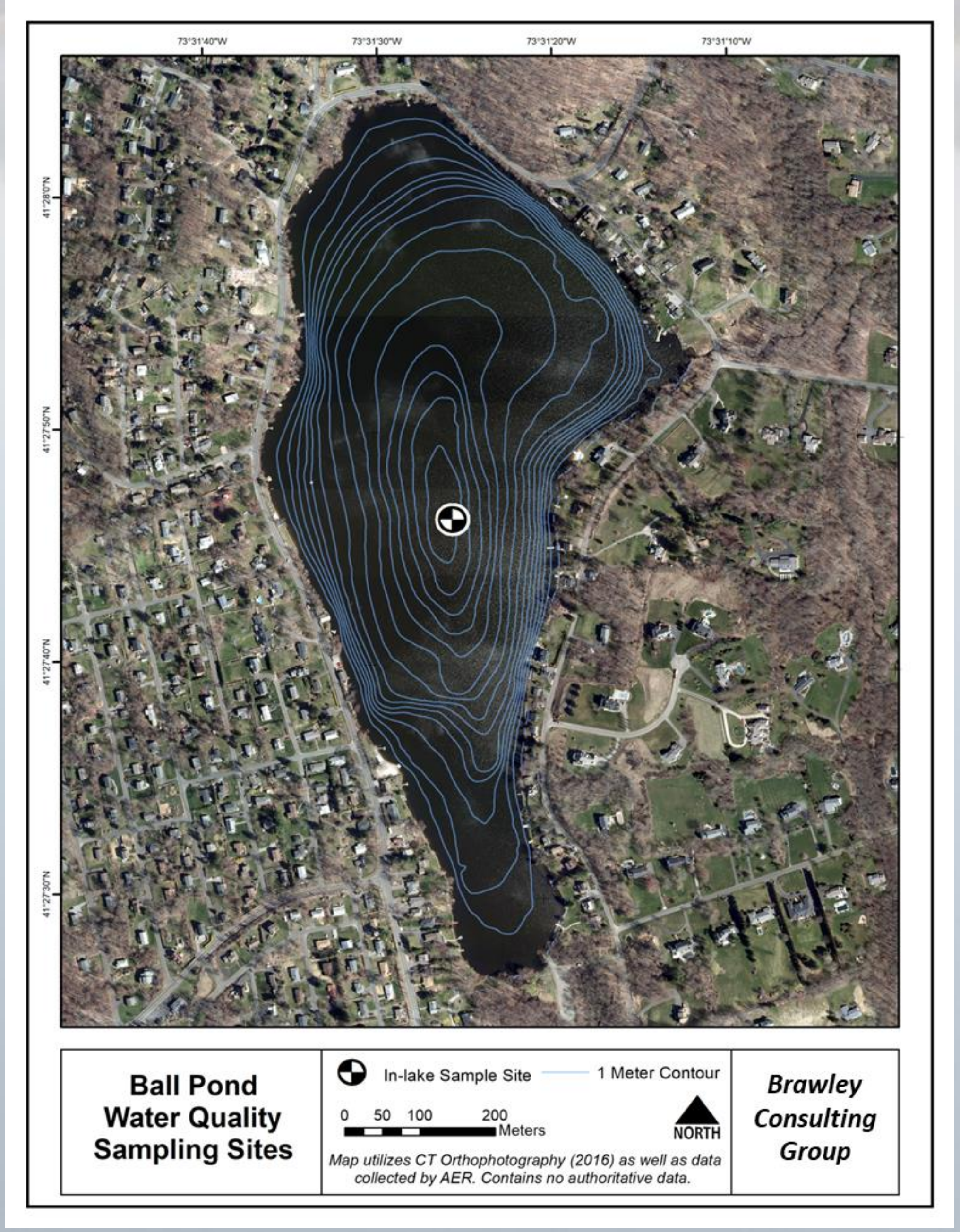
Monica Santos

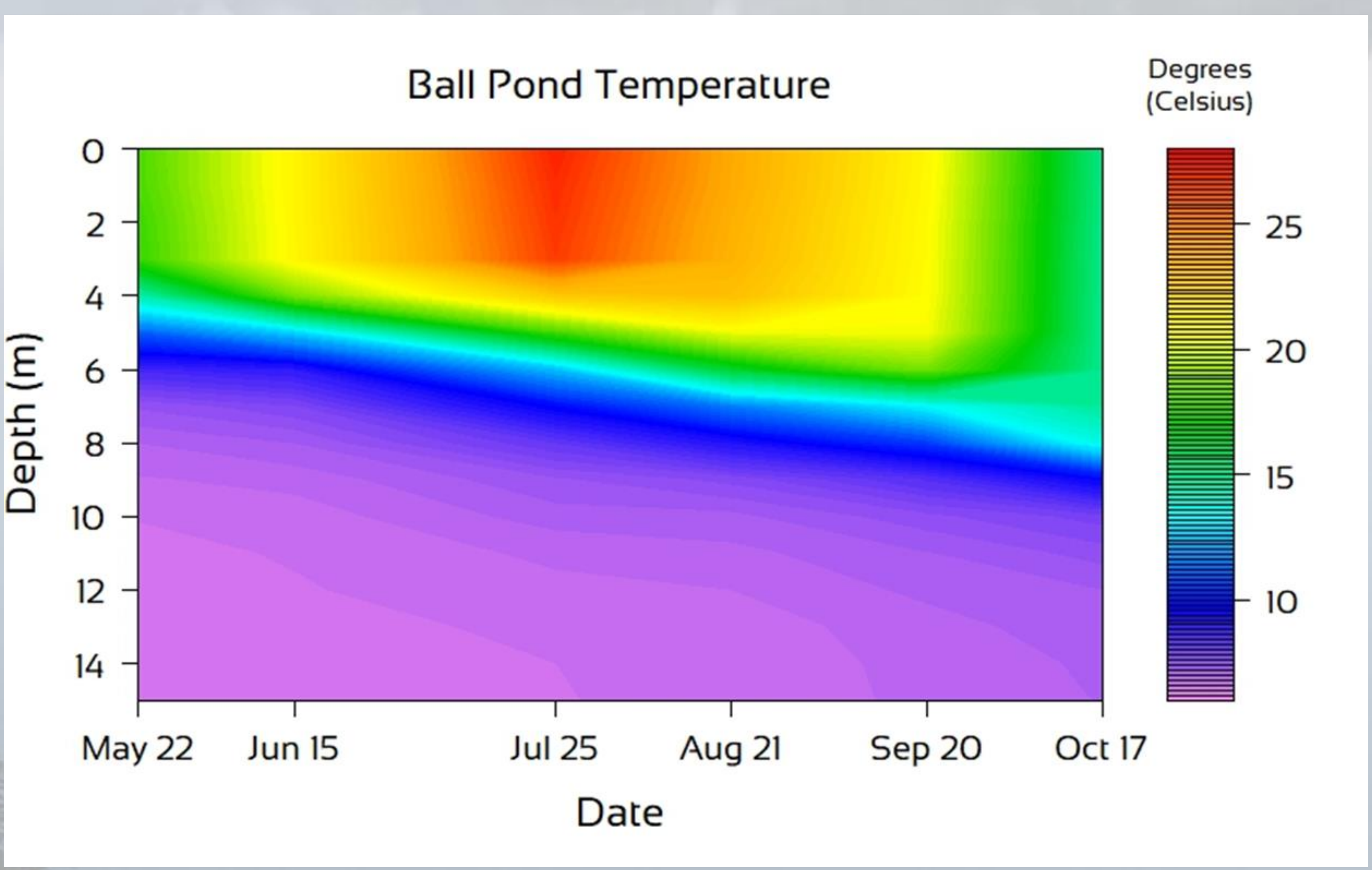
Ball Pond Advisory Committee

Photo: Maureen Dangelo

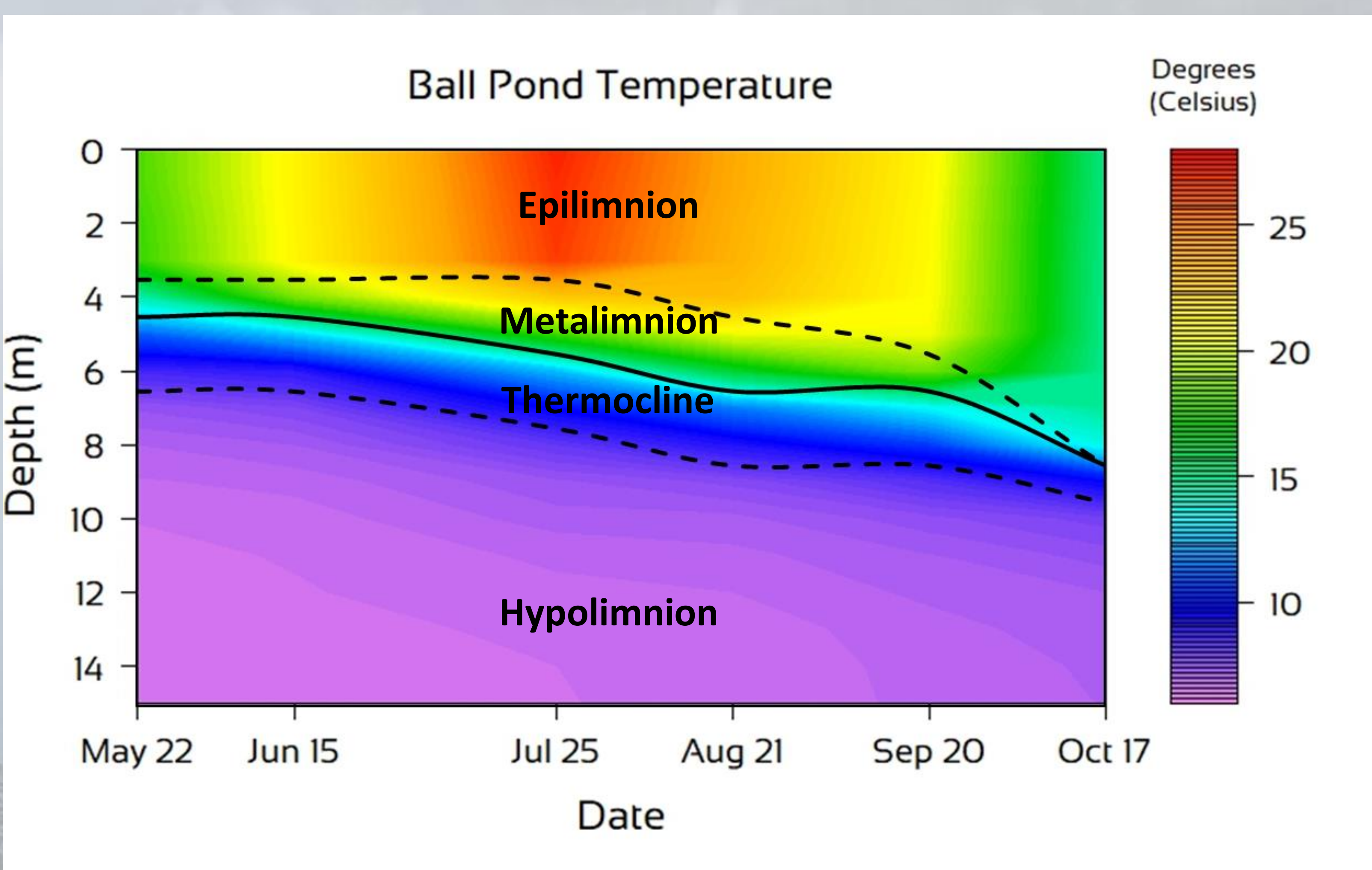
Monitoring Program

- Deep-water sites visited monthly
- Data collected in the field
  - Temp, oxygen, etc. profiles
  - Secchi transparency
- Water samples collected
  - Top, "Middle," Bottom
  - Analyzed for nutrients, chlorophyll, dissolved salts, etc.
- Sample collected for algae counts
  - Reported on monthly
- Cyanotoxin monitoring

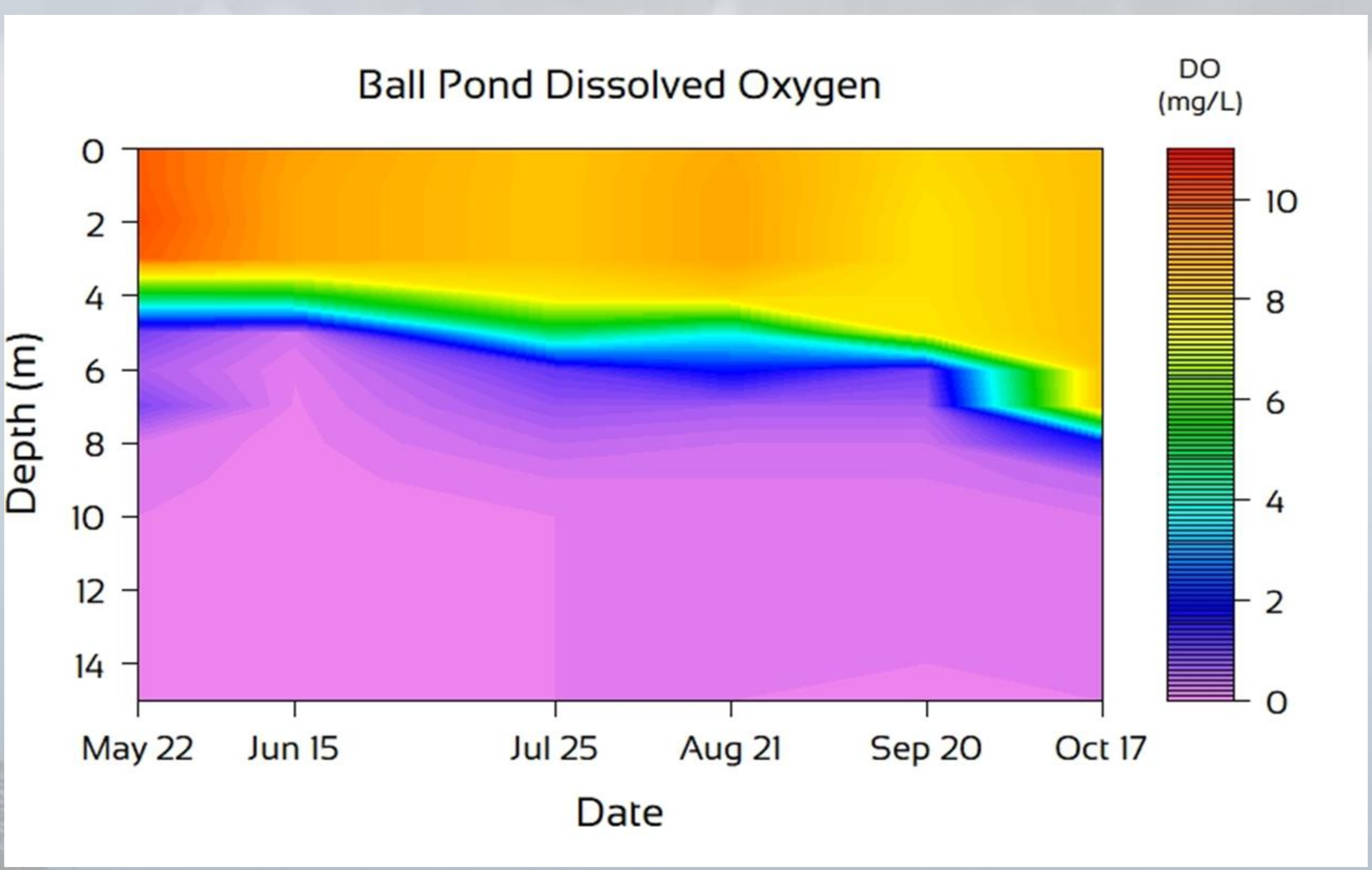




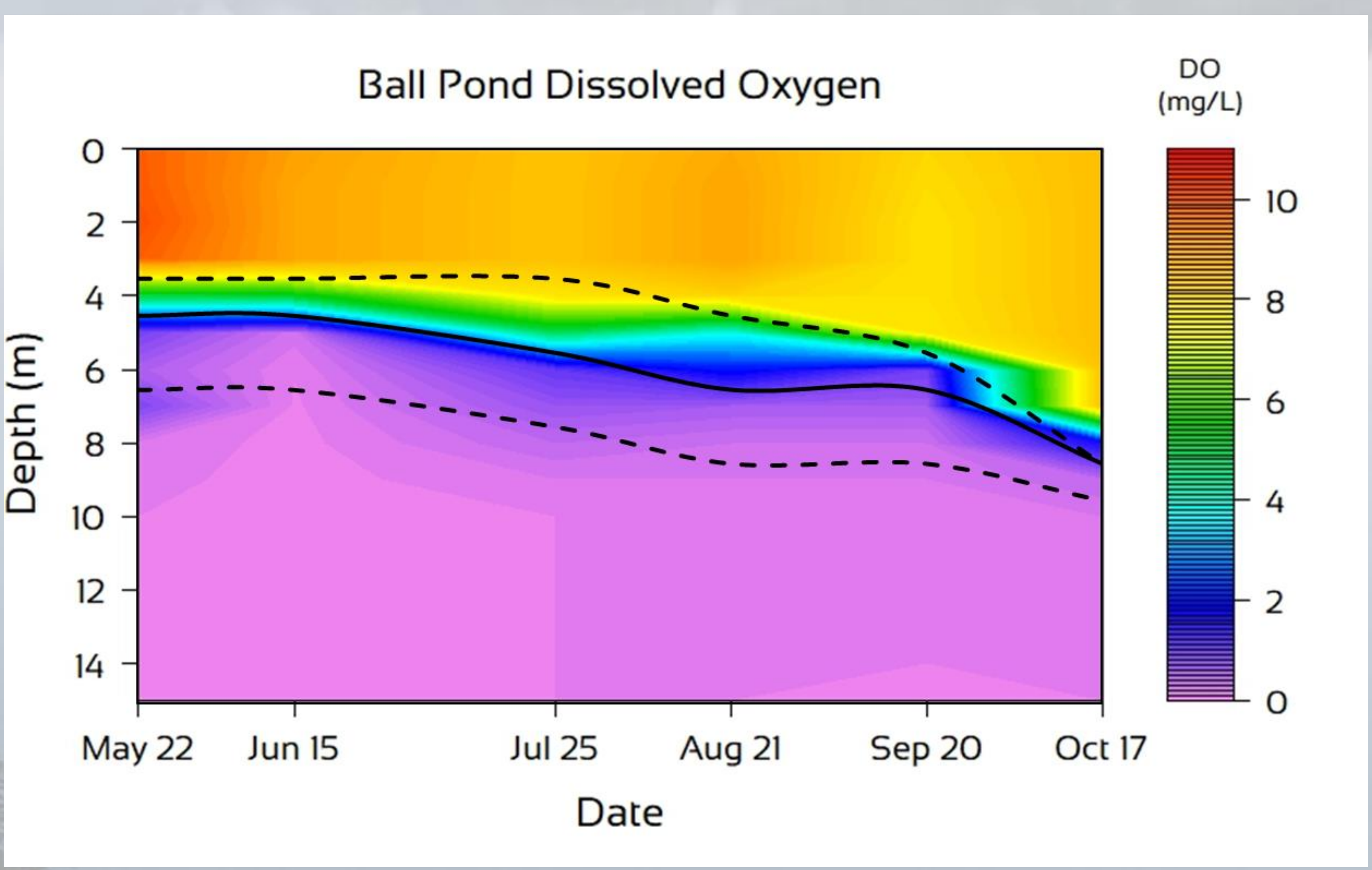
Ball Pond Temperature
Degrees
(Celsius)
0
2
4
6
8
10
12
14
Depth (m)
May 22
Jun 15
Jul 25
Aug 21
Sep 20
Oct 17
Date
25
20
15
10

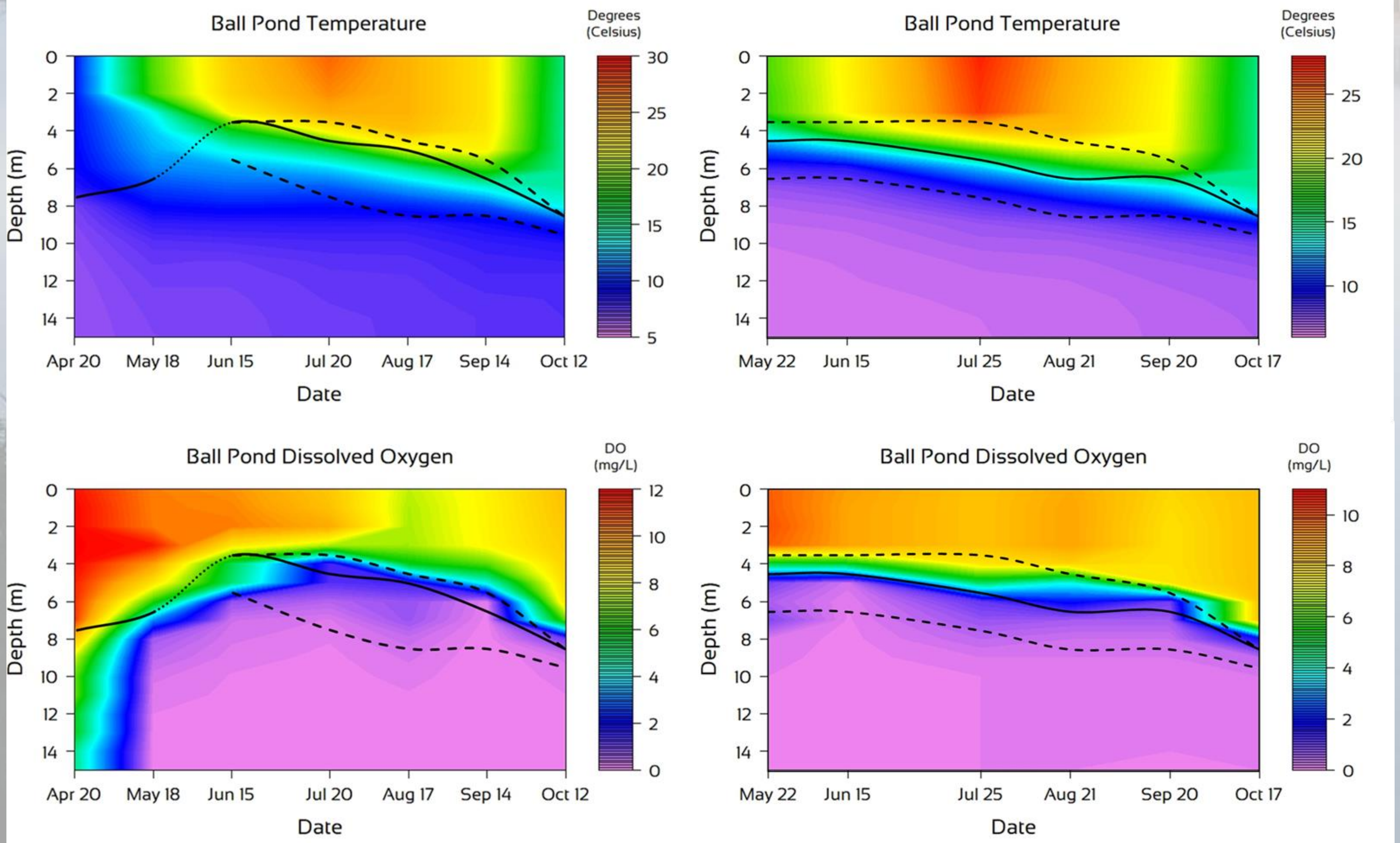


Ball Pond Temperature
Degrees
(Celsius)
Epilimnion
Metalimnion
Thermocline
Hypolimnion
Depth (m)
0
2
4
6
8
10
12
14
May 22
Jun 15
Jul 25
Aug 21
Sep 20
Oct 17
Date
25
20
15
10



Ball Pond Dissolved Oxygen
DO (mg/L)
Depth (m)
0
2
4
6
8
10
12
14
May 22
Jun 15
Jul 25
Aug 21
Sep 20
Oct 17
Date
10
8
6
4
2
0

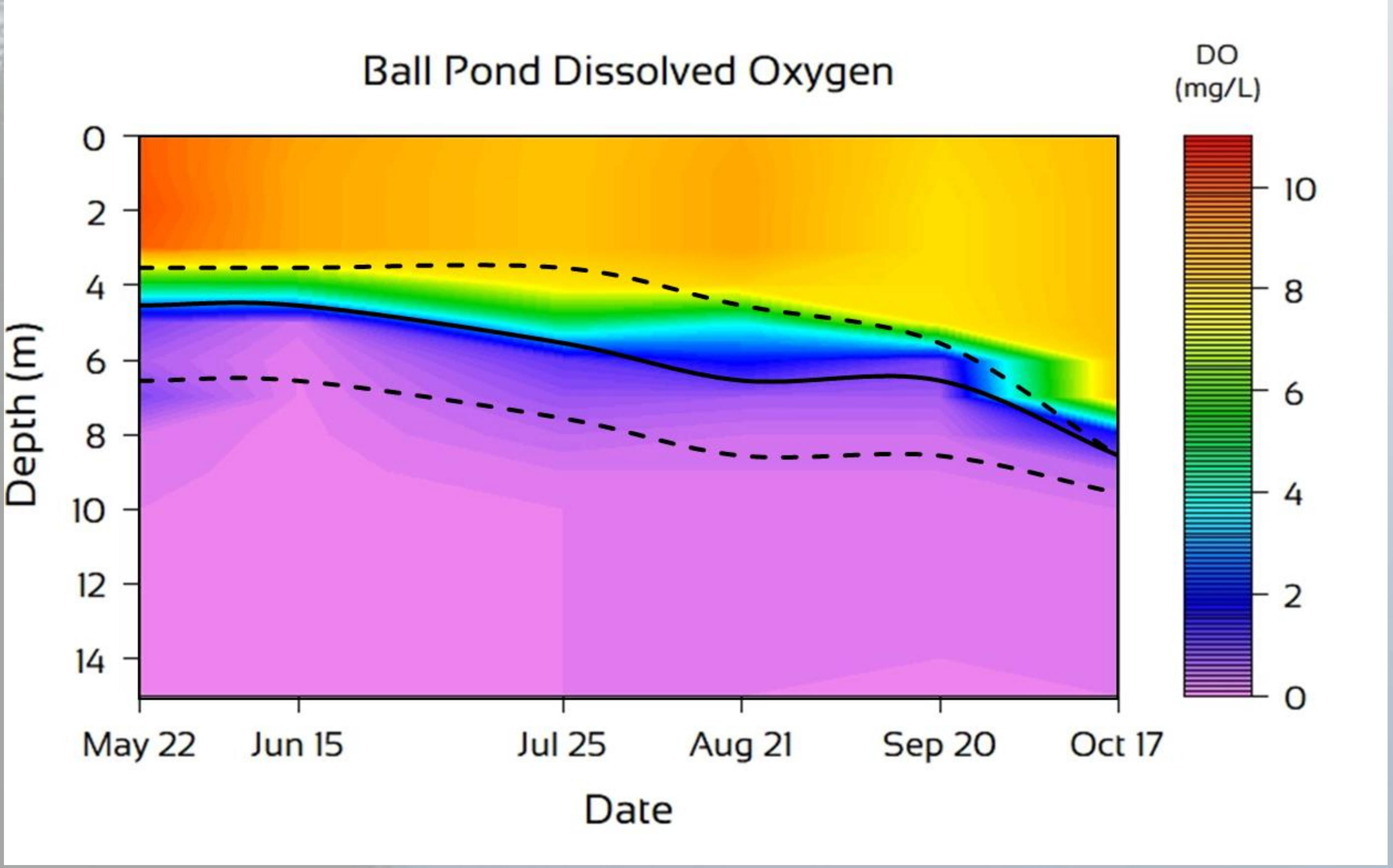

Ball Pond Dissolved Oxygen
DO (mg/L)
0
2
4
6
8
10
12
14
Depth (m)
May 22
Jun 15
Jul 25
Aug 21
Sep 20
Oct 17
Date
10
8
6
4
2
0

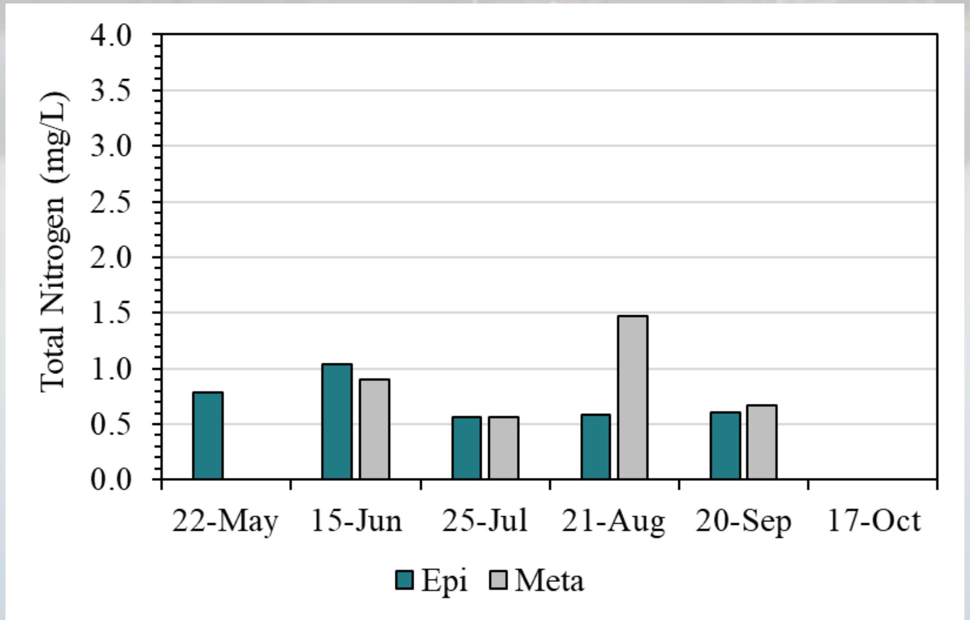


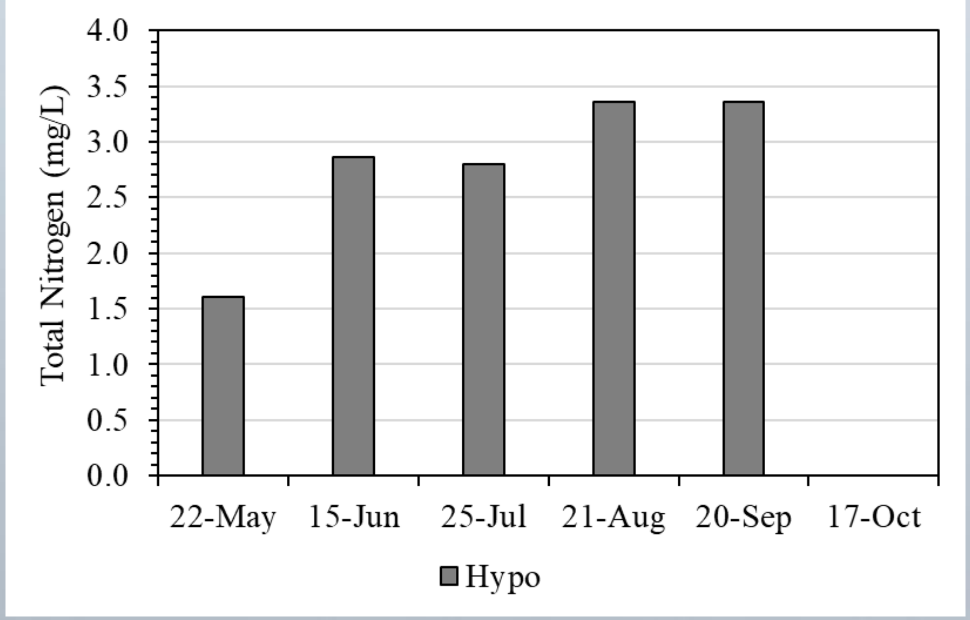
Ball Pond Temperature
Degrees (Celsius)
Depth (m)
0 2 4 6 8 10 12 14
Apr 20 May 18 Jun 15 Jul 20 Aug 17 Sep 14 Oct 12
Date
30 25 20 15 10 5
Ball Pond Temperature
Degrees (Celsius)
Depth (m)
May 22 Jun 15 Jul 25 Aug 21 Sep 20 Oct 17
Date
25 20 15 10
Ball Pond Dissolved Oxygen
DO (mg/L)
Depth (m)
Apr 20 May 18 Jun 15 Jul 20 Aug 17 Sep 14 Oct 12
Date
12 10 8 6 4 2 0
Ball Pond Dissolved Oxygen
DO (mg/L)
Depth (m)
May 22 Jun 15 Jul 25 Aug 21 Sep 20 Oct 17
Date
10 8 6 4 2 0

Total Nitrogen

Most often the second most limiting for algae growth.

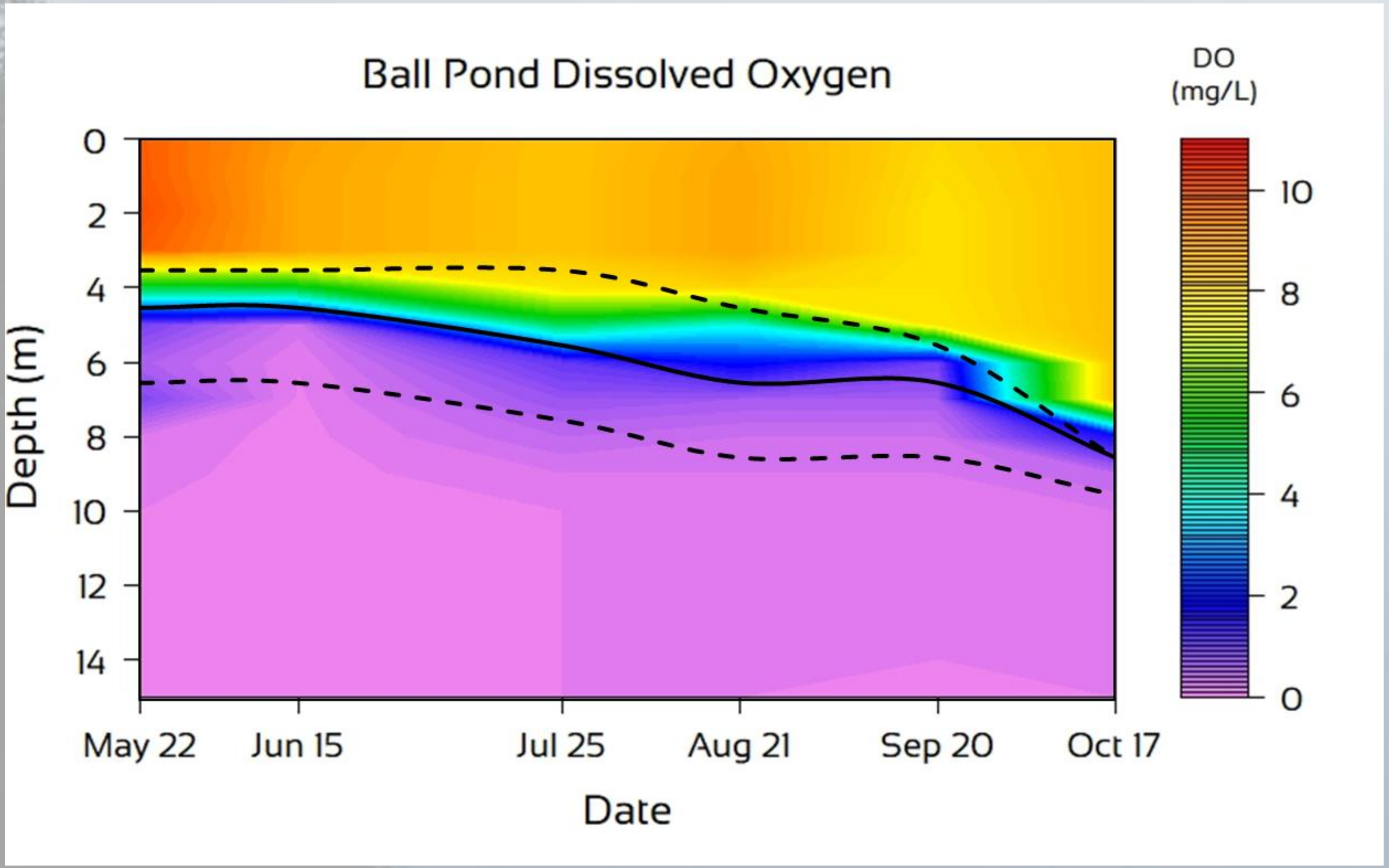


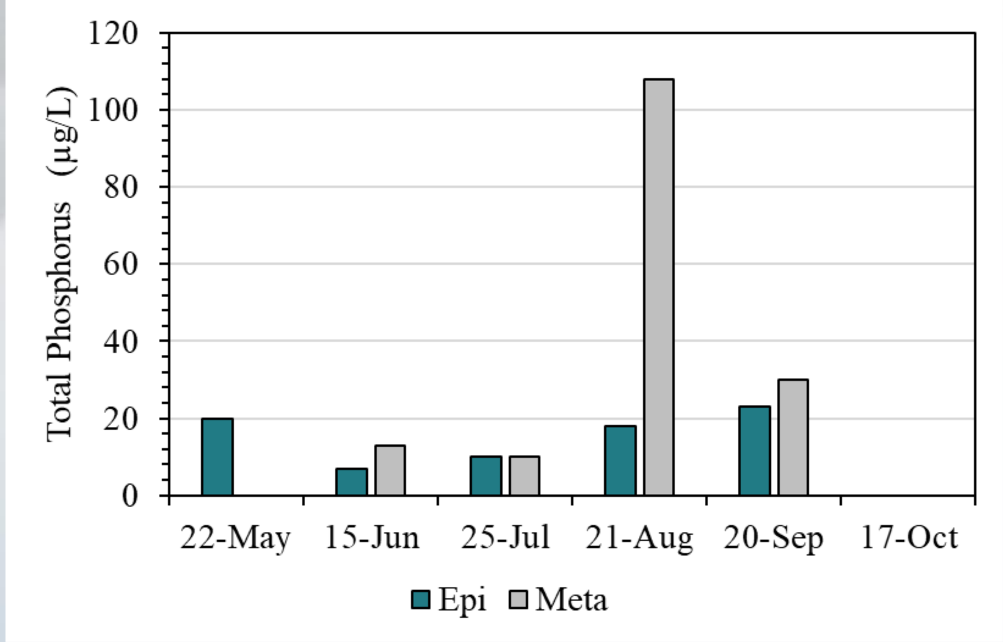


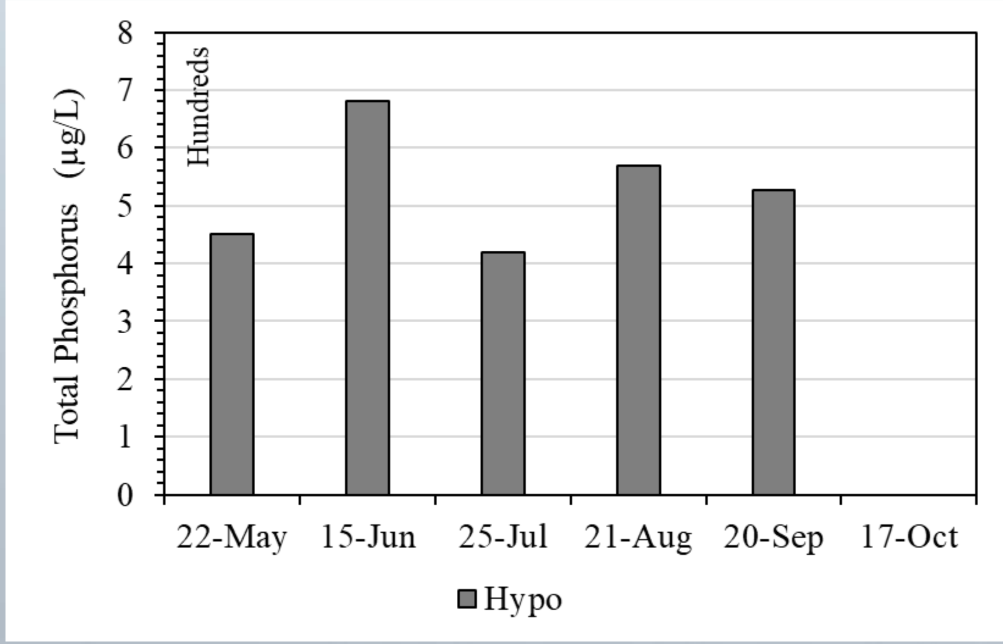


Total Phosphorus

Most often the "limiting nutrient" for algae growth.

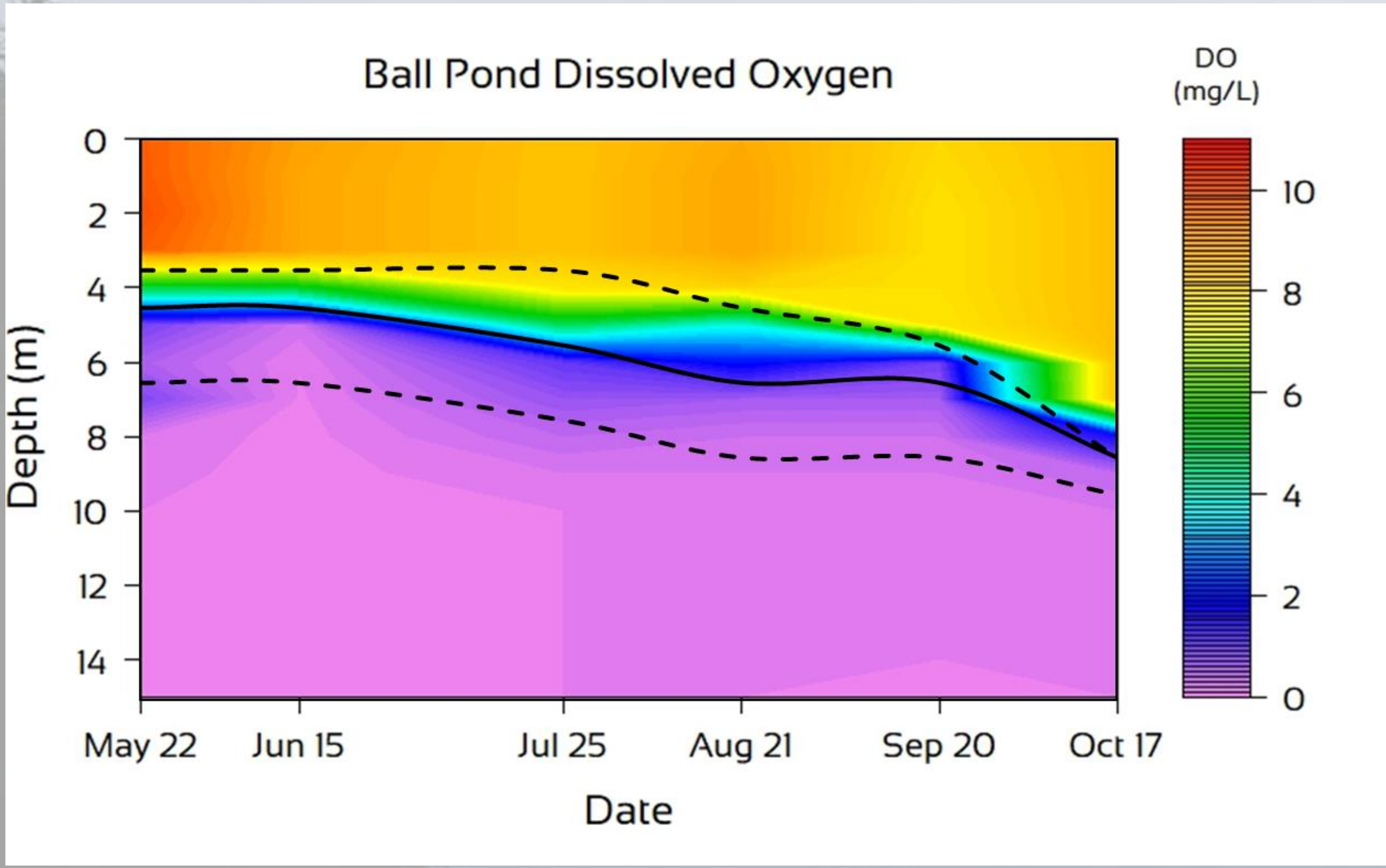


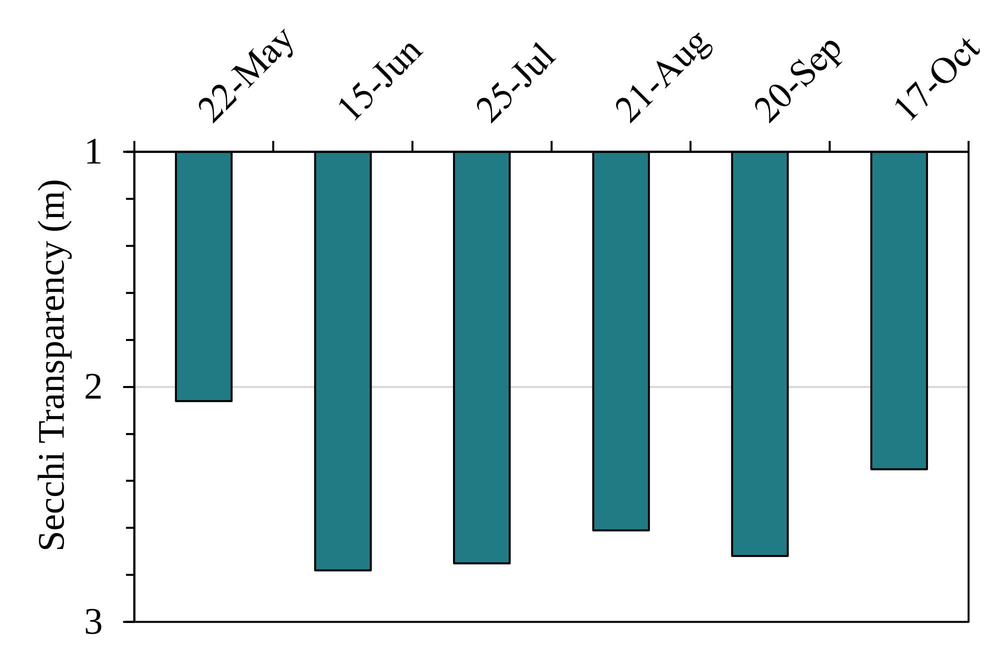


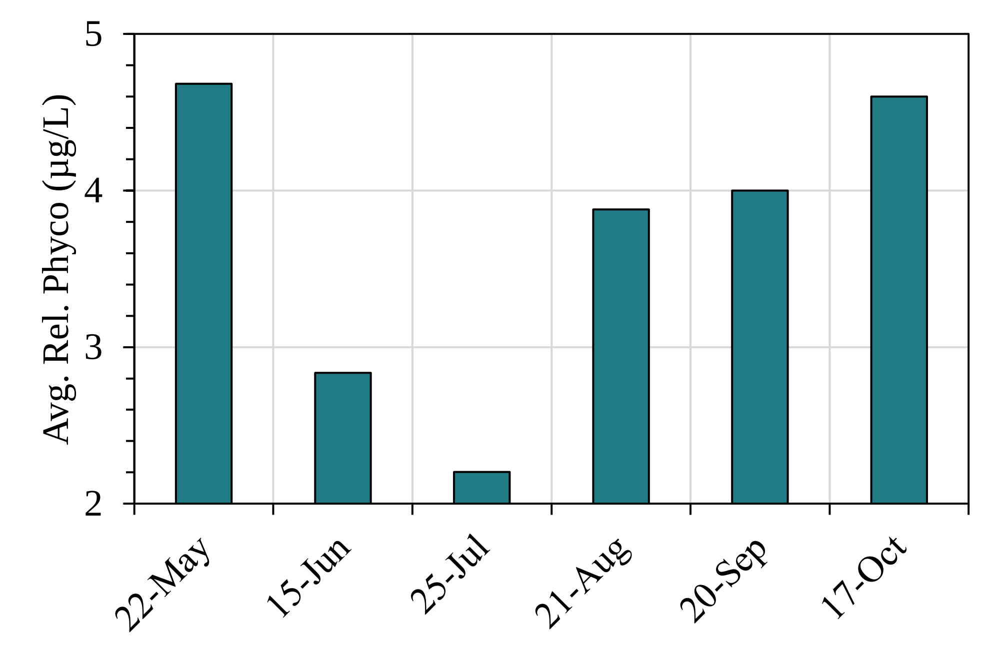


Epilimnetic Algal Productivity

How much algae and cyanobacteria growth is there?







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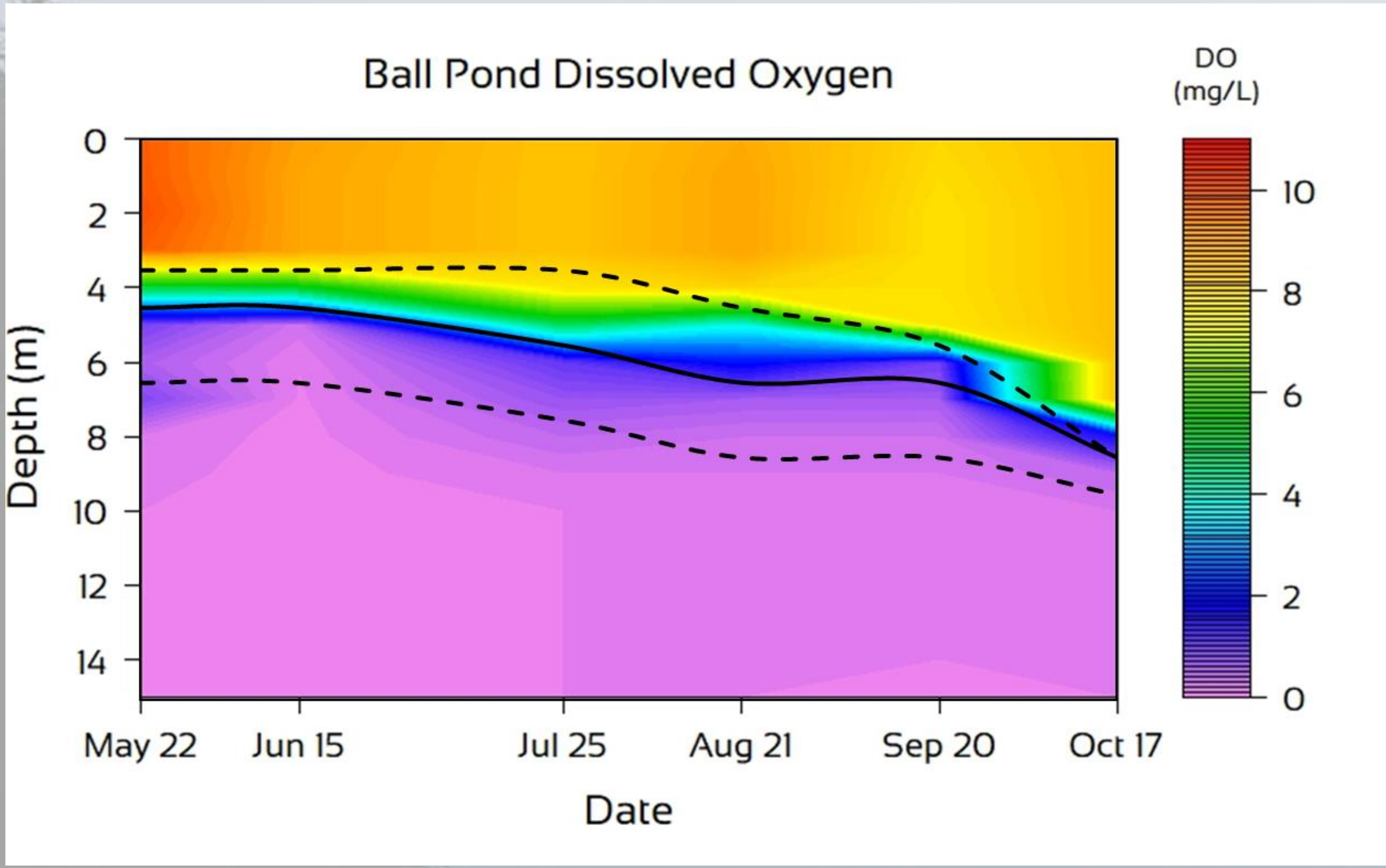
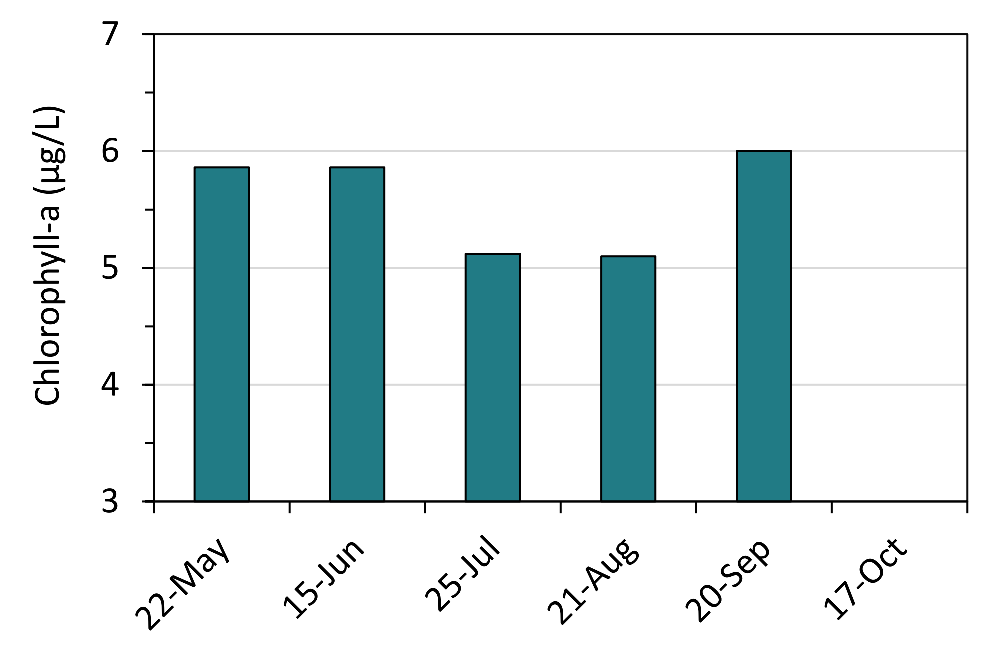
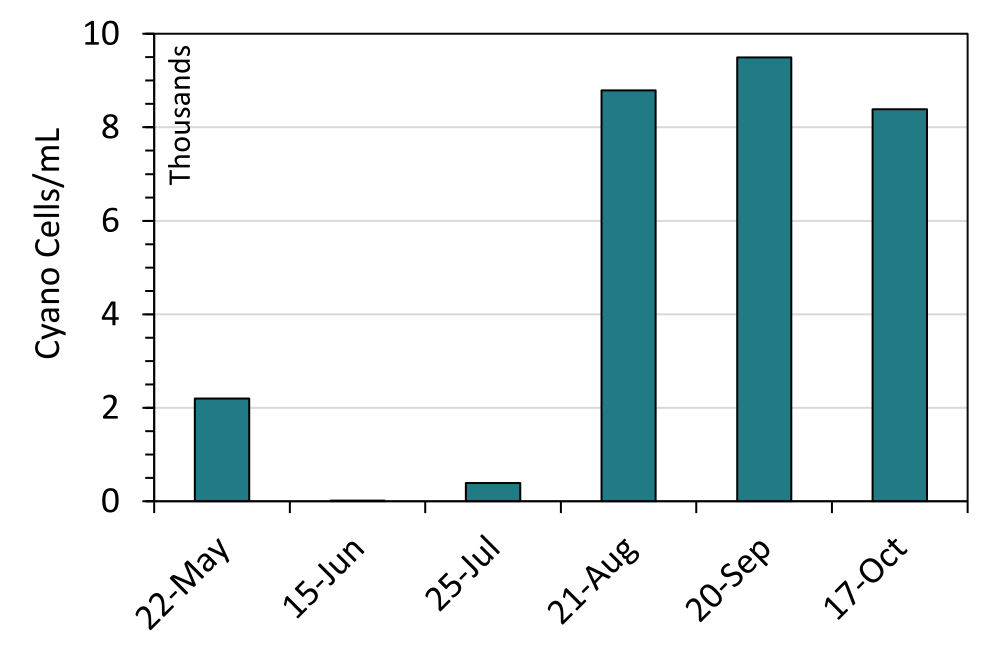
How much algae and cyanobacteria growth is there?



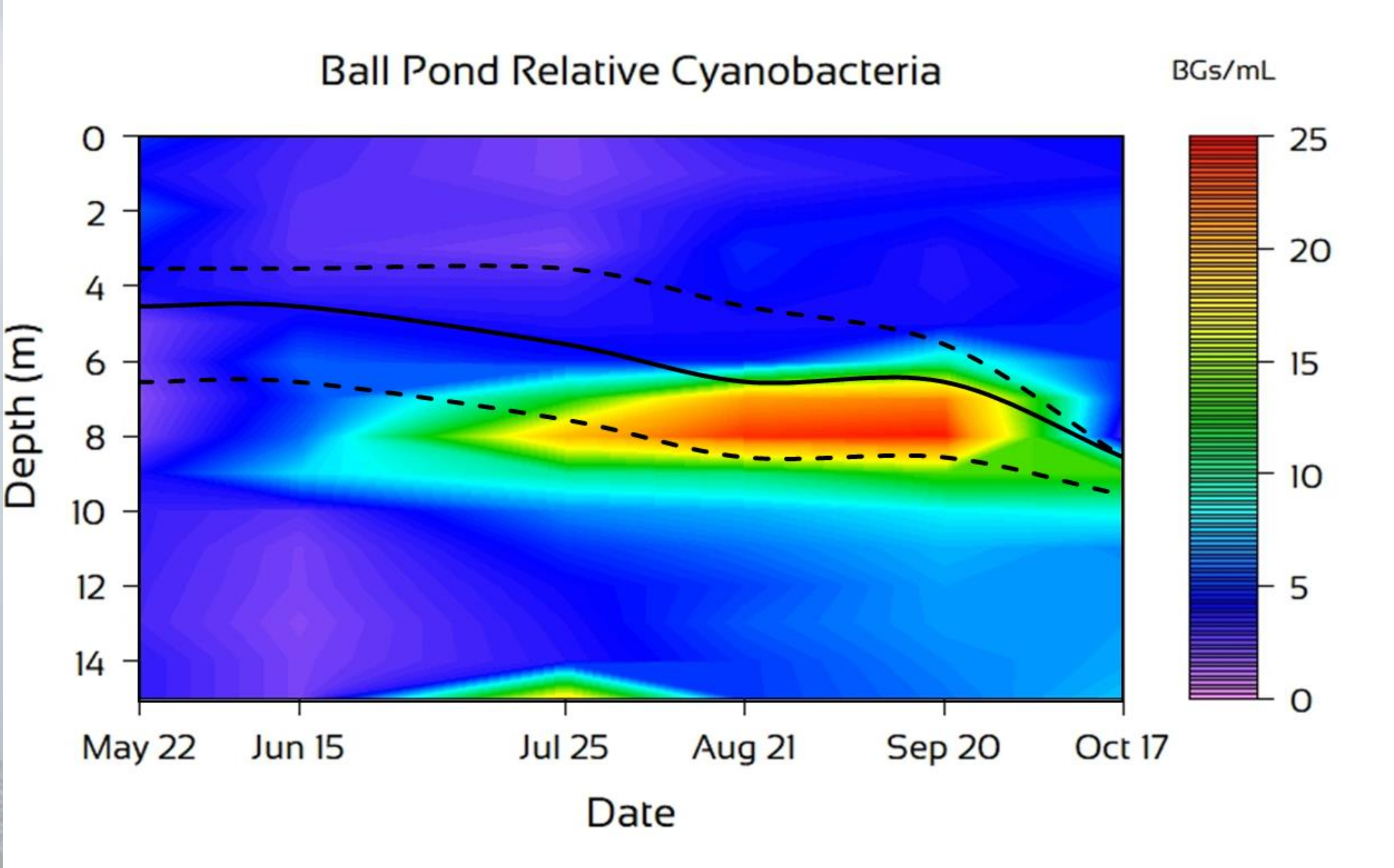




Trophic Status
(aka “How much productivity?”)

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



Ball Pond Relative Cyanobacteria
BGs/mL
0
2
4
6
8
10
12
14
Depth (m)
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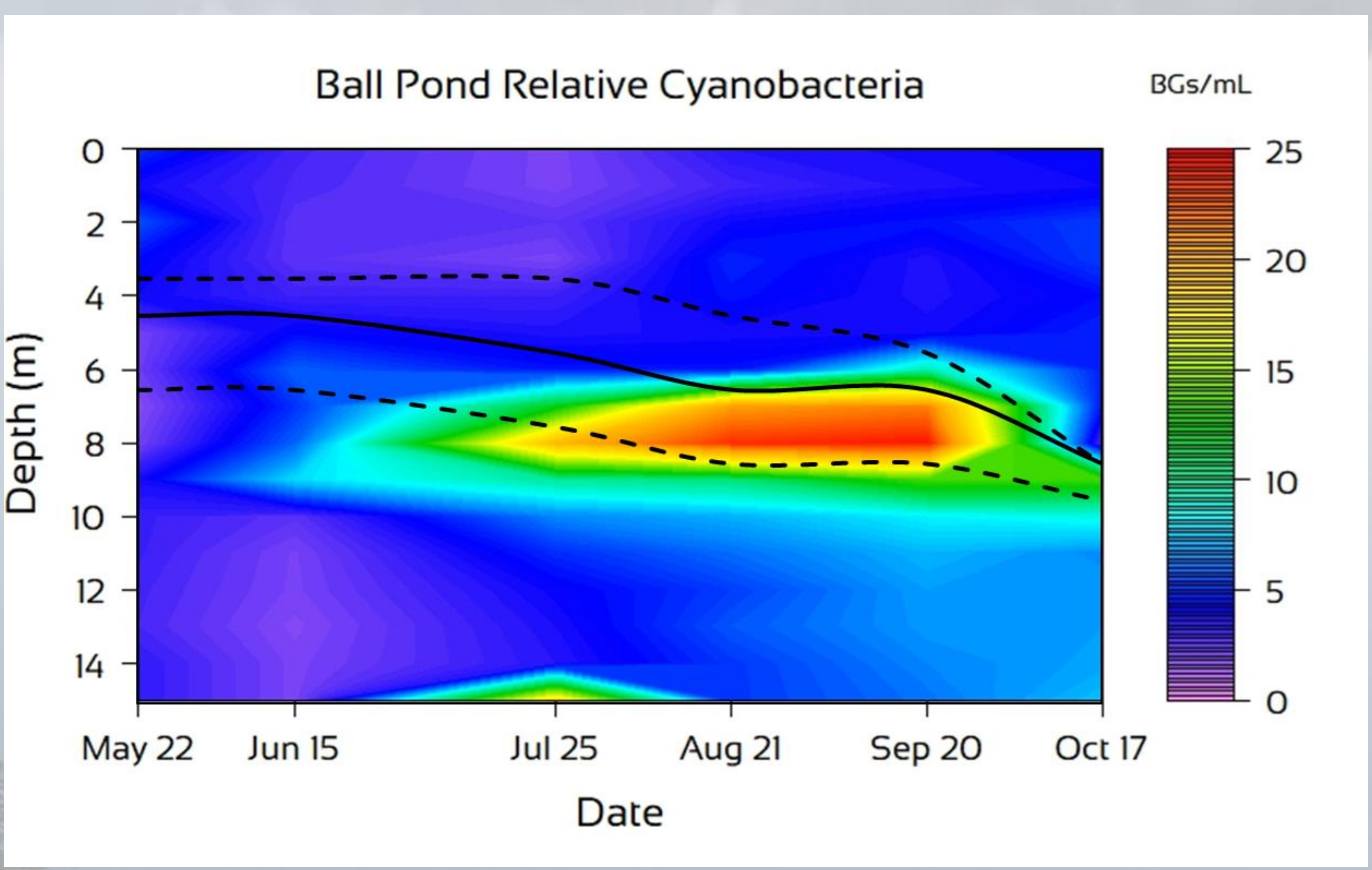
Jun 15
Jul 25
Aug 21
Sep 20
Oct 17
Date
25
20
15
10
5
0



Ball Pond Relative Cyanobacteria
BGs/mL
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15
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0

Shoreline Cyano Blooms

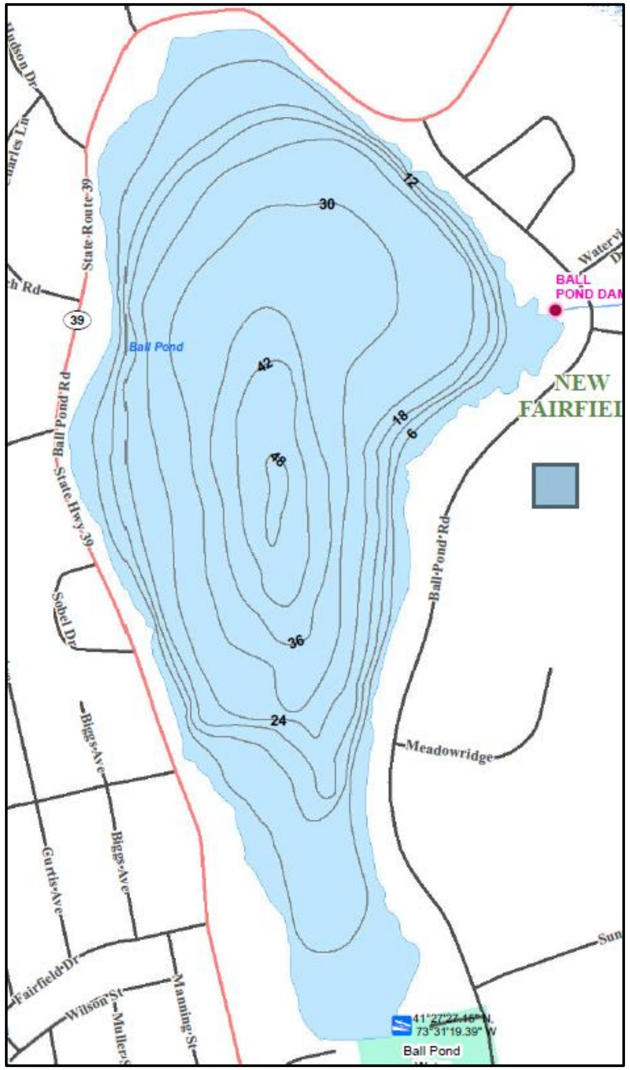
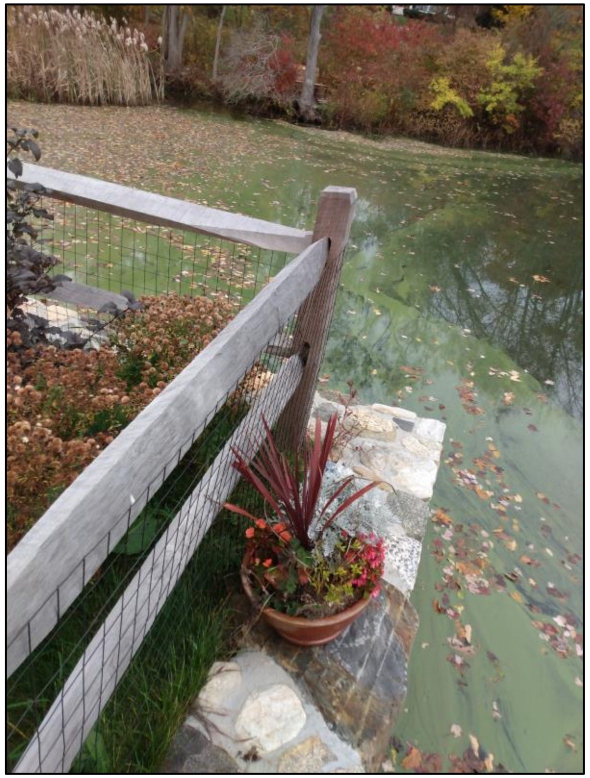


Photo credits:
Elissa Johnson

September



October

Bloom Genera

Dolichospermum spp.
Woronichinia spp.

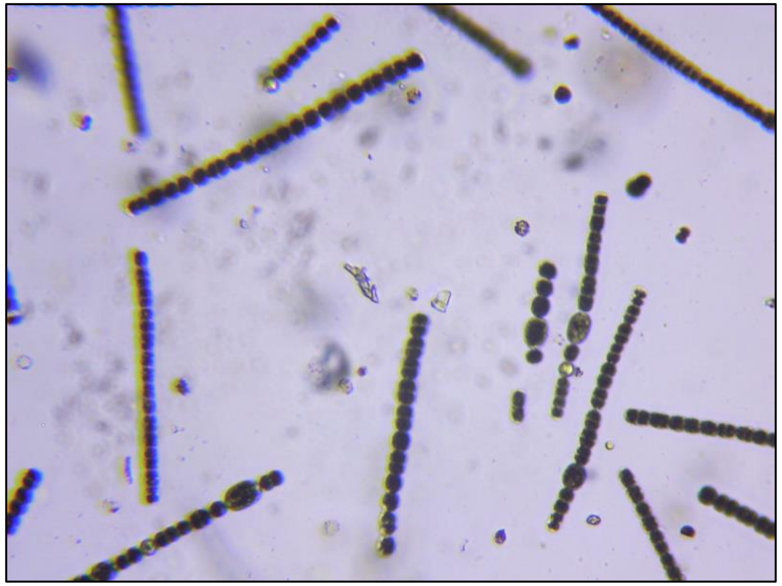
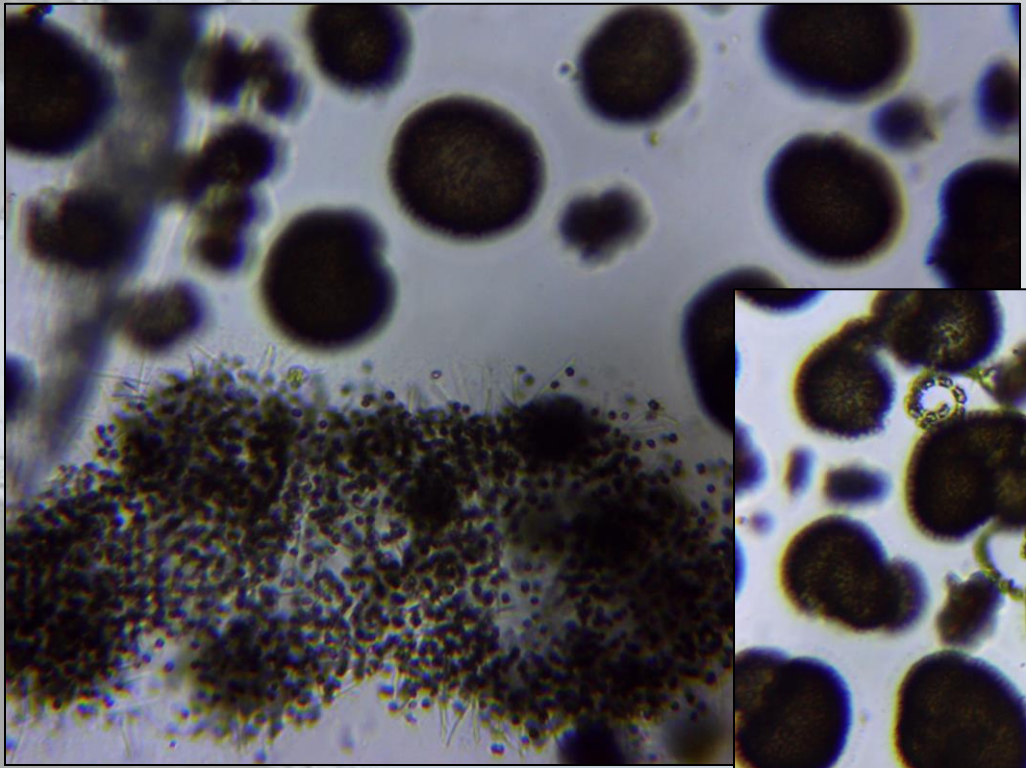
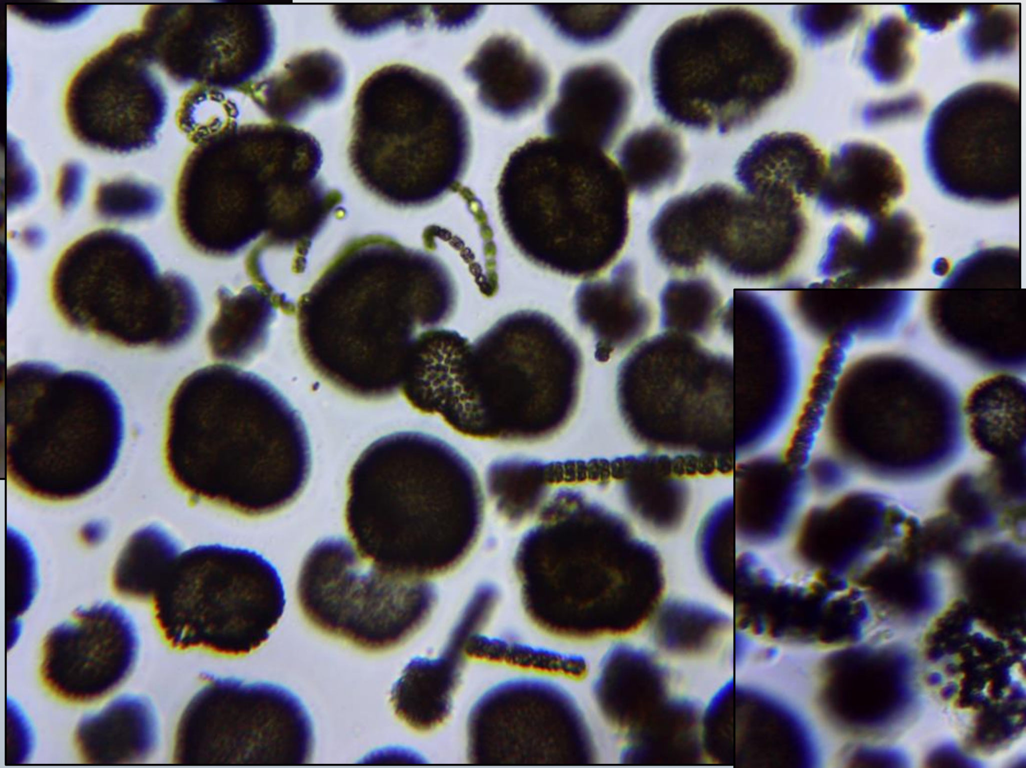
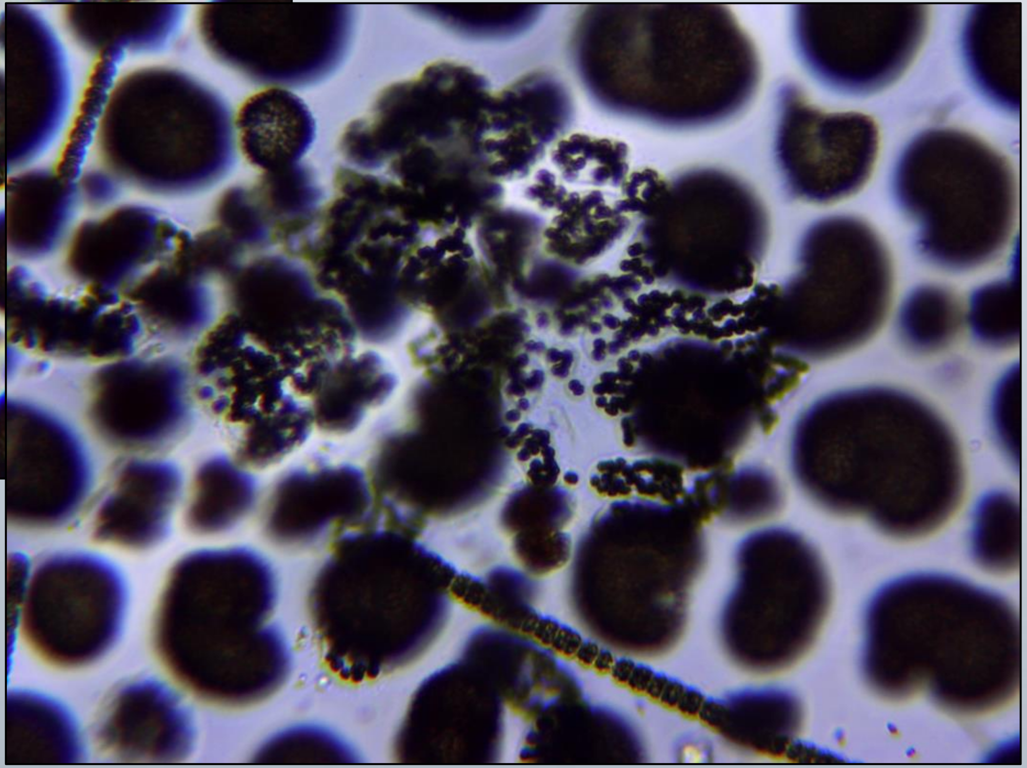


Photo credit: Elissa Johnson

- *Woronichinia spp.*
- *Dolichospermum spp.*
- *Microcystis spp.*







June 25, 2022
Photos – *Elissa Johnson*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Aquatic Nuisance Species Research Program

Identification and Preventative Treatment of Overwintering Cyanobacteria in Sediments

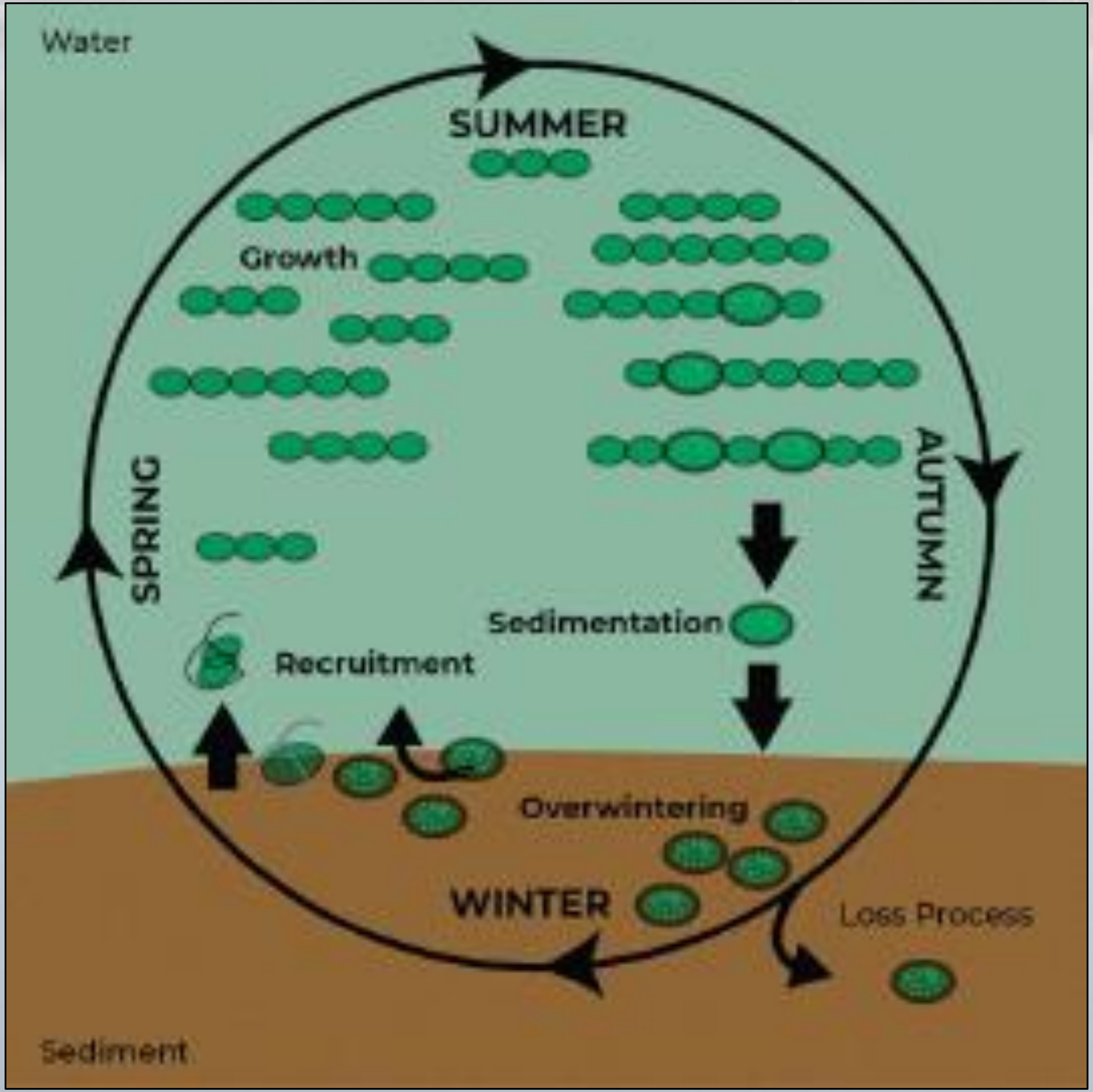
A Literature Review

Alyssa J. Calomeni, Andrew D. McQueen, Ciera M. Kinley-Baird, and Gerard A. Clyde, Jr.

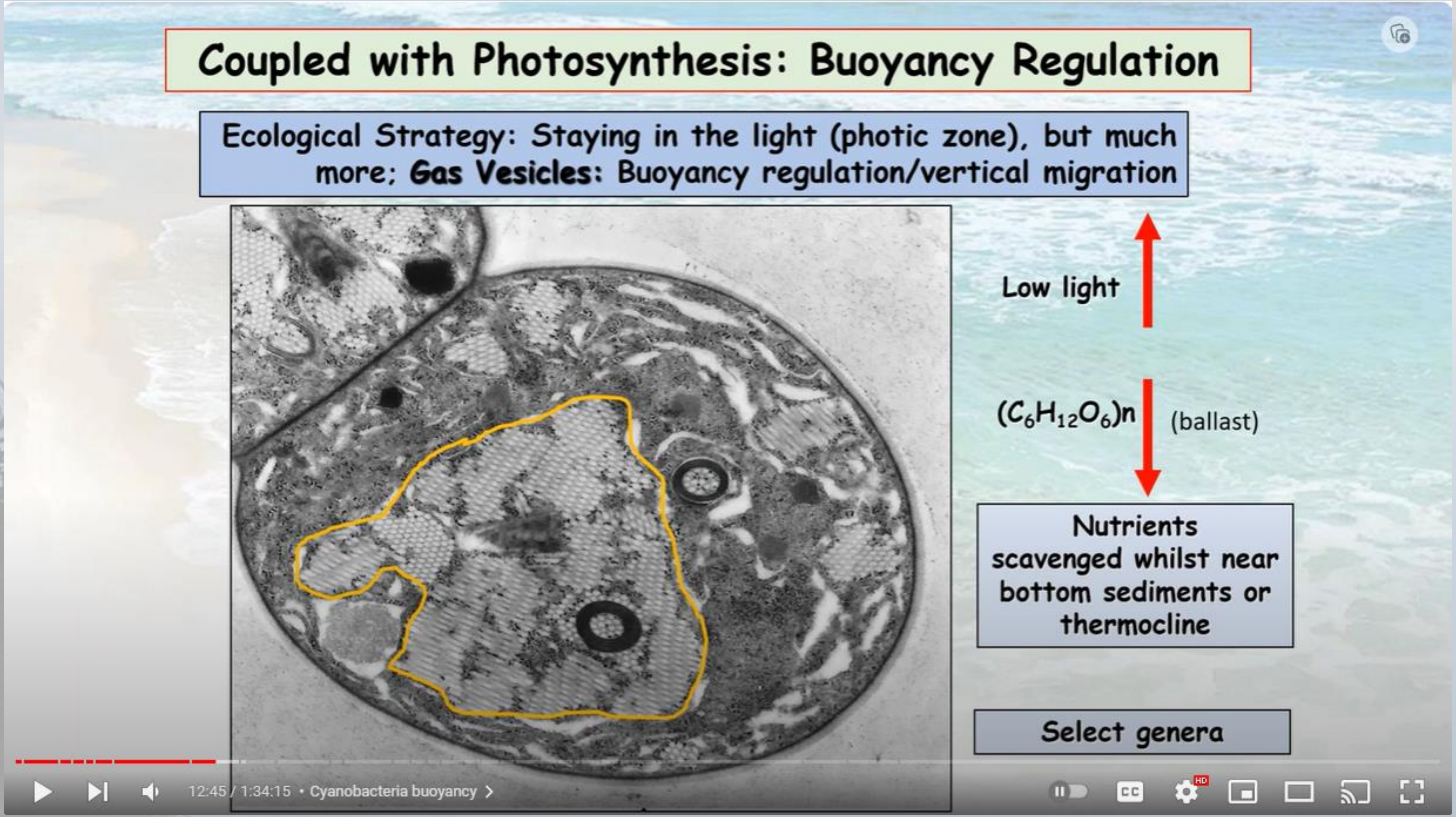
August 2022

Approved for public release; distribution is unlimited.

Environmental Laboratory



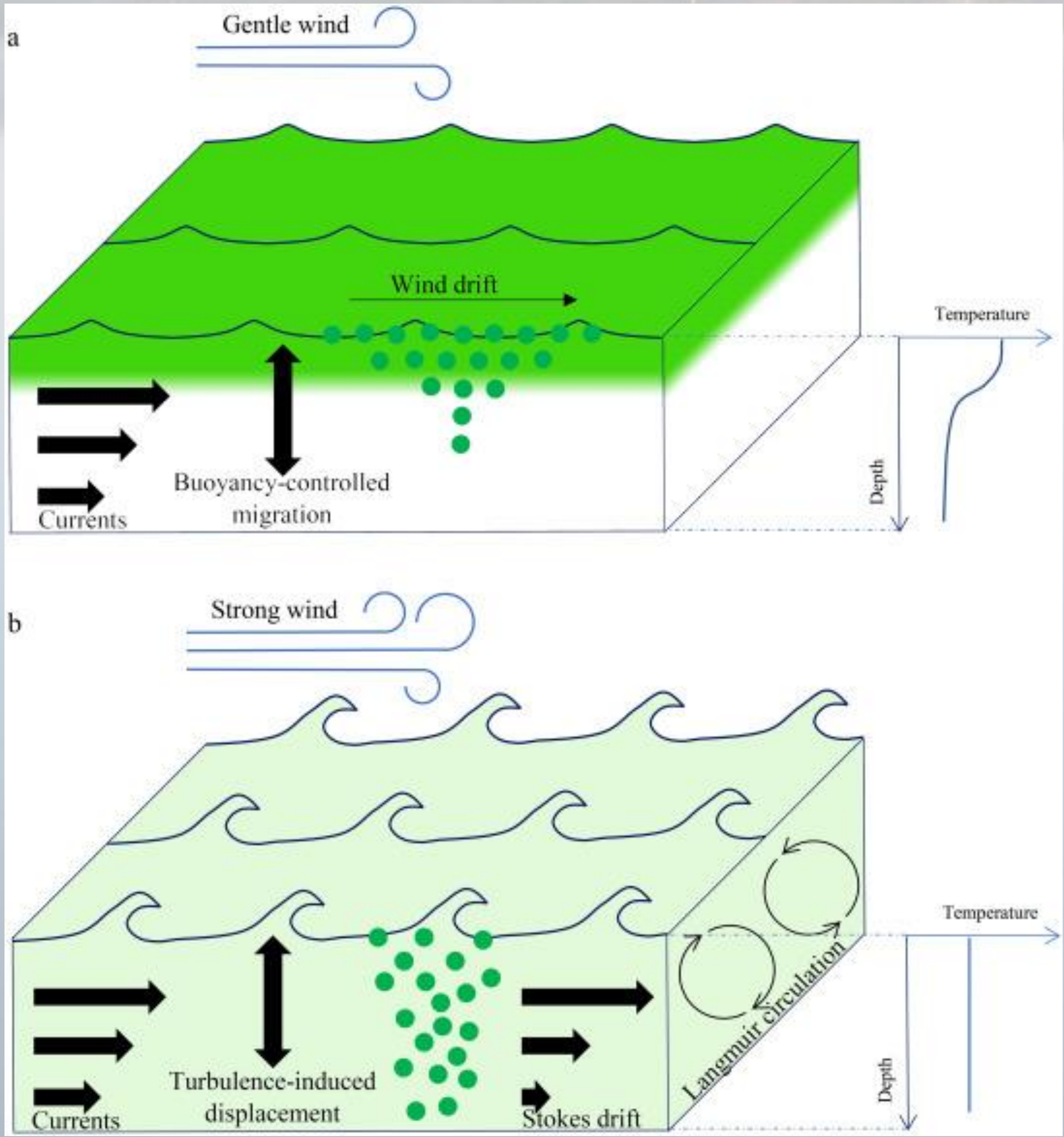
Reactive vs Proactive Treatment



[Cyanobacteria: What you Need to Know – Part 1: Cyanobacteria Biology and Toxin Formation](https://www.youtube.com/watch?v=eaUp178DXFQ)

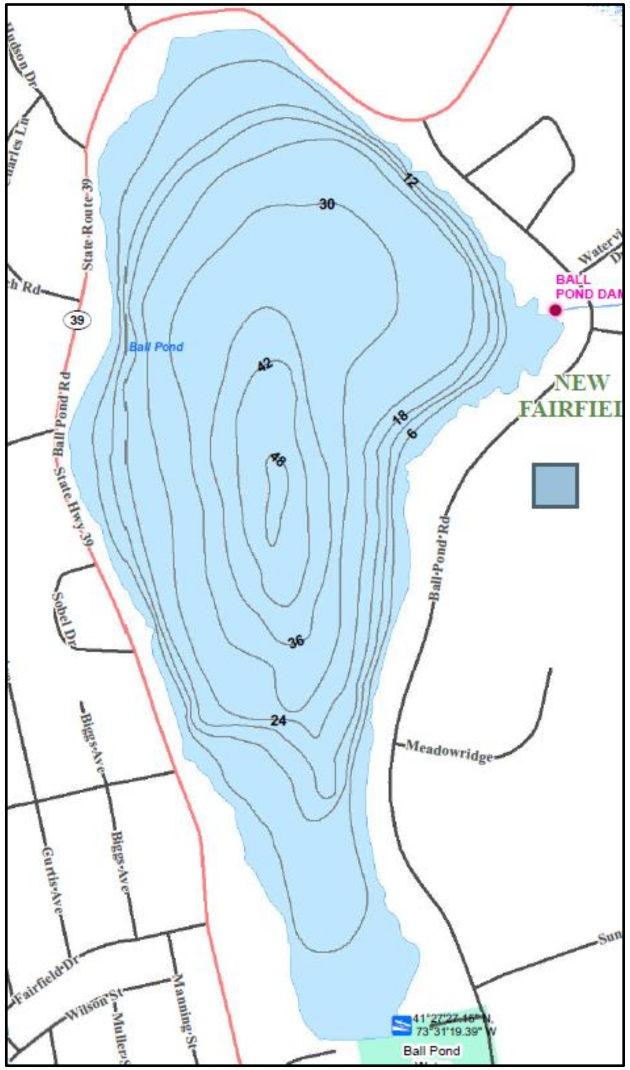
https://www.youtube.com/watch?v=eaUp178DXFQ

Fig. 2. The primary processes involved in the transport of cyanobacteria species under gentle (upper) and strong (lower) wind conditions in the surface mixed layer. The background colour represents chlorophyll *a*.



MH Ranjbar, DP Hamilton, A Etemad-Shahidi, F Helfer. ***Individual-based modelling of cyanobacteria blooms: Physical and physiological processes.*** Science of The Total Environment,Volume 792, 2021, 148418, ISSN 0048-9697,

Shoreline Cyano Blooms



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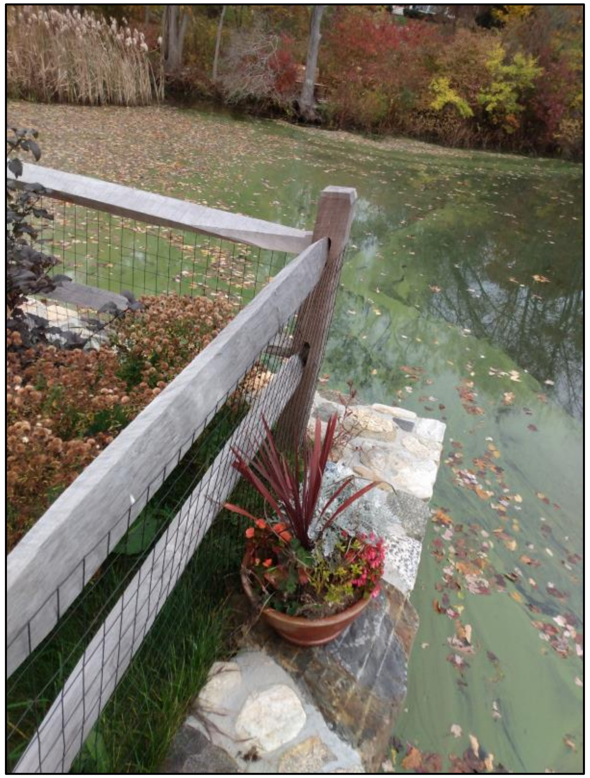
Elissa Johnson

September



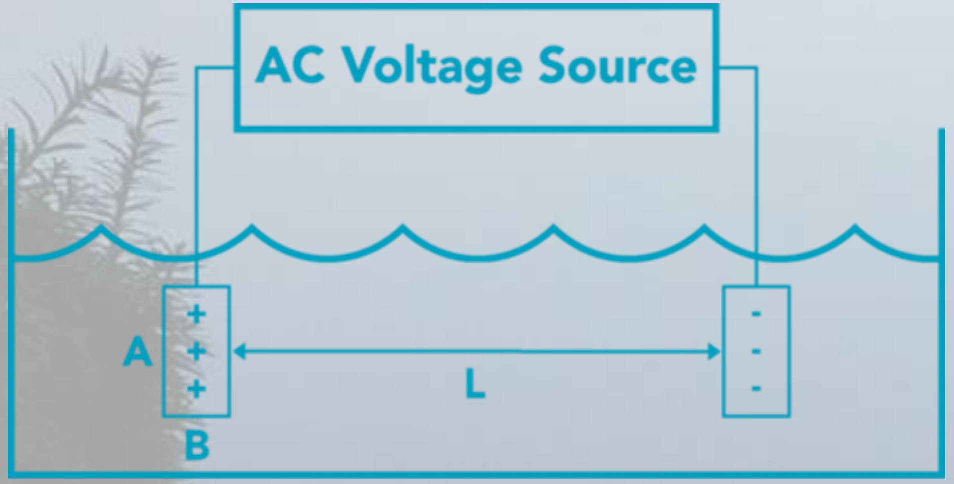
October

Specific Conductance

The specific conductance of lake water is a measure of the resistance of a solution to electrical flow

Greater ionic concentrations = greater specific conductivity

The conductance is expressed in µSiemens cm^{-1} or µS cm^{-1} (previously µmhos cm^{-1}, the reciprocal ohms)



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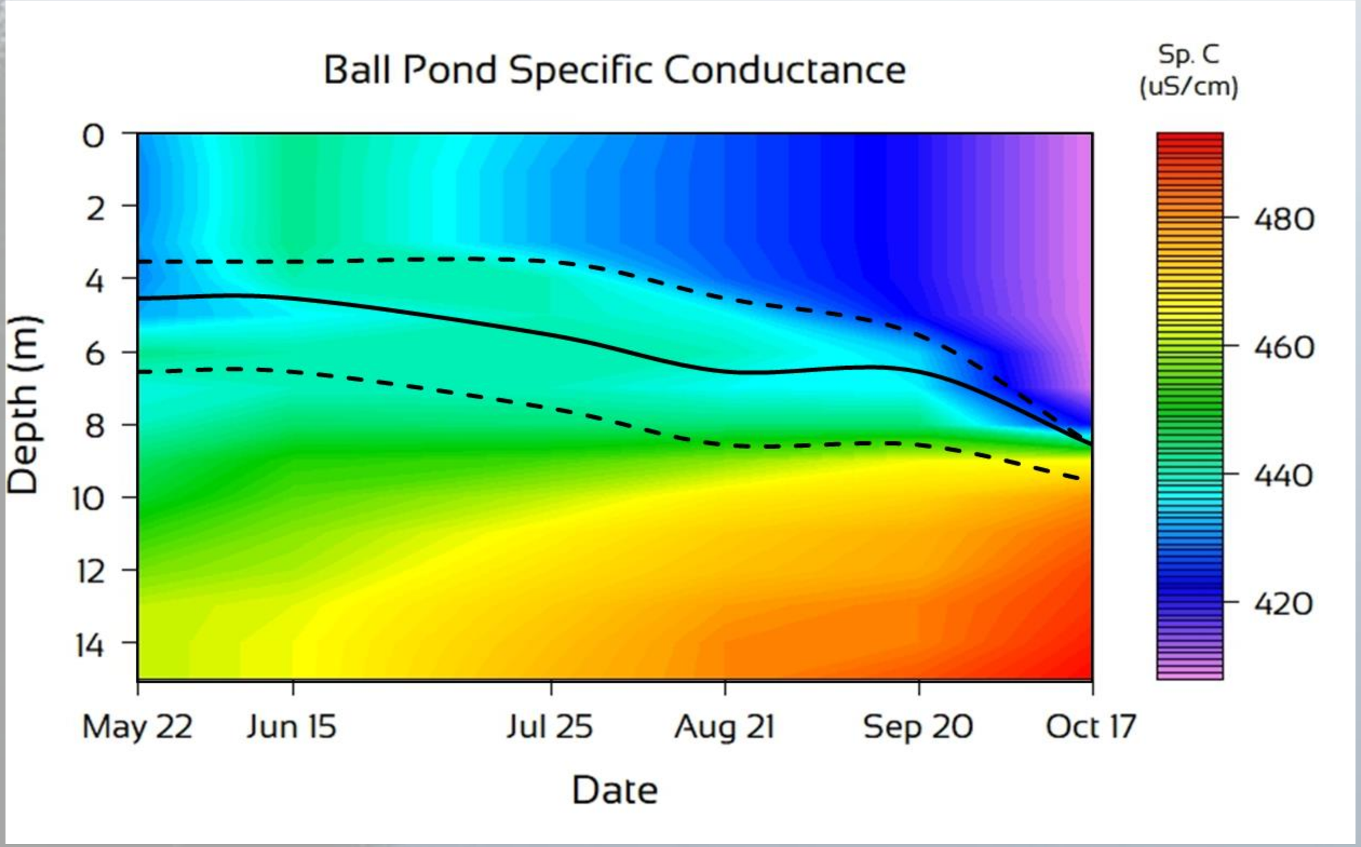
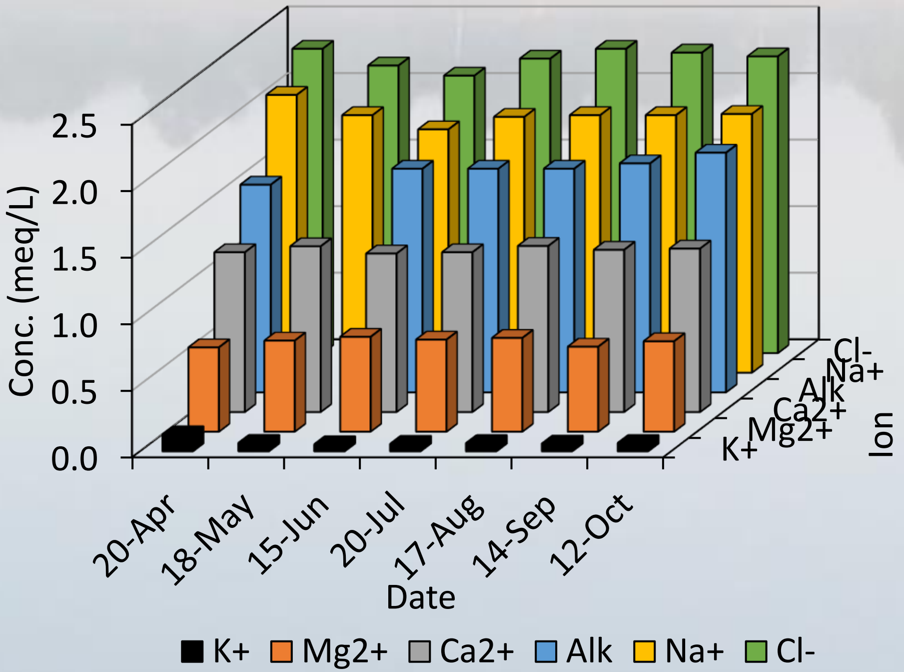
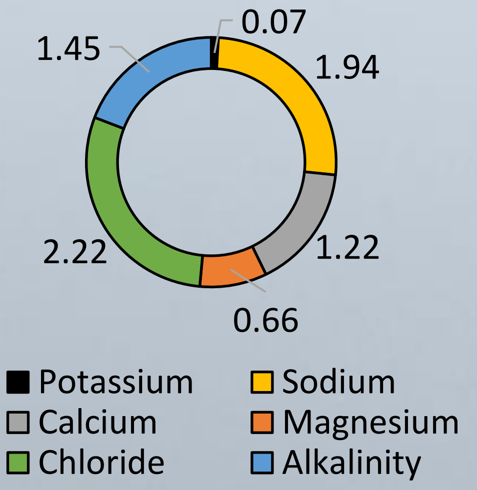
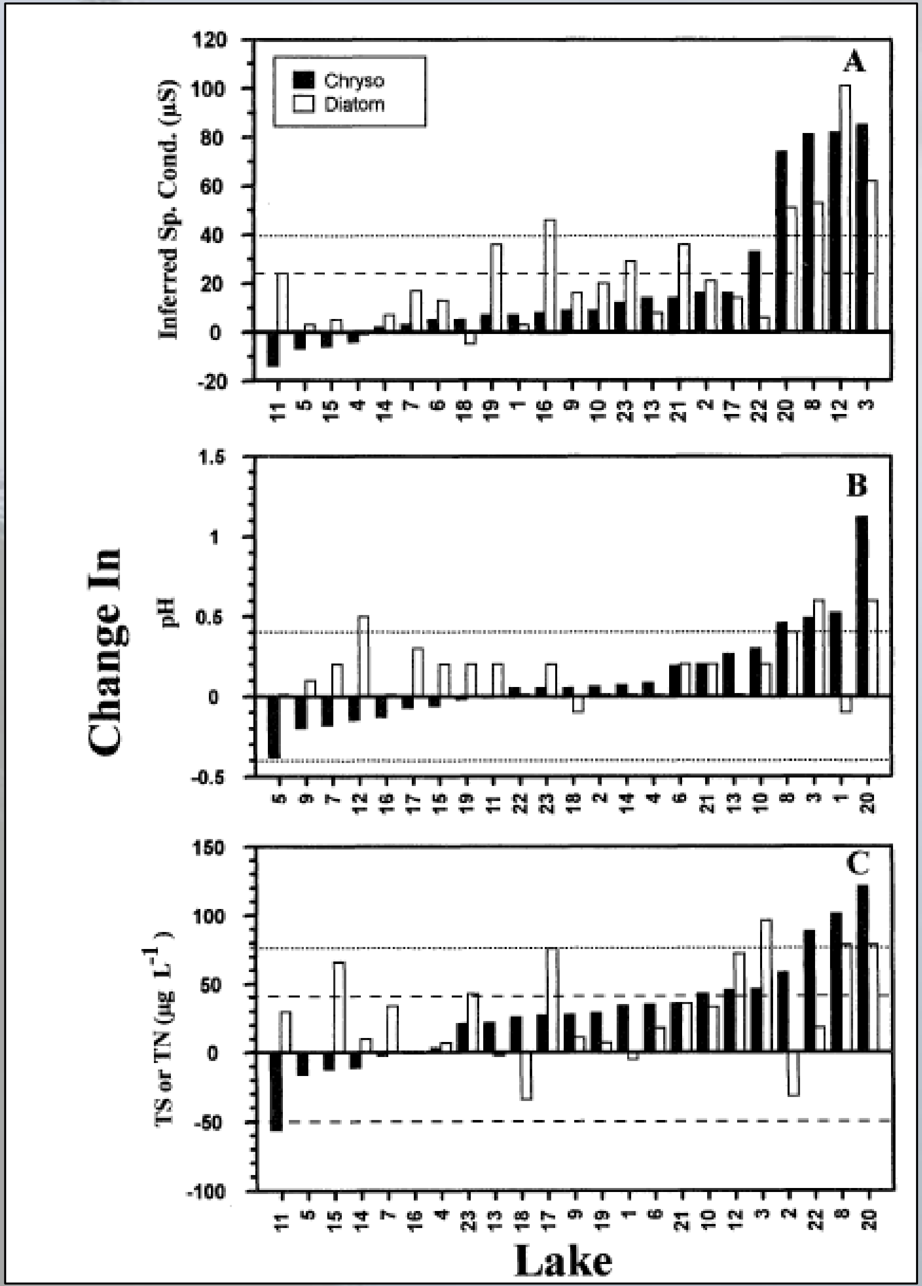
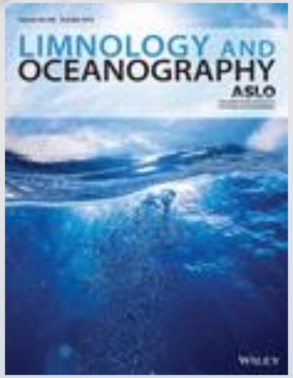








Century Changes in Connecticut, U.S.A., Lakes as Inferred from Siliceous Algal Remains and Their Relationships to Land-Use Change



Peter A. Siver, Anne Marie Lott, Ethan Cash, Jamal Moss and Laurence J. Marsicano. Limnology and Oceanography, Vol. 44, No. 8 (Dec., 1999), pp. 1928-1935

Fig. 1. A comparison of 100-yr changes in inferred specific conductivity (A), pH (B), trophic score (C), and total nitrogen (C) of 23 Connecticut lakes based on scaled chrysophyte (solid bars) and planktonic diatom (open bars) remains. Both organismal groups were used to infer specific conductivity and pH; however, only scaled chrysophytes or planktonic diatoms were used to infer trophic score and total nitrogen, respectively. In each panel, lakes are arranged in ascending order based on inferences made with scaled chrysophytes. Lake numbers refer to those listed in Table 1. Small or large dashed horizontal lines represent changes equal in magnitude to the RMSEboot, for the diatom or scaled chrysophyte models, respectively. For models with similar RMSEboot values only a small dashed line is shown. Note that for some lakes a given change in the inferred value of a parameter may be zero. TS = trophic score and TN = total nitrogen.

Table 4. Comparisons of the 2021, 2022, 2023 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 except for Secchi transparency were from samples collected at 1 meter depth.

Parameter	Units	Ball Pond				Marble Valley			Western Uplands			60 Lake Set		
		2023 Means	2022 Means	2021 Means	1993 Means	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		13	34	22	27	42	31	10	57	33	9	334	33
Chlorophyll-*a*	µg/L		6.8	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	2.6	2.7	2.4	2.6	2.0	4.9	3.3	1.7	7.6	3.5	0.9	7.6	3.3
pH	SU	8.8	8.9	9.0	8.7	7.8	8.3	8.2	4.6	8.1	7.2	4.6	8.8	7.1
Sp. Conductivity	µS/cm	427	413	417	283	180	317	258	25	188	96	24	317	102
Alkalinity	mg/L		84	82	64	54.5	120.5	90	23.7	44	21	0	120.5	14.5
Chloride (Cl^-)	mg/L	80.2	77.6	---	42.2	3.2	42.2	21.3	0.7	24.1	9.2	0.7	42.2	10.3
Calcium (Ca^{2+})	mg/L	22.5	24.4	24.1	19.7	16.6	28.8	22.8	2.8	11.4	6.8	1.2	28.8	7.6
Magnesium (Mg^{2+})	mg/L	7.8	8.1	---	6.6	5.9	15.2	9.8	1	5.2	4.1	0.2	15.2	2.5
Sodium (Na^+)	mg/L	39.9	44.6	---	24.6	2.5	24.6	13.1	1.4	10.4	5.3	1.4	24.6	6.9
Potassium (K^+)	mg/L	2.4	2.7	---	2.7	1.2	2.7	1.9	0.2	0.9	0.5	0.4	2.7	1.2

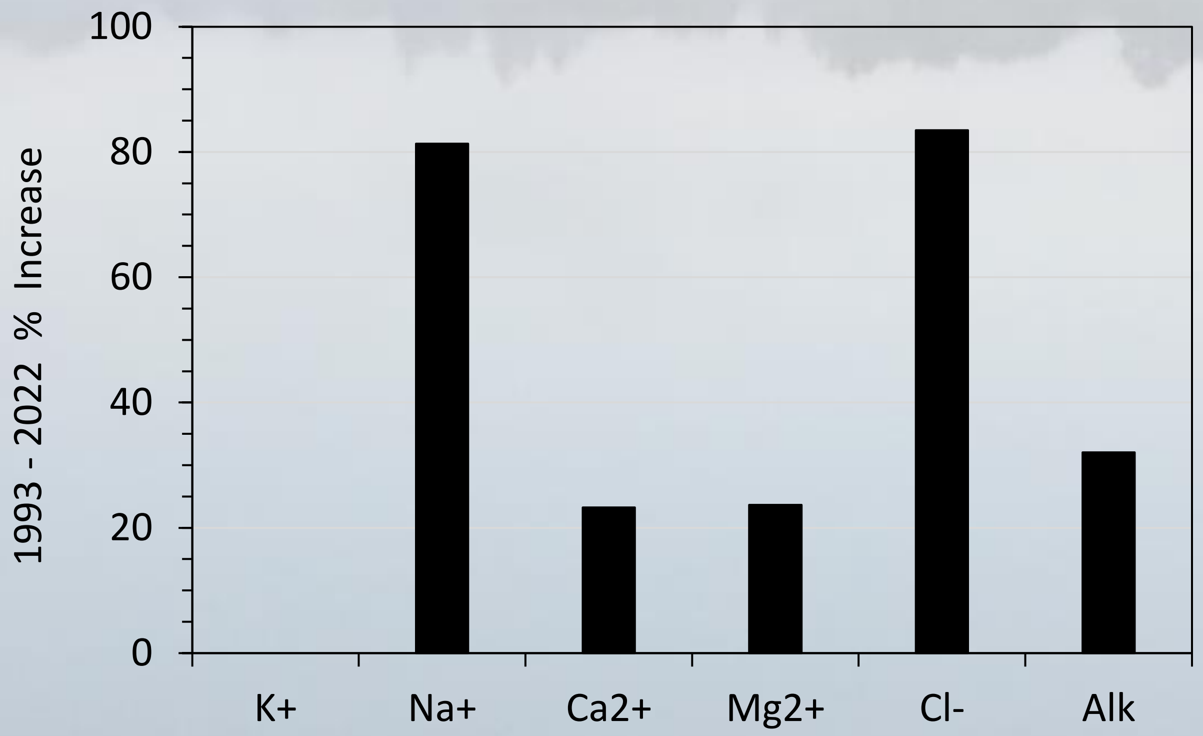
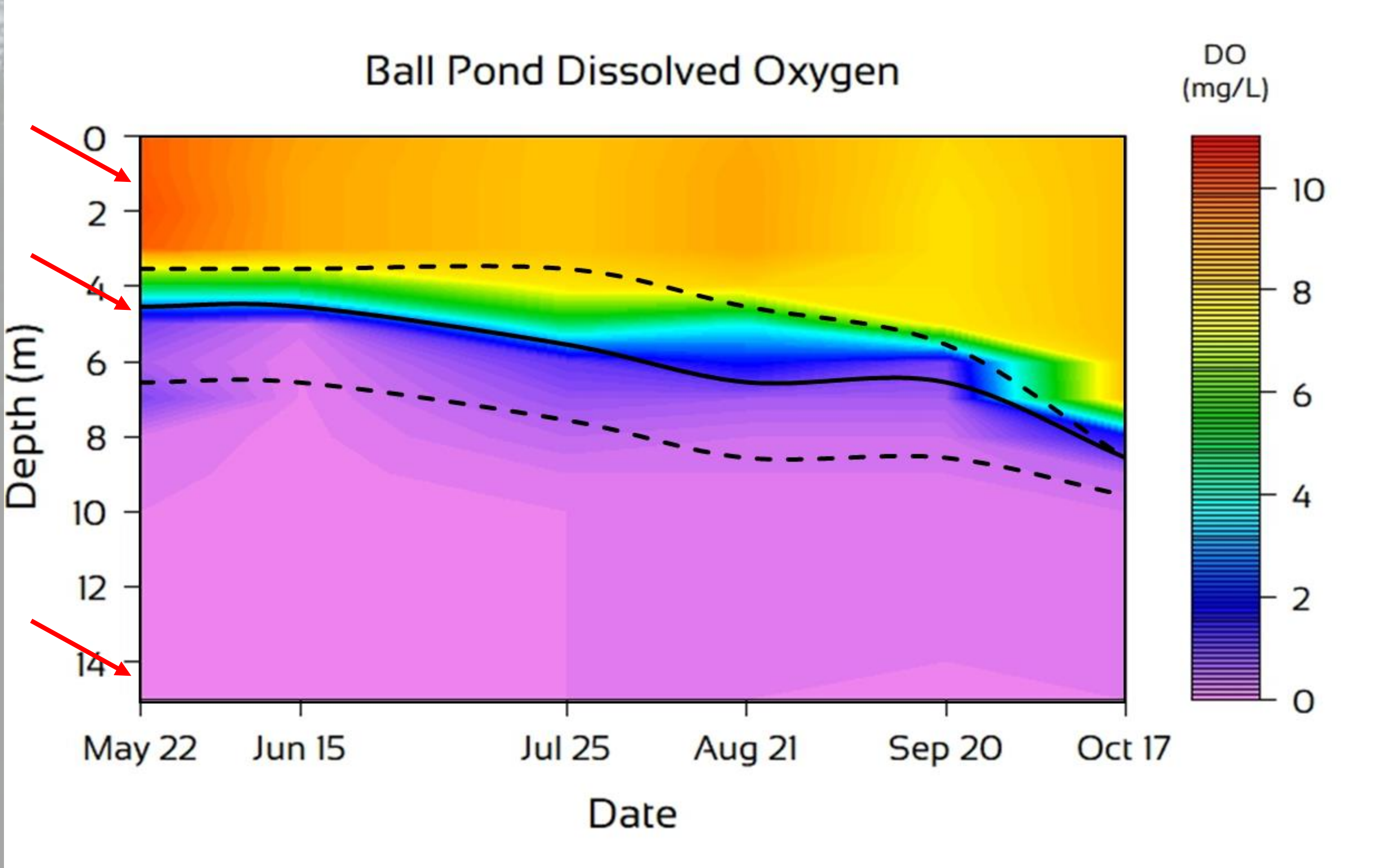
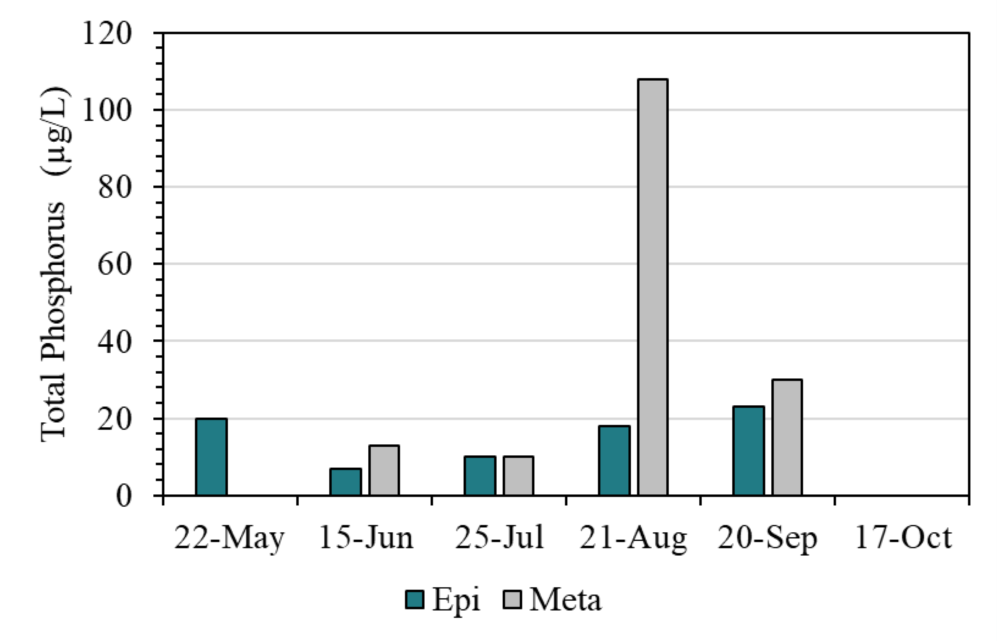


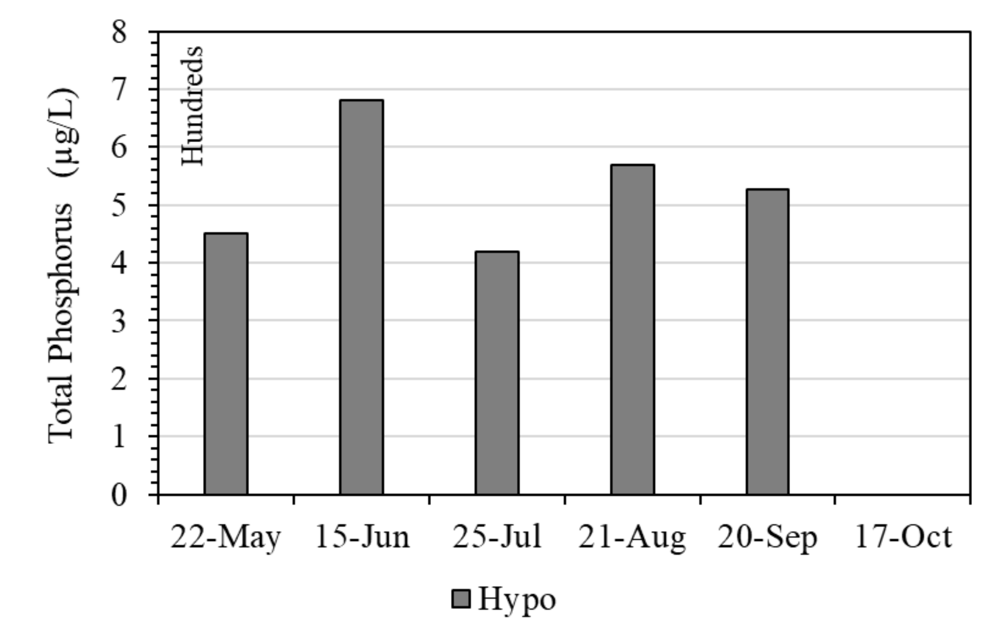
Figure 19. Percent increase in base cation, chloride, and alkalinity anions from 199.3 to 2022. K+ = potassium; Na+ = sodium; Ca2+ = calcium; Mg2+ = magnesium; Cl- = chloride; and Alk = alkalinity anions.

Total Phosphorus

Most often the "limiting nutrient" for algae growth.







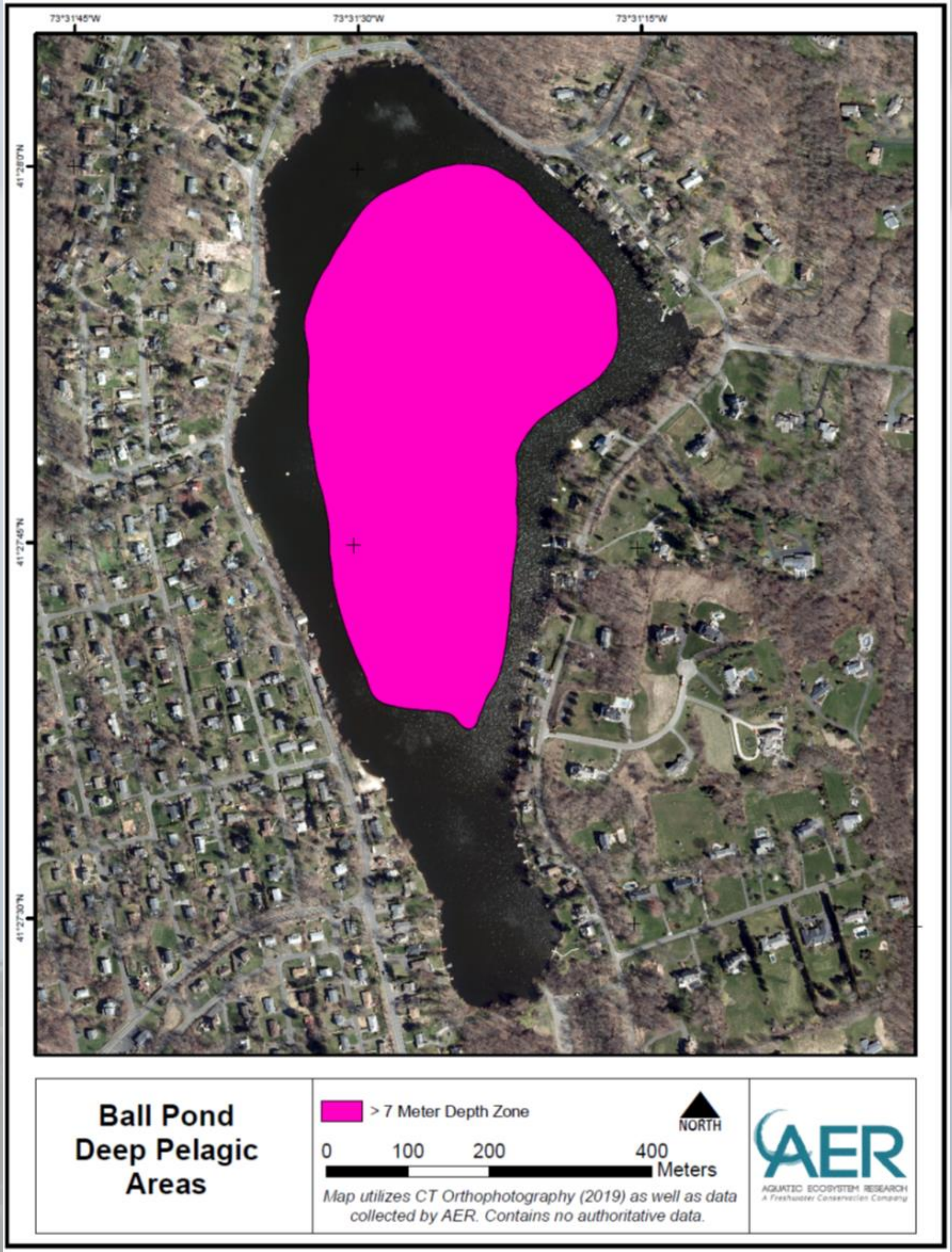
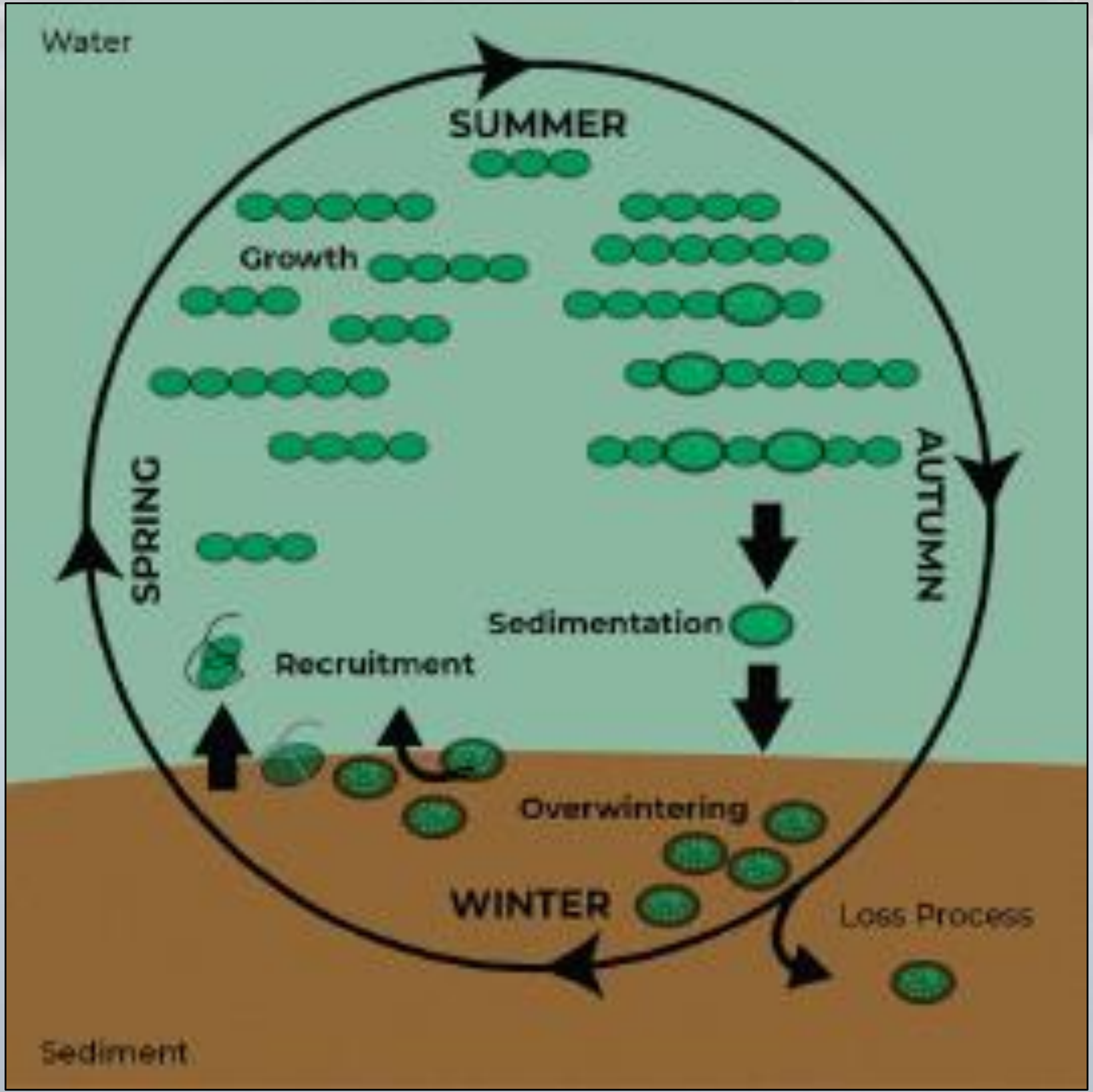


Figure 16. Area of the bottom of Ball Pond located in waters 7 meters deep or deeper. That total area is 42.8 acres.



Reactive vs Proactive Treatment

Shoreline Cyano Blooms

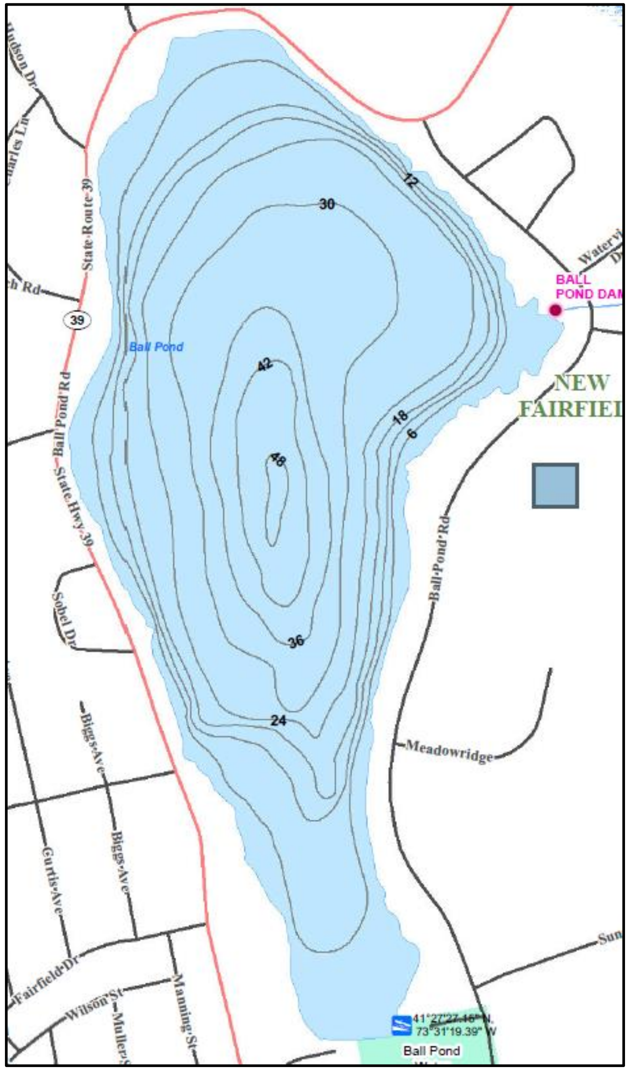
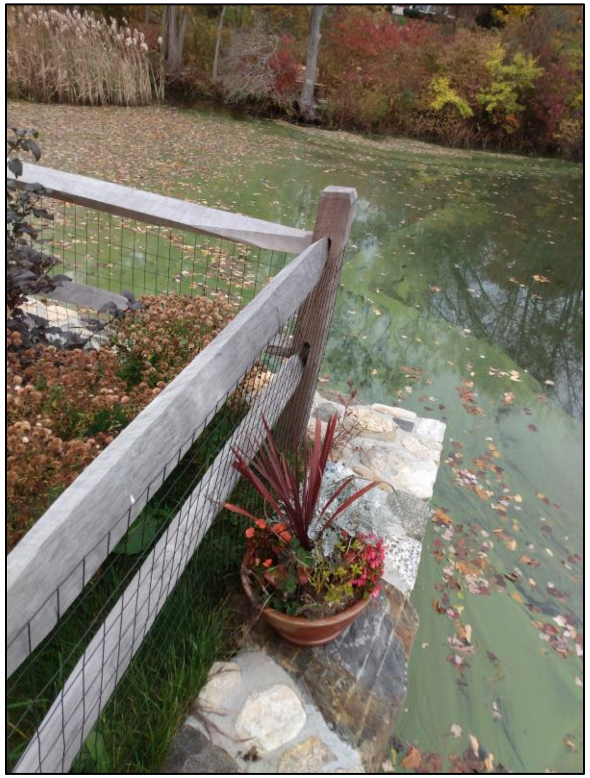
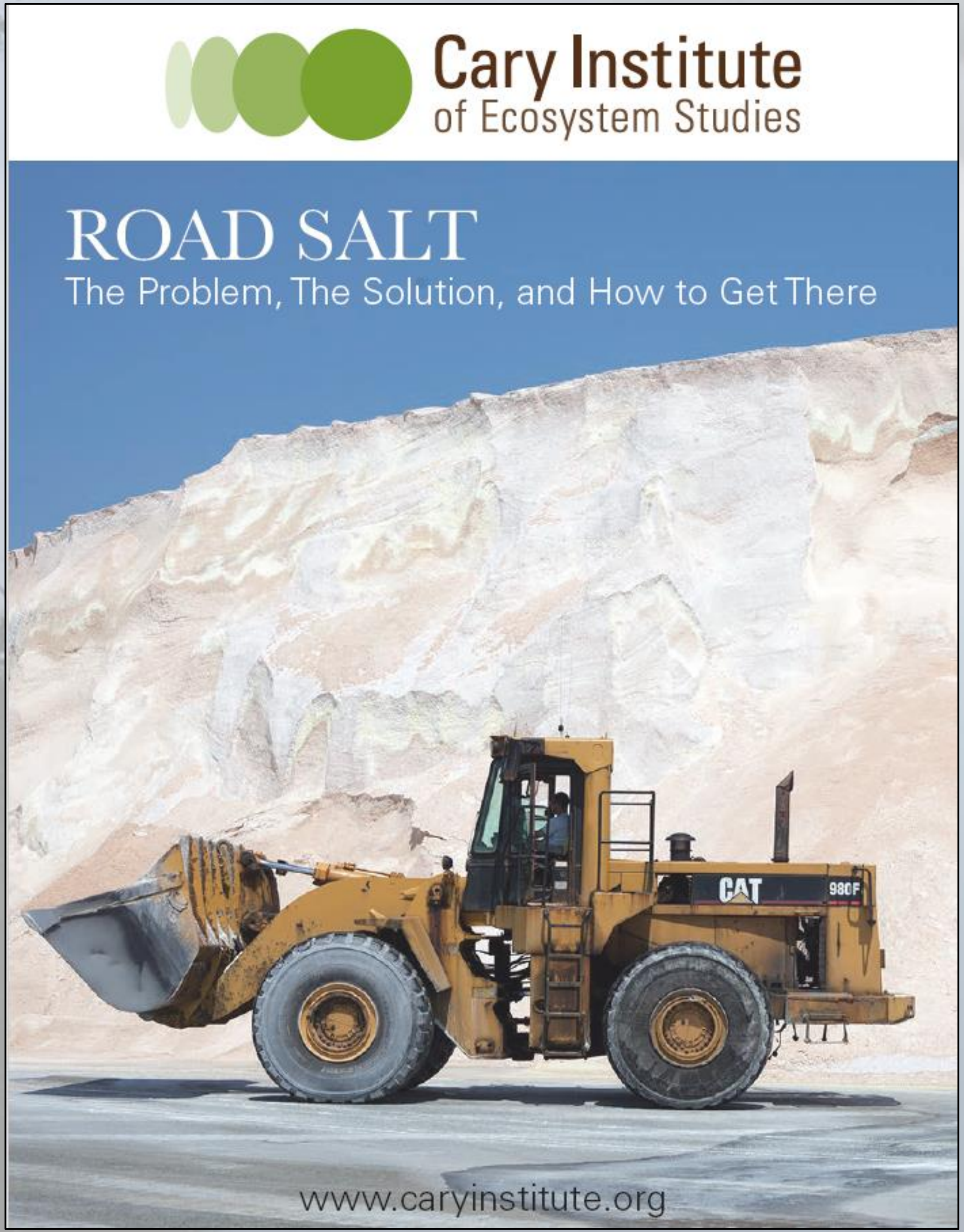


Photo credits:
Elissa Johnson

September



October



https://www.caryinstitute.org/news-insights/road-salt-problem-solution-and-how-get-there-report

Biology

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Department
- Lake Symposia
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Lake Symposia

A Fall Science at Night seminar series for the public, students, and scientists interested in local lake conservation and management.

Based on the conversation started in 2019, stakeholders will be able to understand how they can help prioritize economic interests in Connecticut Lakes.

Co-sponsored by Connecticut Federation of Lakes

View the **2023 Lake Symposium** information here: https://www.wcsu.edu/biology/lake-symposium-2023/

2023 Lake Symposia Series Recordings

PAST SYMPOSIA

Lake Symposium Recordings 2022

Please find below the online recordings from each of the virtual events from this semester.

**Note that recordings are not to be shared unless given permission by the Biology & Environmental Sciences department. Please email biochair@wcsu.edu if you would like to download a copy or ask for permission.

Monday, Oct. 17, 2022 @7 pm (virtual): Fall 2022 Regional Lake Communities Symposium "Salt in Our Lakes"

7:00 pm – Larry Marsicano,Aquatic Ecosystem Research LLC., WCSU Limnology Instructor, Welcome address and speaker introduction

7:15 pm – ***Vicky Kelly, Manager, Environmental Monitoring Program, Cary Institute of Ecosystem Studies***, *"Road Salt, the Problem, the Solution, and How to Get There."*

8:10 pm – Questions from Audience.

8:30 pm – ***Robert Wyant, Highway Superintendent, Rhinebeck NY,*** *"An introduction to available resources and expert support."*

Thank you!

Questions?