Lake Management at Amston Lake

Aquatic Ecosystem Research LLC
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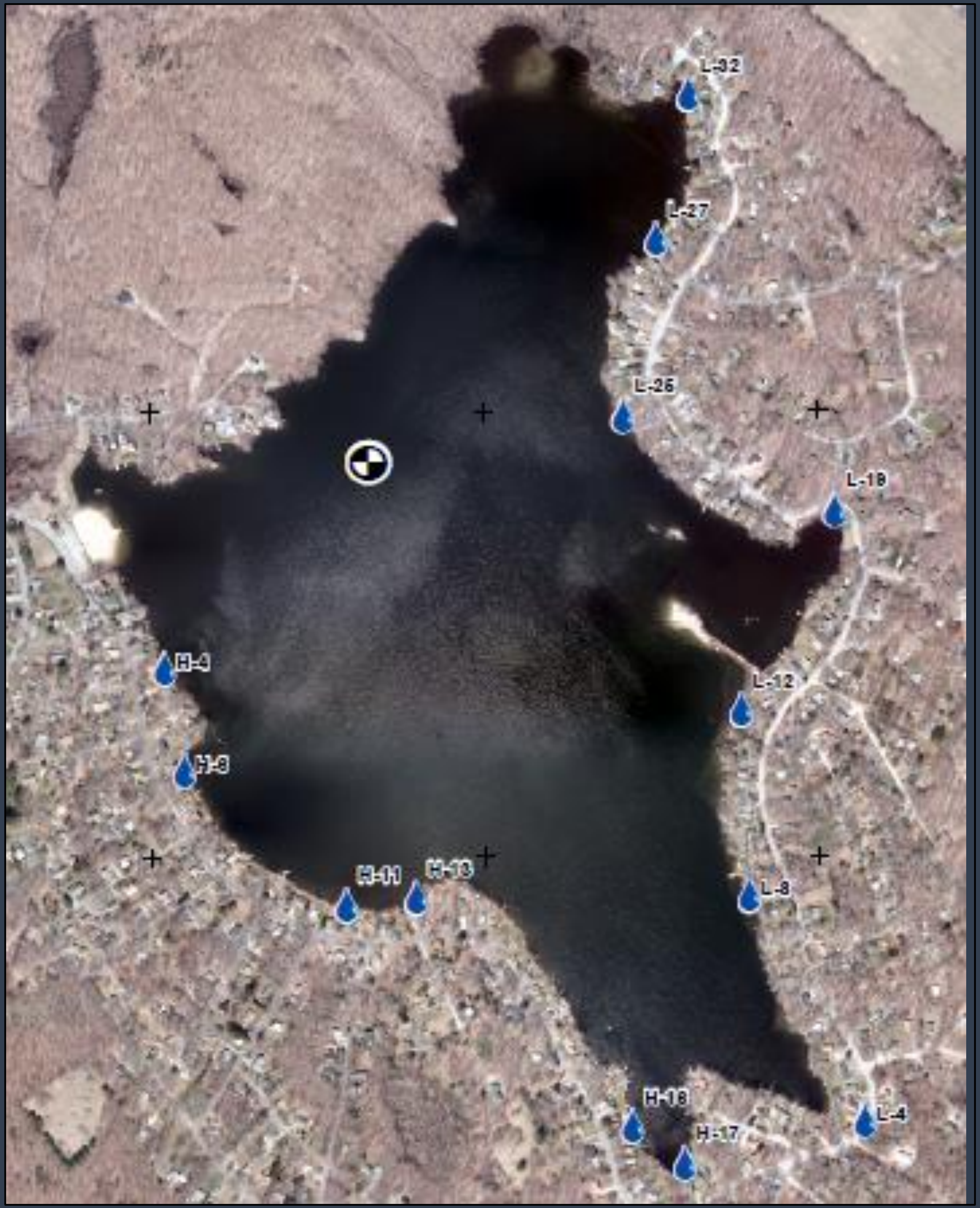
June 26, 2021

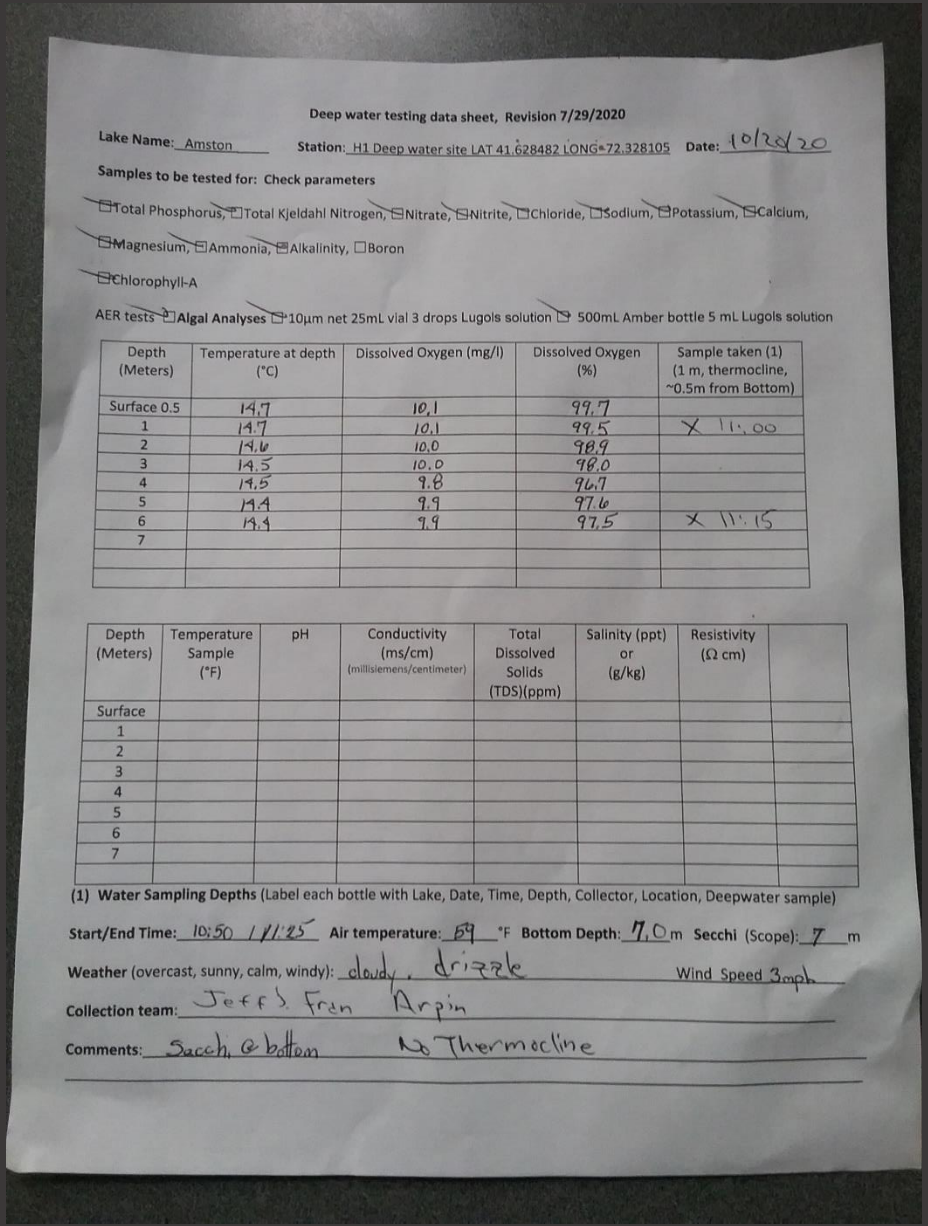
Lake Management at Amston Lake

- Collaboration between ALTD and AER
- 2019, 2020, 2021
- Lake Water Quality Monitoring
- Stormwater Quality Monitoring
- Aquatic Plant Mapping
- Bathymetric Mapping



Water Quality

- Lake Health Committee collect field data and water samples
- Water samples analyzed by Phoenix Environmental Laboratories
- Field data and laboratory results conveyed to AER



Deep water testing data sheet, Revision 7/29/2020

Lake Name: Amston **Station:** H1 Deep water site LAT 41.628482 LONG-72.328105 **Date:** 10/20/20

Samples to be tested for: Check parameters

☐Total Phosphorus, ☐Total Kjeldahl Nitrogen, ☐Nitrate, ☐Nitrite, ☐Chloride, ☐Sodium, ☐Potassium, ☐Calcium,

☐Magnesium, ☐Ammonia, ☐Alkalinity, ☐Boron

☐Chlorophyll-A

AER tests ☐**Algal Analyses** ☐10µm net 25mL vial 3 drops Lugols solution ☐ 500mL Amber bottle 5 mL Lugols solution

Depth (Meters)	Temperature at depth (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Sample taken (1) (1 m, thermocline, ~0.5m from Bottom)
Surface 0.5	14.7	10.1	99.7	
1	14.7	10.1	99.5	X 11:00
2	14.6	10.0	98.9	
3	14.5	10.0	98.0	
4	14.5	9.8	96.7	
5	14.4	9.9	97.6	
6	14.4	9.9	97.5	X 11:15
7				

Depth (Meters)	Temperature Sample (°F)	pH	Conductivity (ms/cm) (millisiemens/centimeter)	Total Dissolved Solids (TDS)(ppm)	Salinity (ppt) or (g/kg)	Resistivity (Ω cm)	
Surface							
1							
2							
3							
4							
5							
6							
7							

(1) Water Sampling Depths (Label each bottle with Lake, Date, Time, Depth, Collector, Location, Deepwater sample)

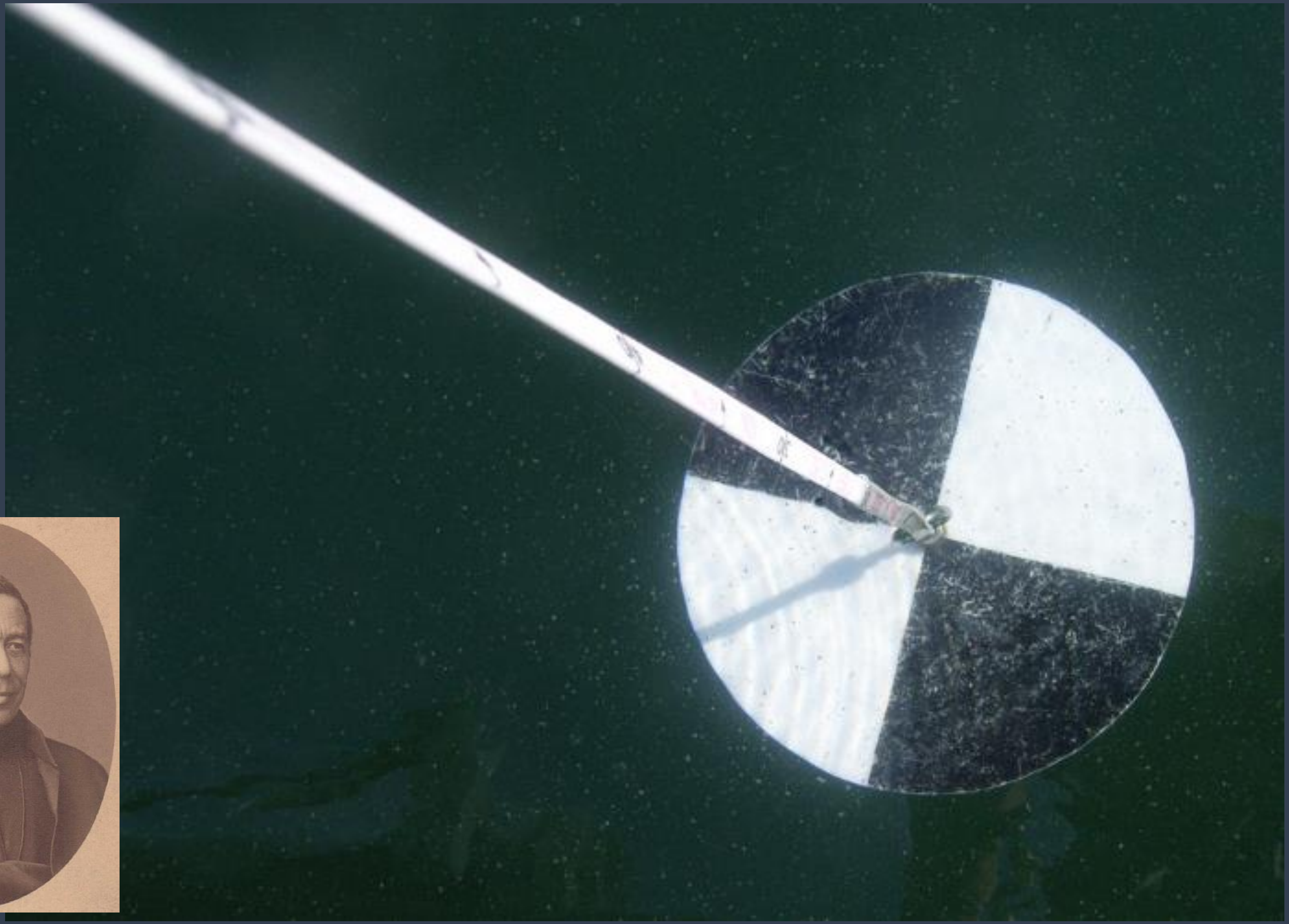
Start/End Time: 10:50 / 11:25 **Air temperature:** 59 °F **Bottom Depth:** 7.0 m **Secchi** (Scope): 7 m

Weather (overcast, sunny, calm, windy): cloudy, drizzle Wind Speed 3mph

Collection team: Jeff S. Fran Arpin

Comments: Secch. @ bottom No Thermocline

Secchi Disk Transparency



Fr. Angelo Secchi
1865

Secchi Disk Transparency

- Generally a 20 cm black and white disk.
- Secchi disk devised in 1865 by Fr. Secchi
- Estimates transparency
- Centimeters to 40m
- 10% of surface light

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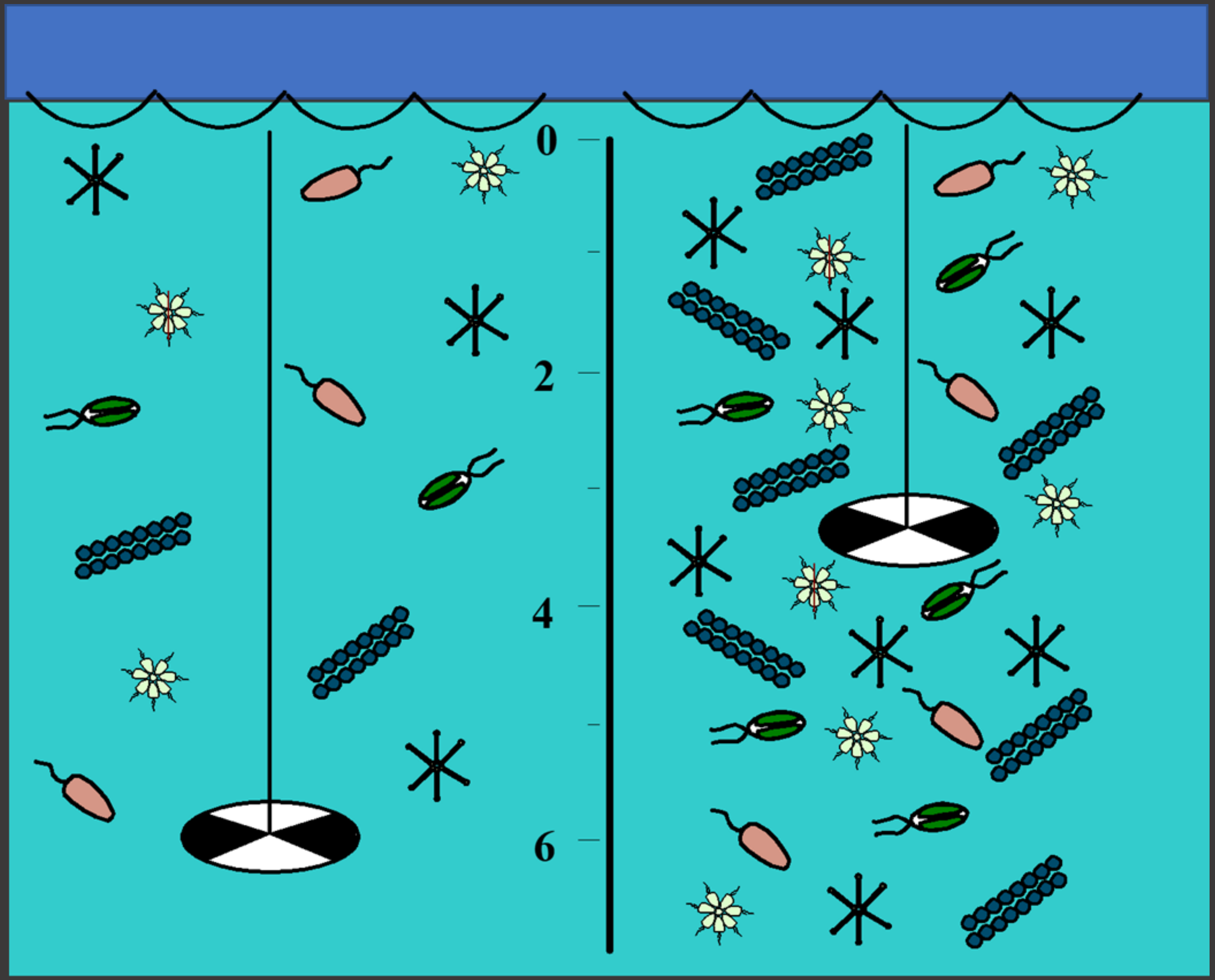
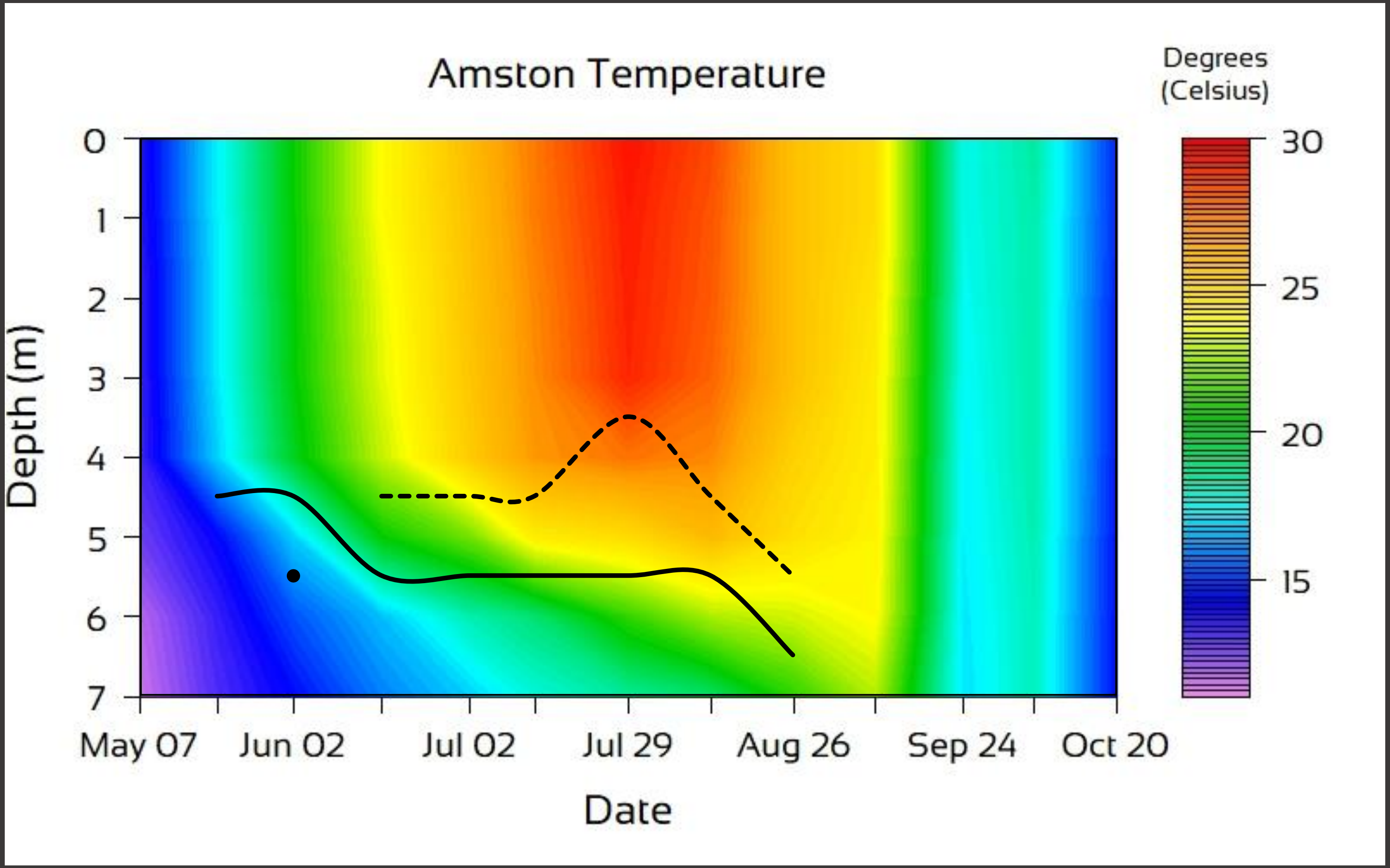


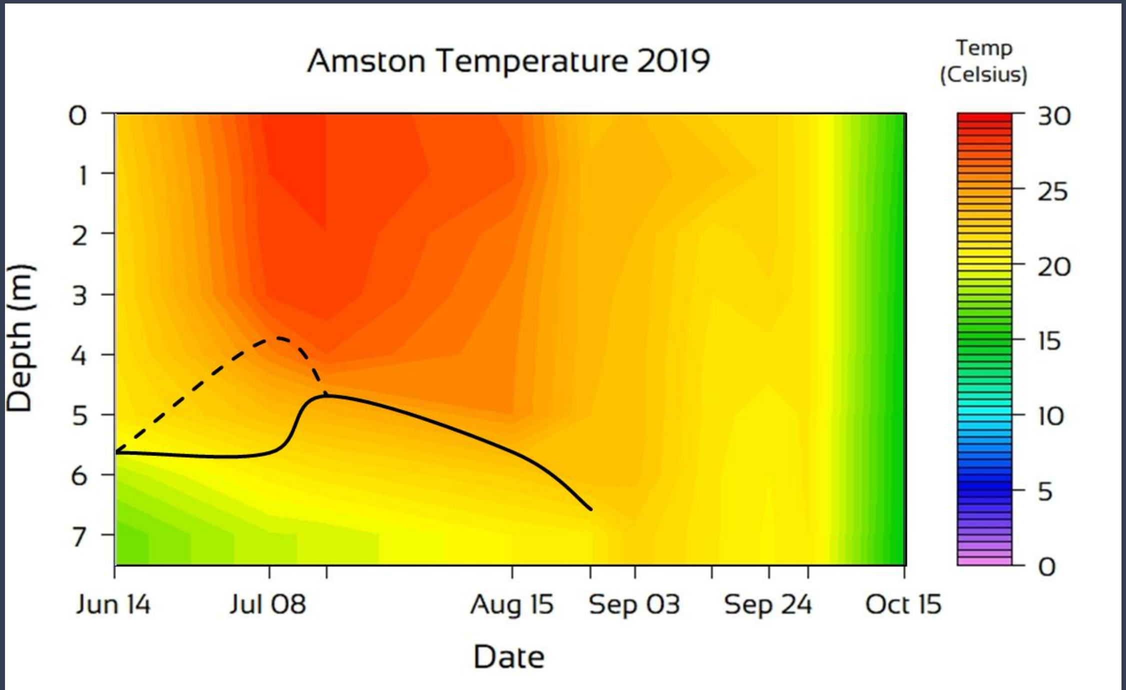
Chlorophyll-*a*

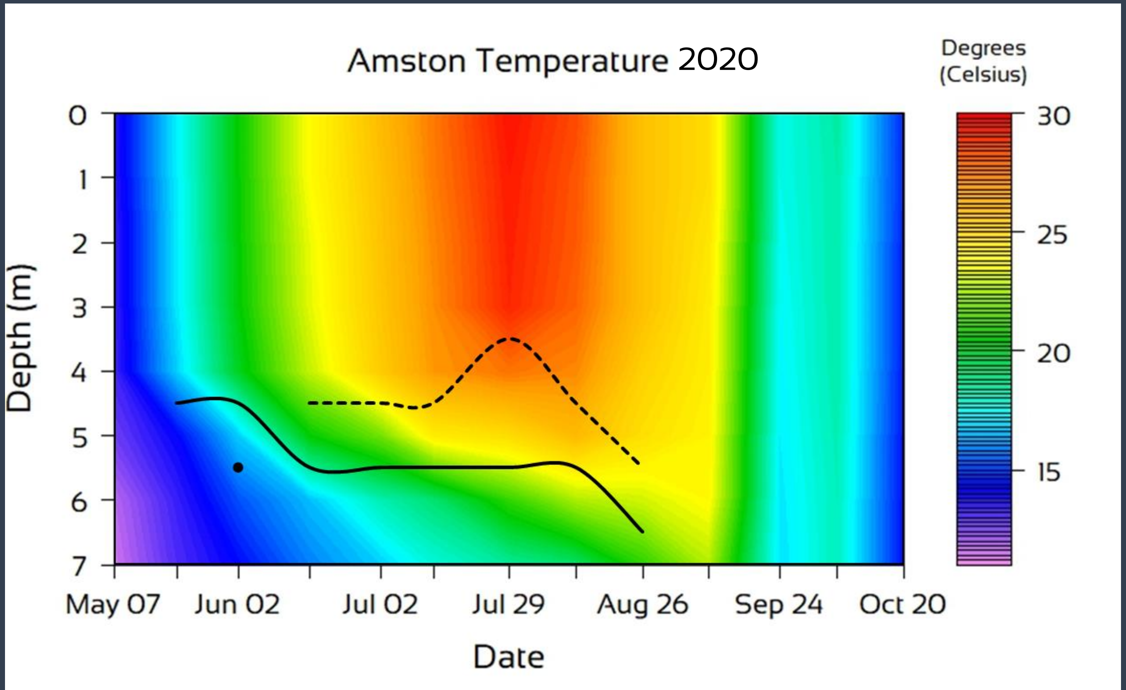
- Photosynthetic pigment common to all algae
- Used to characterize trophic level, as is Secchi transparency
- Should be a good correlation with Secchi transparency

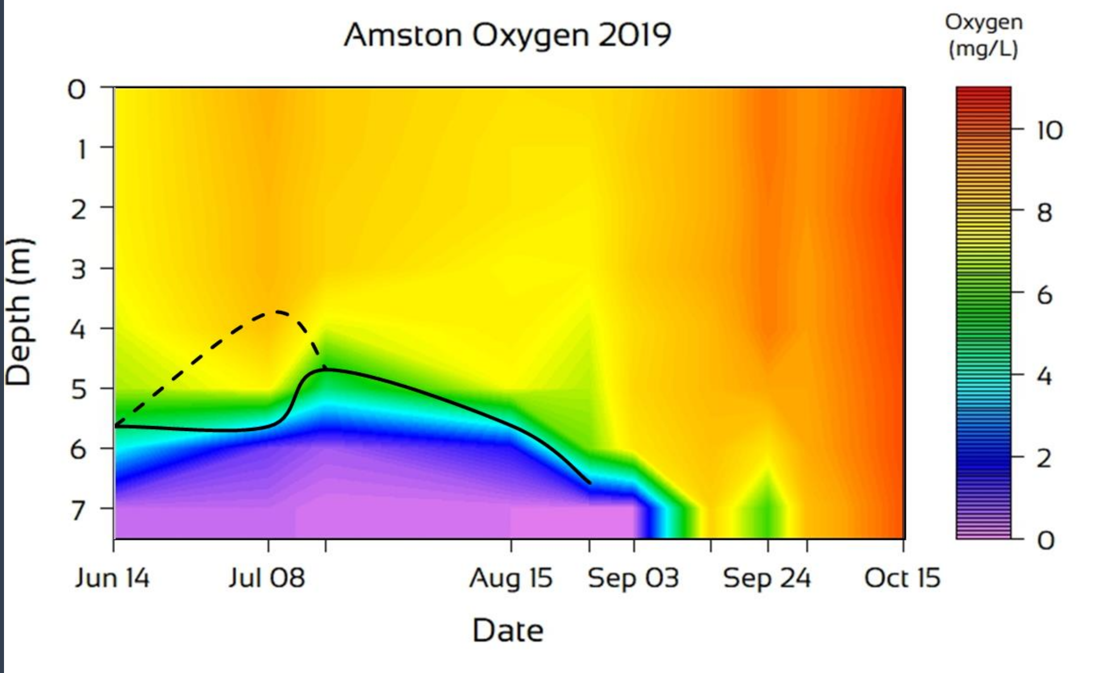
Thermal Structure

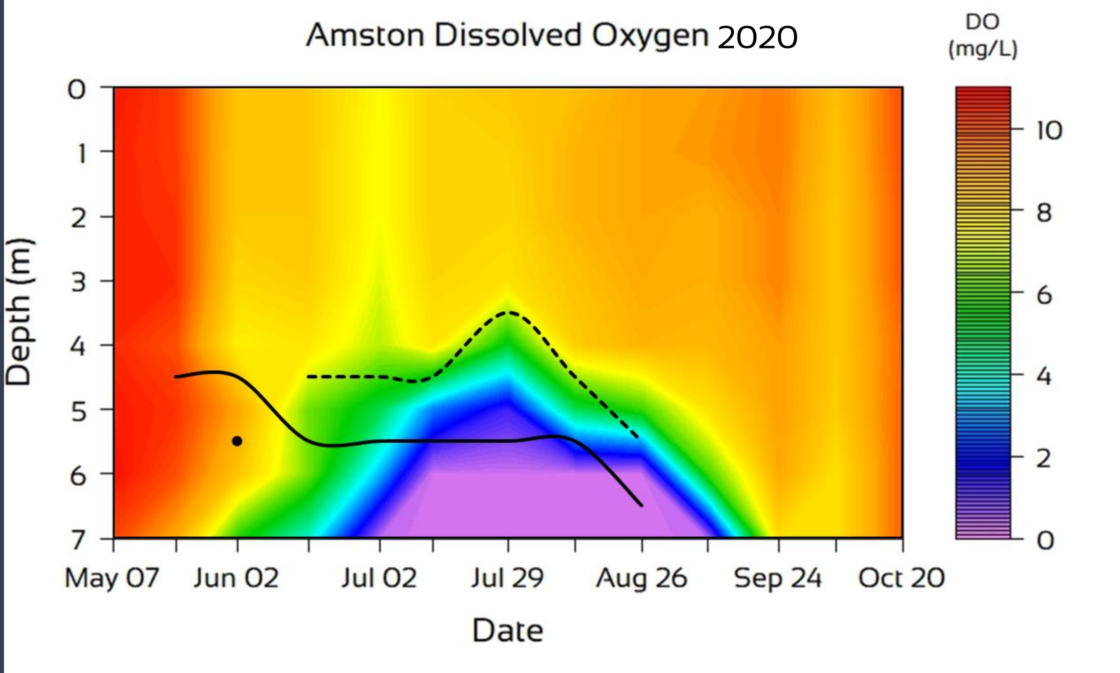
- Temperature/density gradients in water column create resistance to mixing among different strata
- Plane of greatest resistance to mixing is the thermocline
- Prevents diffusion of oxygen to lower depths




Amston Temperature 2019
Temp (Celsius)
Depth (m)
0
1
2
3
4
5
6
7
Jun 14
Jul 08
Aug 15
Sep 03
Sep 24
Oct 15
Date
30
25
20
15
10
5
0


Amston Temperature 2020
Degrees (Celsius)
Depth (m)
0
1
2
3
4
5
6
7
May 07
Jun 02
Jul 02
Jul 29
Aug 26
Sep 24
Oct 20
Date
30
25
20
15


Amston Oxygen 2019
Oxygen (mg/L)
Depth (m)
0
1
2
3
4
5
6
7
Jun 14
Jul 08
Aug 15
Sep 03
Sep 24
Oct 15
Date
10
8
6
4
2
0


Amston Dissolved Oxygen 2020
DO (mg/L)
Depth (m)
0
1
2
3
4
5
6
7
May 07
Jun 02
Jul 02
Jul 29
Aug 26
Sep 24
Oct 20
Date
10
8
6
4
2
0

What happens at the bottom when oxygen is depleted?

Kortmann, R. 2015. Cyanobacteria in Reservoirs: Causes, Consequences, Controls. NEW ENGLAND WATER WORKS ASSOCIATION. 129(2):73-90

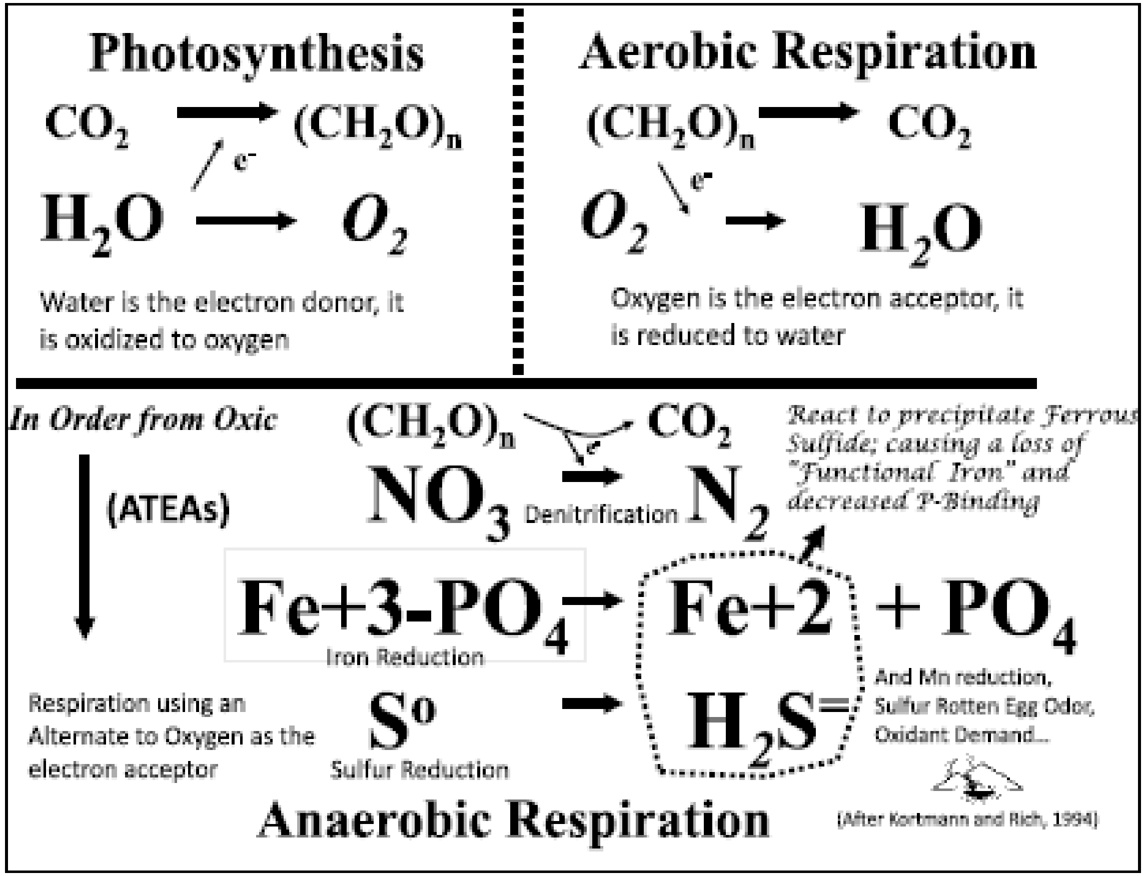
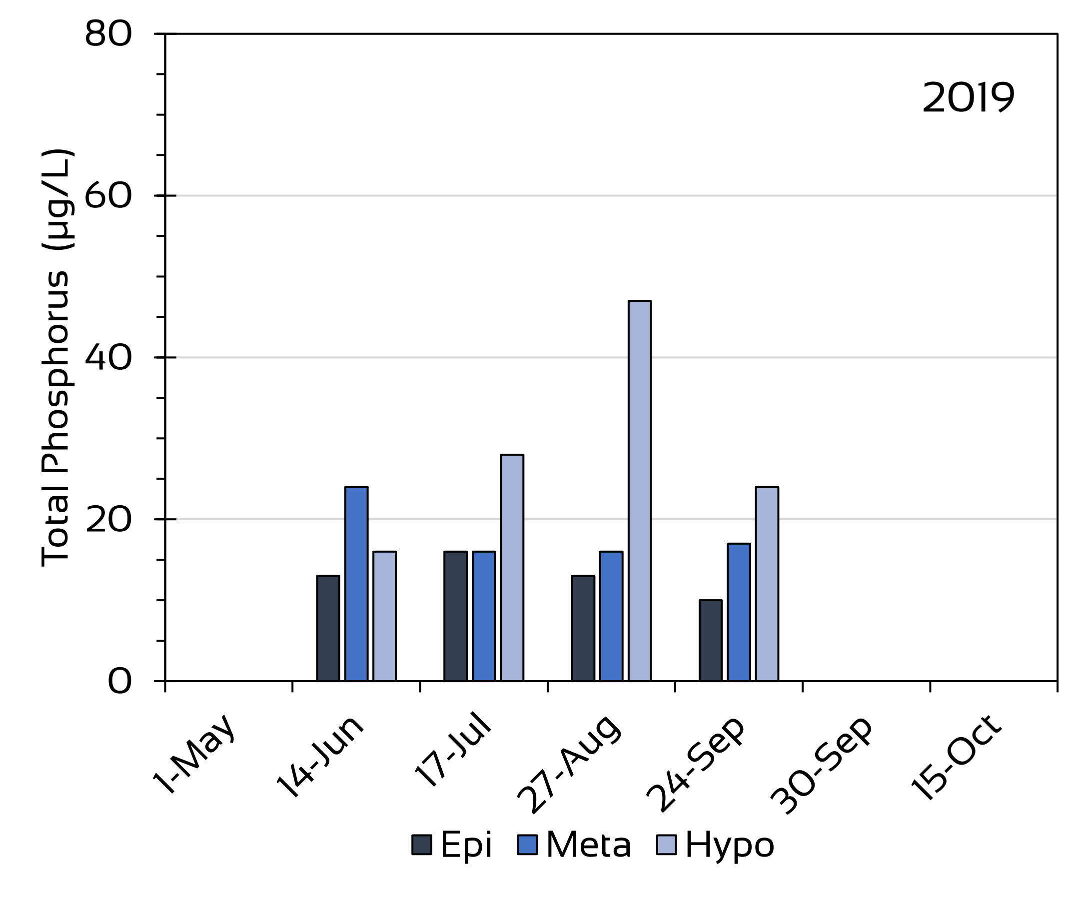
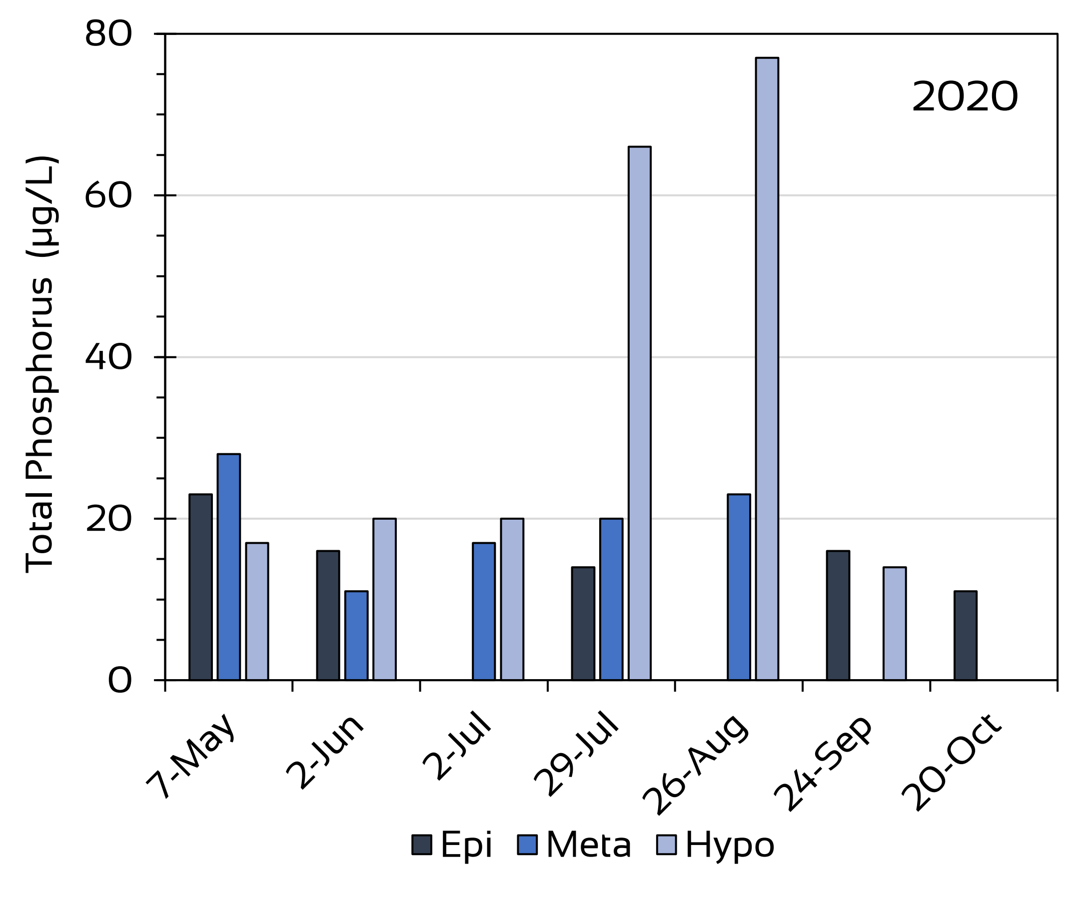


Figure No. 5 Important Biological Processes in Source Water Reservoirs.

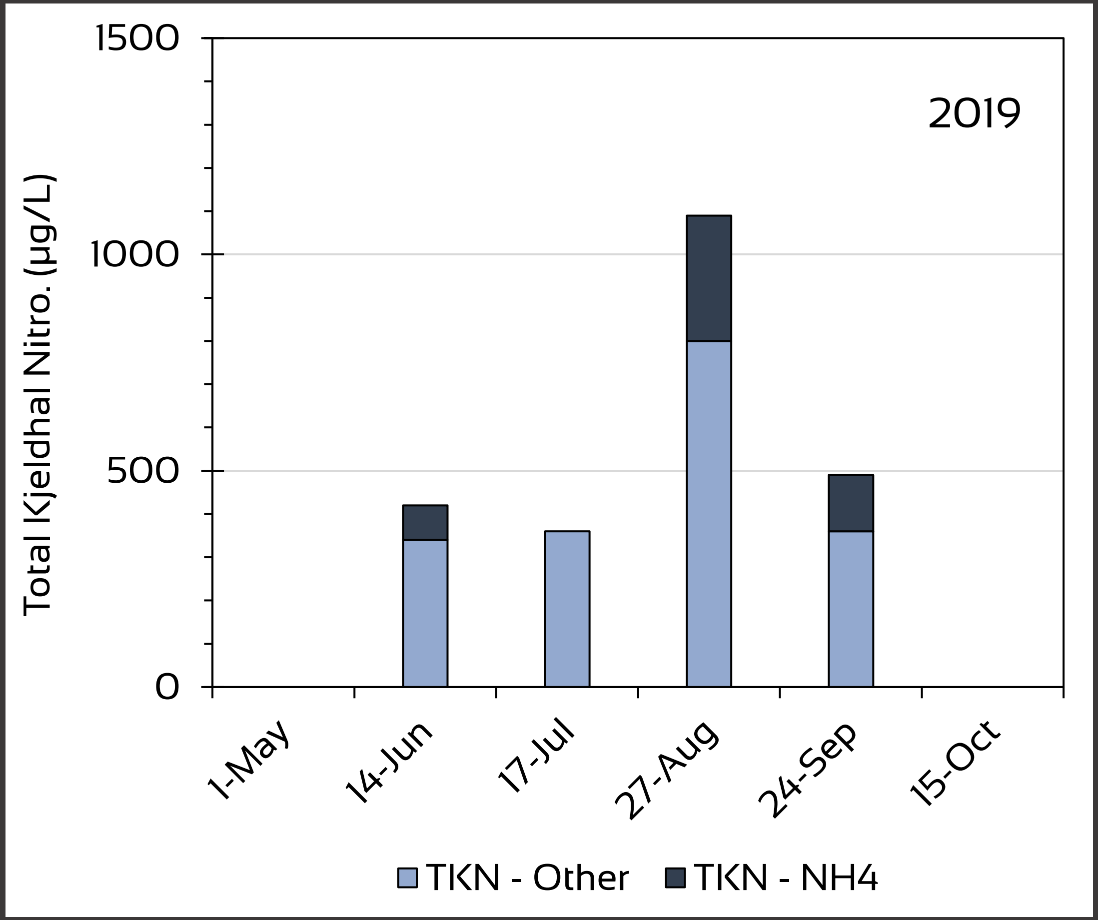
Phosphorus – The "Limiting" Nutrient

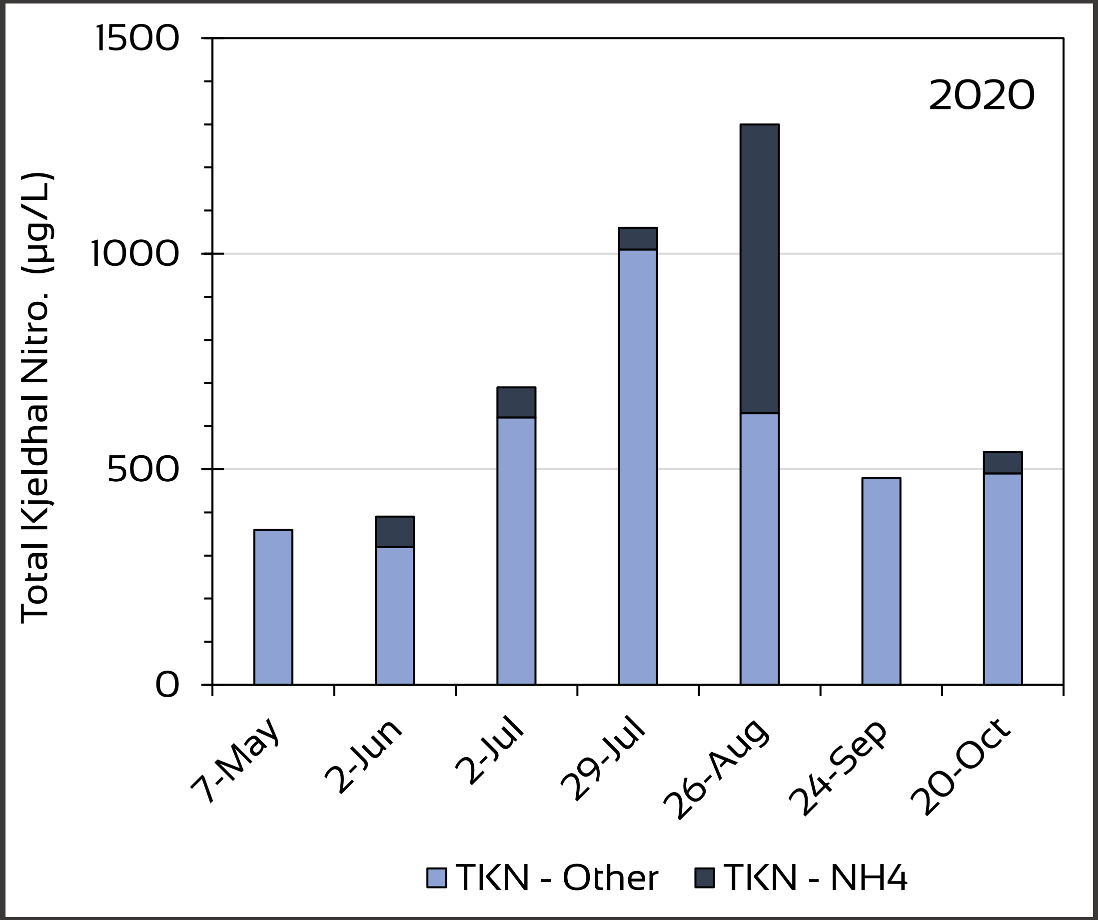




Water column depth: Epilimnion = top; Metalimnion = middle (near thermocline); Hypolimnion = bottom.
Hypolimnetic total phosphorus increases after protracted period of anoxia at near bottom

Nitrogen in the Hypolimnion





Nitrogen in the hypolimnion (at the bottom). The ammonia constituent of the total amount of nitrogen Increases after protracted period of anoxic conditions at the bottom.

Algal Community

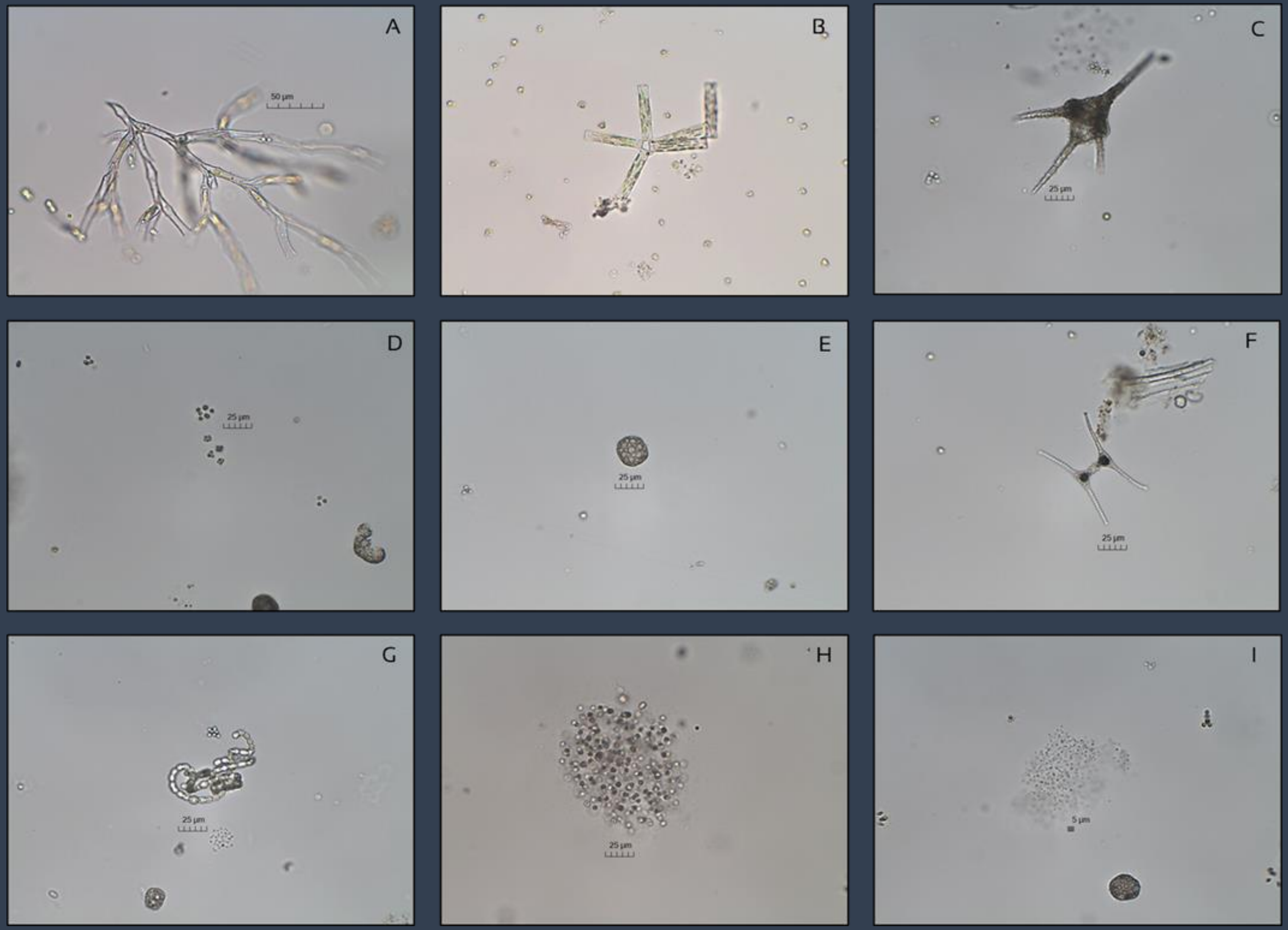


Figure 12. Micrographs of algae specimens taken from Amston Lake samples in 2020. A. The Golden Algae *Dinobryon spp*.; B. the Diatom *Tabellaria spp*.; C. the Dinoflagellate *Ceratium spp*.; the Green Algae D. *Gloeocystis spp*., E. *Coelastrum spp*., and F. *Staurastrum spp*.; the Cyanobacteria G. *Dolichospermum spp*., H. *Microcystis spp*., and I. *Aphanocapsa spp*.

Algal Community

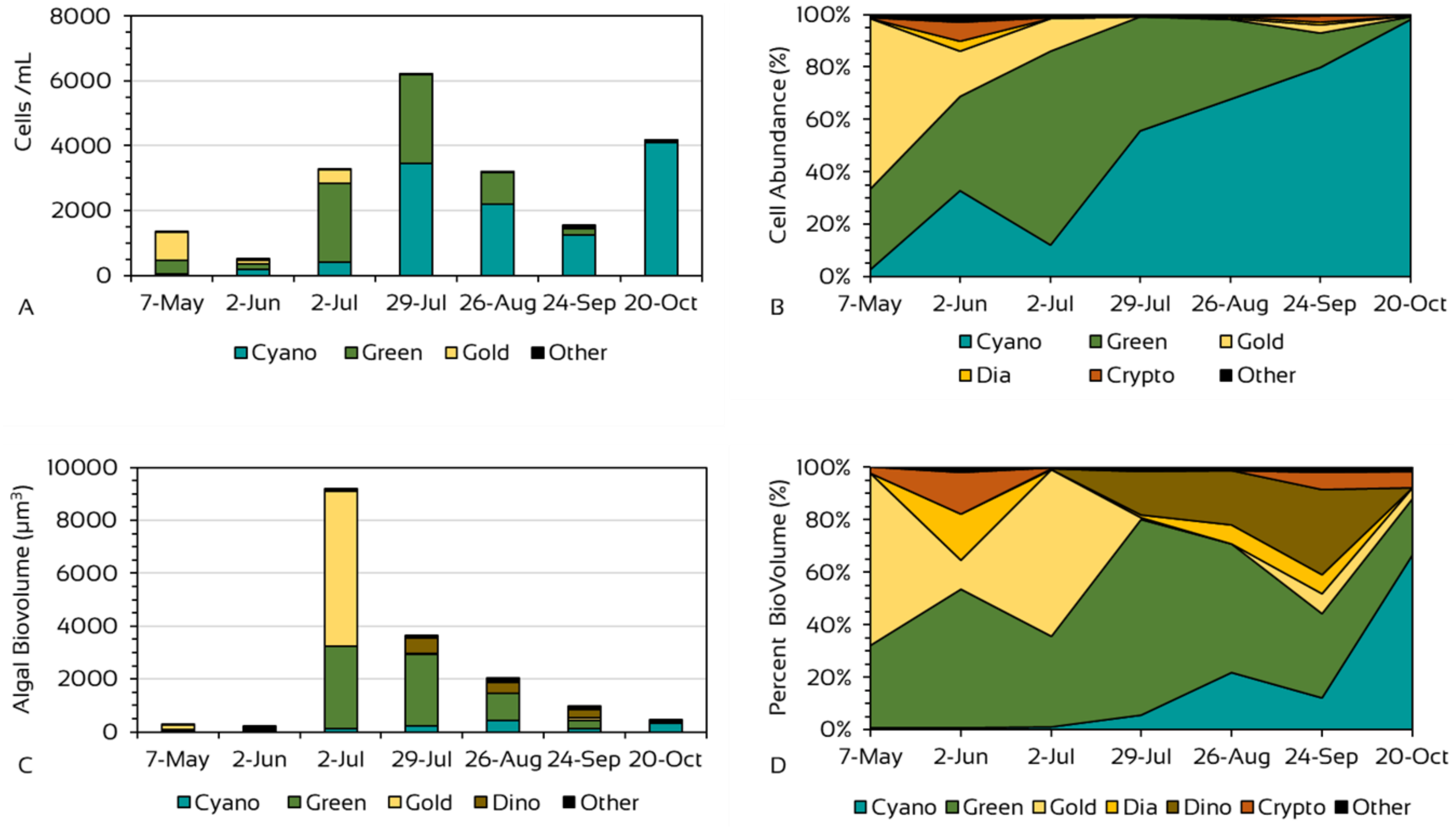


Figure 11. A – algal cell concentrations by taxa and date; B – relative abundances of cells by taxonomic group and date; C – algal biovolume by taxonomic group and date; and D – percent biomass by taxonomic group and date. Cyanobacteria = Cyano, Green = Green Algae or Chlorophyta, Gold = Golden Algae or Chrysophyta, Dia = Diatom or Bacillariophyta, Dino = Dinoflagellate or Pyrrhophyta, Crypto = Cryptophyta

Trends in Lake and Stormwater Water Quality

- Multiple Linear Regression
  - Assessed significant change, if any, based on combinations of variables since 1994
  - For the lake, applied to variables in epilimnion, hypolimnion, and combination of both
  - For stormwater, applied to variables grouped by municipality (Hebron and Lebanon) and collectively

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Table 5. Variables used in Multiple Linear Regression and ANOVA. Spec. Cond. = specific conductance; Total Phos. = total phosphorus

Variable	Lake	Stormwater
Alkalinity	✓	
Ammonia		
Nitrate		✓
pH		
Spec. Cond.	✓	✓
TKN	✓	
Total Phos.*	✓	✓
Turbidity		✓

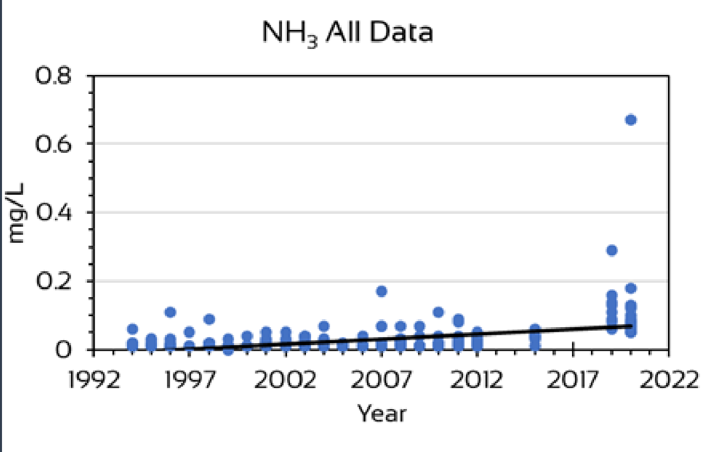
*Total phosphorus was removed from the lake epilimnetic dataset due to lack of variance

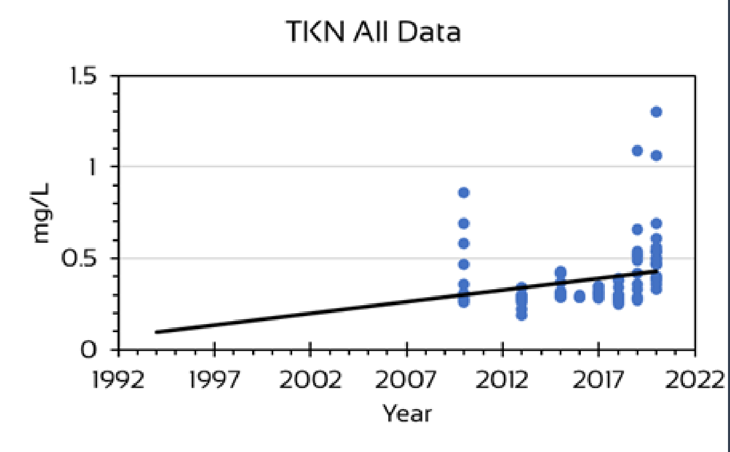
Are the Systems Significantly Changing?

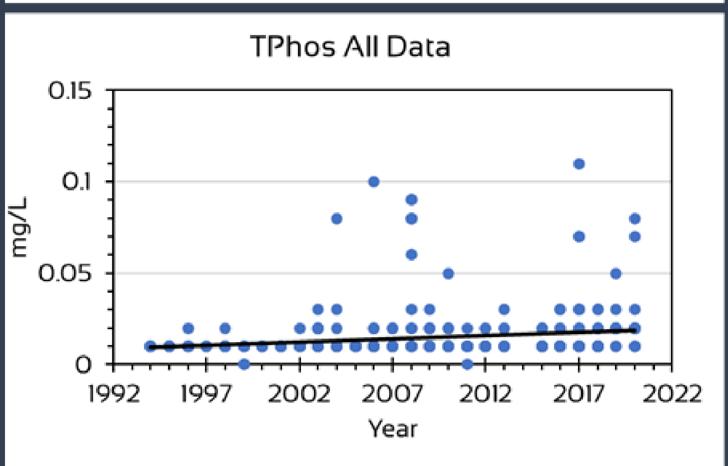
- There has been significant change in the water quality of Amston Lake since 1994.
- Was based on the combined dataset, i.e. no significant change based on epi or hypo datasets.
- Variables contributing the most were alkalinity, and to a lesser extent, total phosphorus and specific conductance.

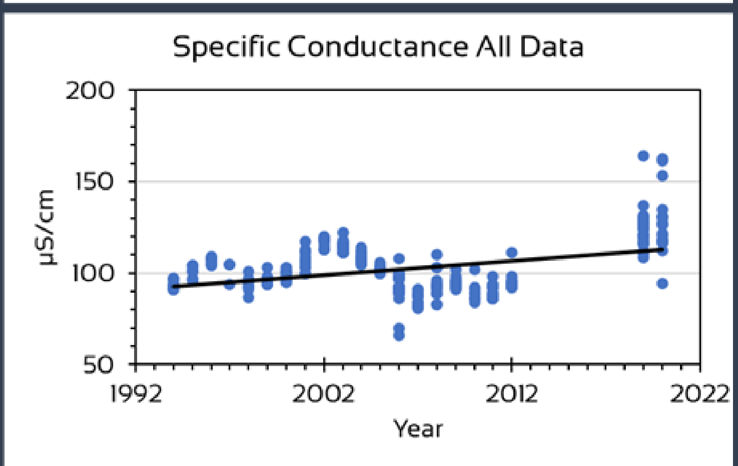
- There has been significant change in the chemistry of stormwater entering Amston Lake since 2001.
- Was based on the combined Hebron and Lebanon dataset, and on the Hebron and Lebanon sites data utilized independently.
- The most important variable contributing to the significance of the combined data and the Hebron data models was total phosphorus.
- For the Lebanon stormwater sites, the most important variables were nitrate and specific conductance.

Lake water quality variables significantly changing based on ANOVA









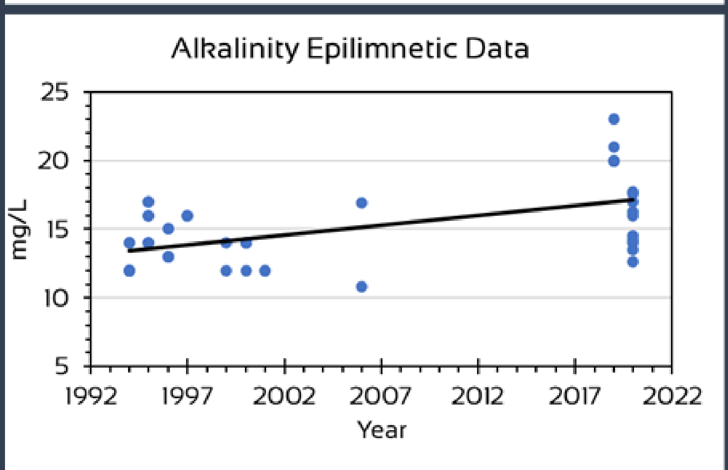


Figure 19. Linear regression of variables exhibiting significant change in Amston Lake since 1994. *All Data* refers to the combined epilimnetic and hypolimnetic dataset. NH3 = ammonia; TKN = total Kjeldahl nitrogen; TPhos = total phosphorus.

Stormwater Quality Variables Significantly Changing based on ANOVA

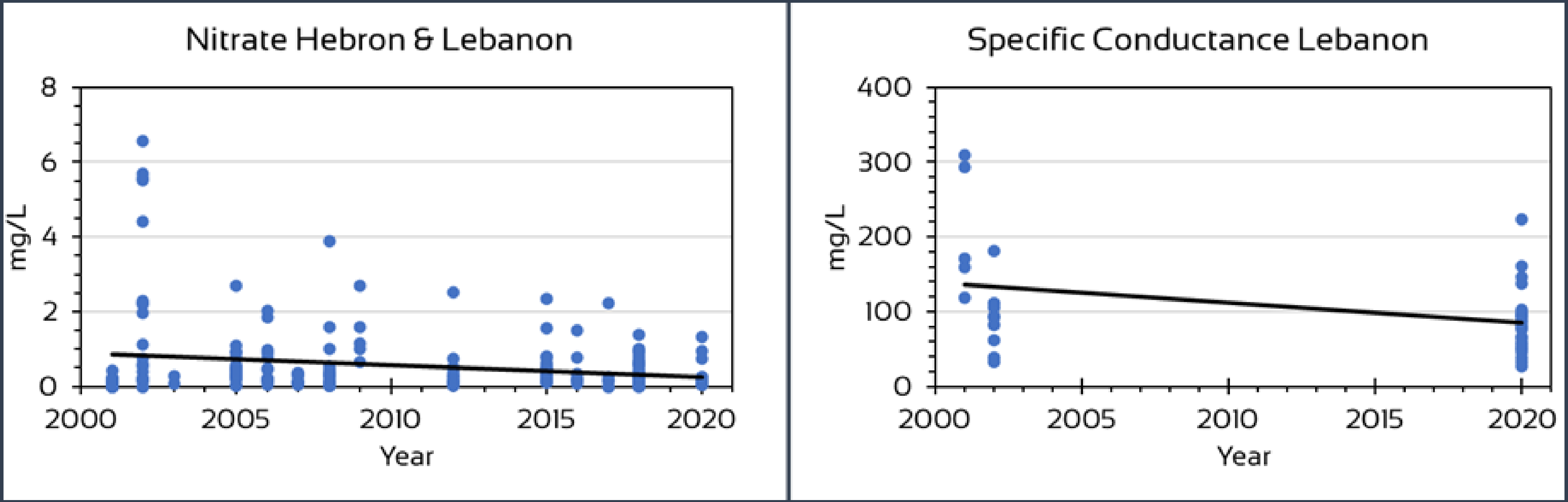
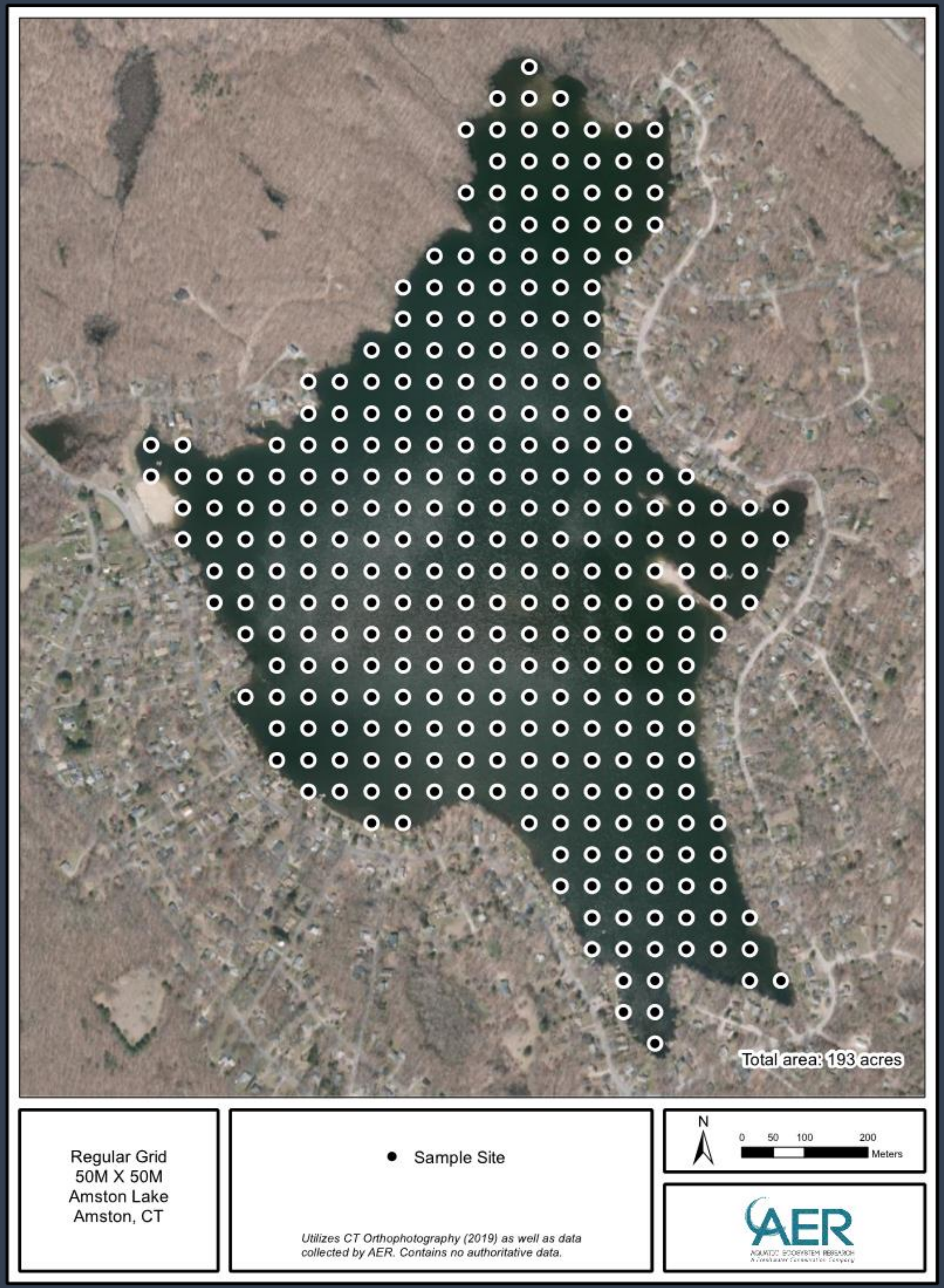


Figure 20. Linear regressions of nitrate over time from the combined Hebron and Lebanon dataset, and specific conductance over time from the Lebanon dataset.

Amston Aquatic Plant Community

- Inventory all species of the plant community.
- Determine the presence of non-native aquatic macrophytes.
- Determine the presence of rare or endangered macrophyte species.
- Evaluate the impact of all macrophyte species on recreational access.
- Statistically model the likelihood of encountering any macrophyte species as depth increases.



Amston Aquatic Plant Community

- Examine the relationships among macrophyte richness, macrophyte diversity, depth, and other macrophyte species.
- Identify species that dominate the community or negatively impact recreational access.
- Create spatial distribution graphics associated with dominant species and/or problematic species.
- Identify data gaps and provide guidance on ecosystem monitoring.

Amston Aquatic Plant Community

Species Name	Common Name	Point Encounters	Percent of Points with Plants	Total Rank Abundance	Average Lake Rank Abundance	Average Abundance Where Present
Brasenia schreberii	Watershield	20	7.25	55	0.18	2.75
Ceratophyllum demersum	Coontail	8	2.90	12	0.04	1.50
Chara spp.	Musk Grass	28	10.14	39	0.12	1.39
Eleocharis acicularis	Dwarf Hair Grass	7	2.54	13	0.04	1.86
Eriocaulon aquaticum	Common Pipewort	7	2.54	12	0.04	1.71
Elodea canadensis	American Waterweed	9	3.26	13	0.04	1.44
Elatine minima	Small Waterwort	4	1.45	5	0.02	1.25
Elodea nuttallii	Western Waterweed	18	6.52	29	0.09	1.61
Lemna minor	Common Duckweed	1	0.36	3	0.01	3.00
Myriophyllum humile	Low Watermilfoil	1	0.36	2	0.01	2.00
Myriophyllum tenellum	Slender Watermilfoil	9	3.26	21	0.07	2.33
Najas flexilis	Nodding Waternymph	49	17.75	97	0.31	1.98
Nuphar variegata	Yellow Pondlily	4	1.45	8	0.03	2.00
Nymphaea odorata	White Waterlily	20	7.25	48	0.15	2.40
Pontederia cordata	Pickerelweed	11	3.99	16	0.05	1.45
Potamogeton amplifolius	Large Leaf Pondweed	128	46.38	226	0.72	1.77
Potamogeton bicupulatus	Snailseed Pondweed	1	0.36	2	0.01	2.00
Potamogeton epihydrus	Ribbonleaf Pondweed	6	2.17	10	0.03	1.67
Potamogeton illinoiensis	Illinois Pondweed	2	0.72	2	0.01	1.00

Amston Aquatic Plant Community

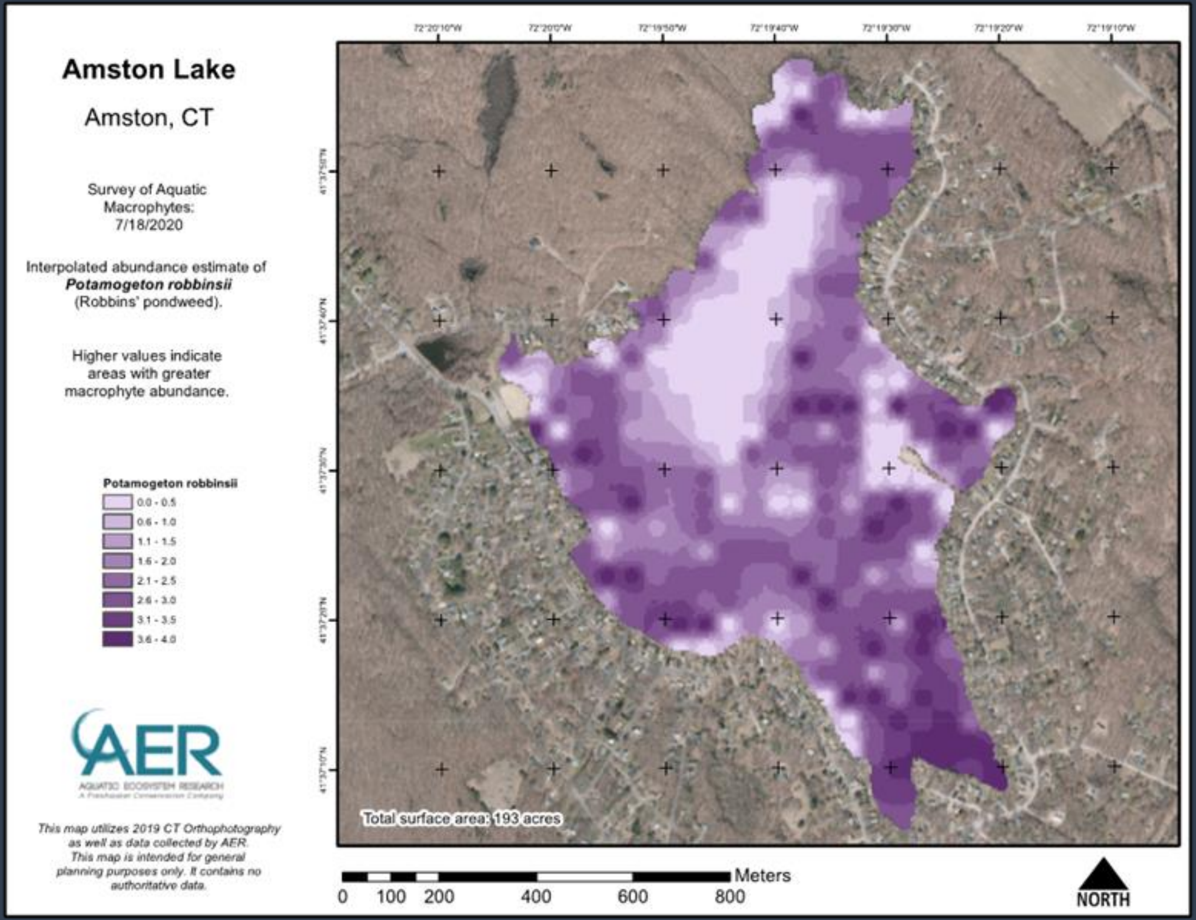
Species Name	Common Name	Point Encounters	Percent of Points with Plants	Total Rank Abundance	Average Lake Rank Abundance	Average Abundance Where Present
Potamogeton natans	Floating Pondweed	12	4.35	25	0.08	2.08
Potamogeton pusillus	Small Pondweed	8	2.90	14	0.04	1.75
Potamogeton robbinsii	Robbins Pondweed	240	86.96	602	1.92	2.51
Potamogeton spirilus	Spiral Pondweed	1	0.36	1	0.00	1.00
Potamogeton zosteriformes	Flatstemmed Pondweed	1	0.36	1	0.00	1.00
Sagittaria graminea	Grassy Arrowhead	4	1.45	6	0.02	1.50
Typha lattifolia	Cattail	1	0.36	2	0.01	2.00
Utricularia macrorrhyza	Common Bladderwort	1	0.36	2	0.01	2.00
Utricularia gibba	Humped Bladderwort	3	1.09	4	0.01	1.33
Utricularia purpurea	Purple Bladderwort	5	1.81	11	0.04	2.20
Utricularia radiata	Floating Bladderwort	3	1.09	4	0.01	1.33
Vallisneria americana	Tape Grass	105	38.04	238	0.76	2.27
Wolffia sp.	Watermeal	1	0.36	3	0.01	3.00

Summary Results

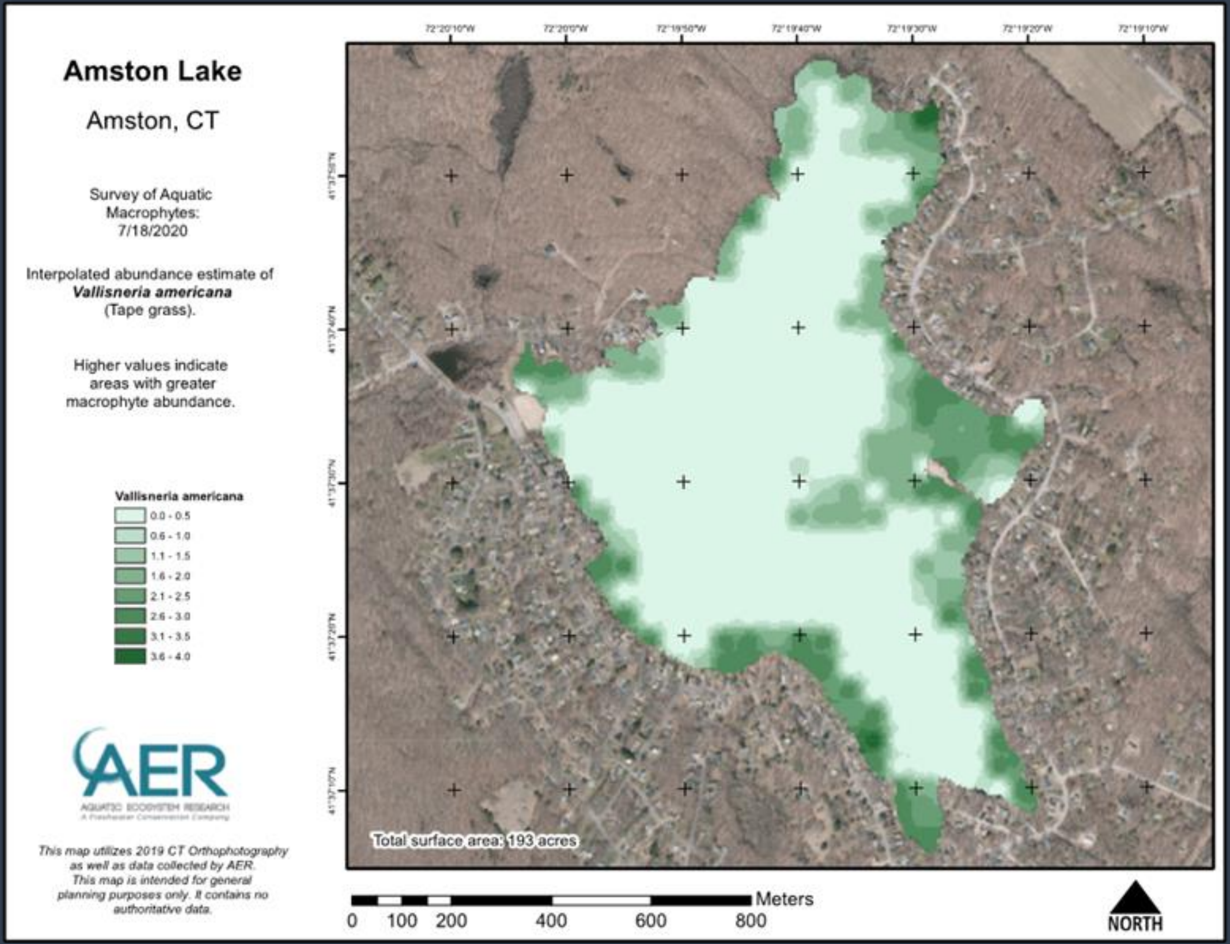
- Amston Lake on July 18, 2020
- Aquatic macrophytes were found at 276 of the 314 grid points
- Suggests that 88% of the waterbody houses one or more plant species.
- In total,
  - 25 submerged/rooted aquatic macrophytes,
  - 3 lily-pad species
  - 2 unrooted floating species
  - 1 macroalgae

- The most common species detected during this survey was *Potamogeton robbinsii* (Robbin's Pondweed)
- The second most common species found was the rooted macrophyte *Vallisneria americana* (Tape Grass)
- The third most common species detected in Amston Lake was *Potamogeton amplifolius* (Large-leaf Pondweed)
- The fourth most common species was *Najas flexilis* (Nodding Waternymph)

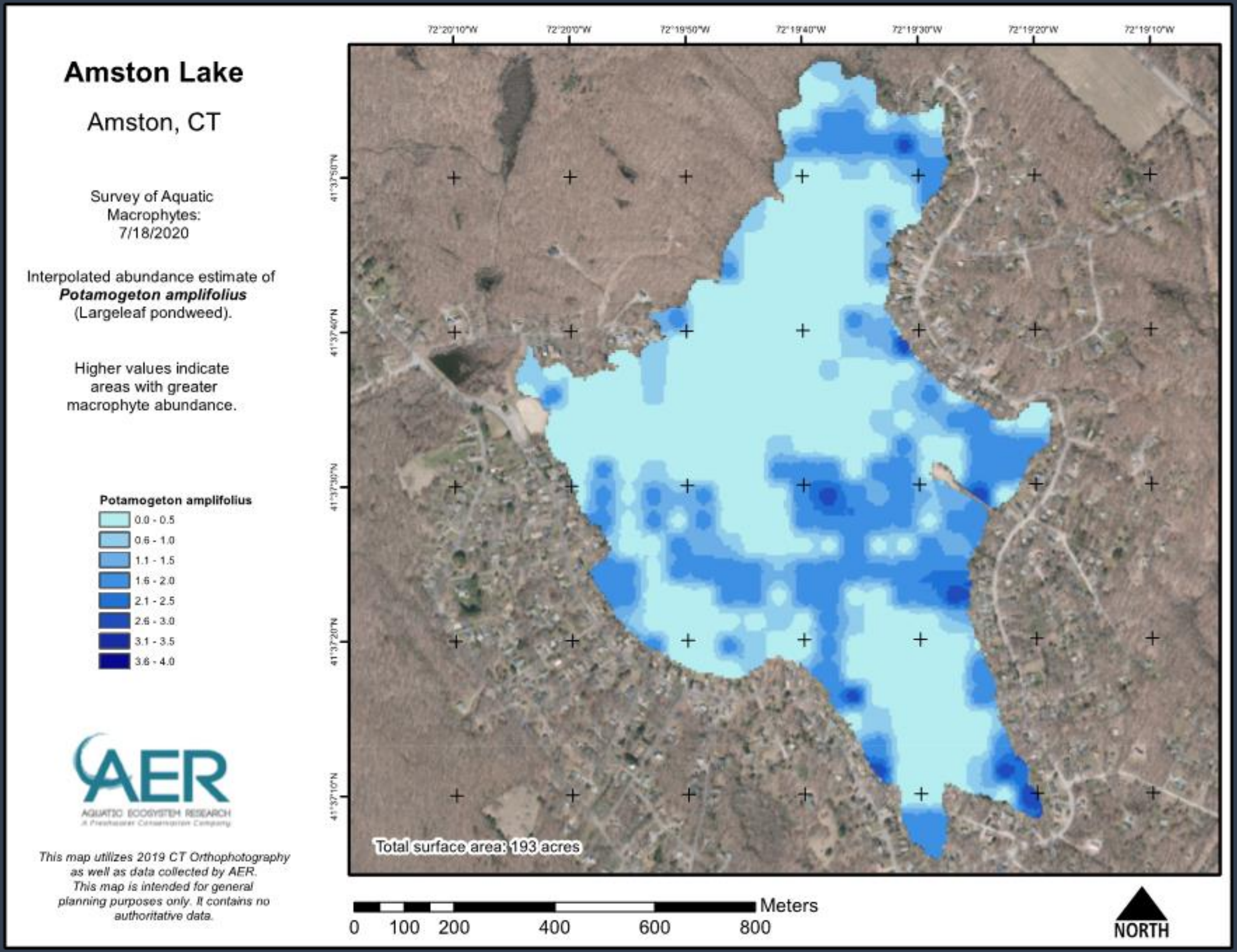
Potamogeton robbinsii

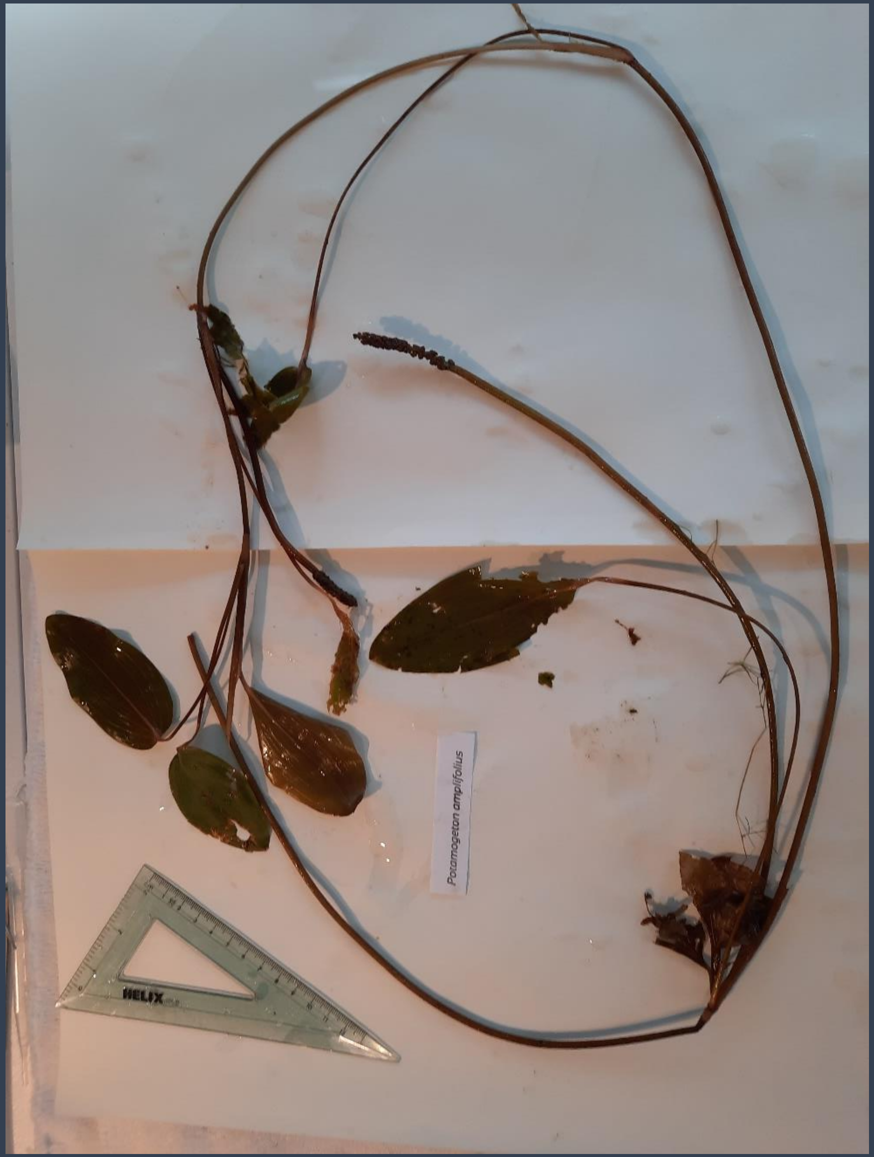


Vallisneria americana

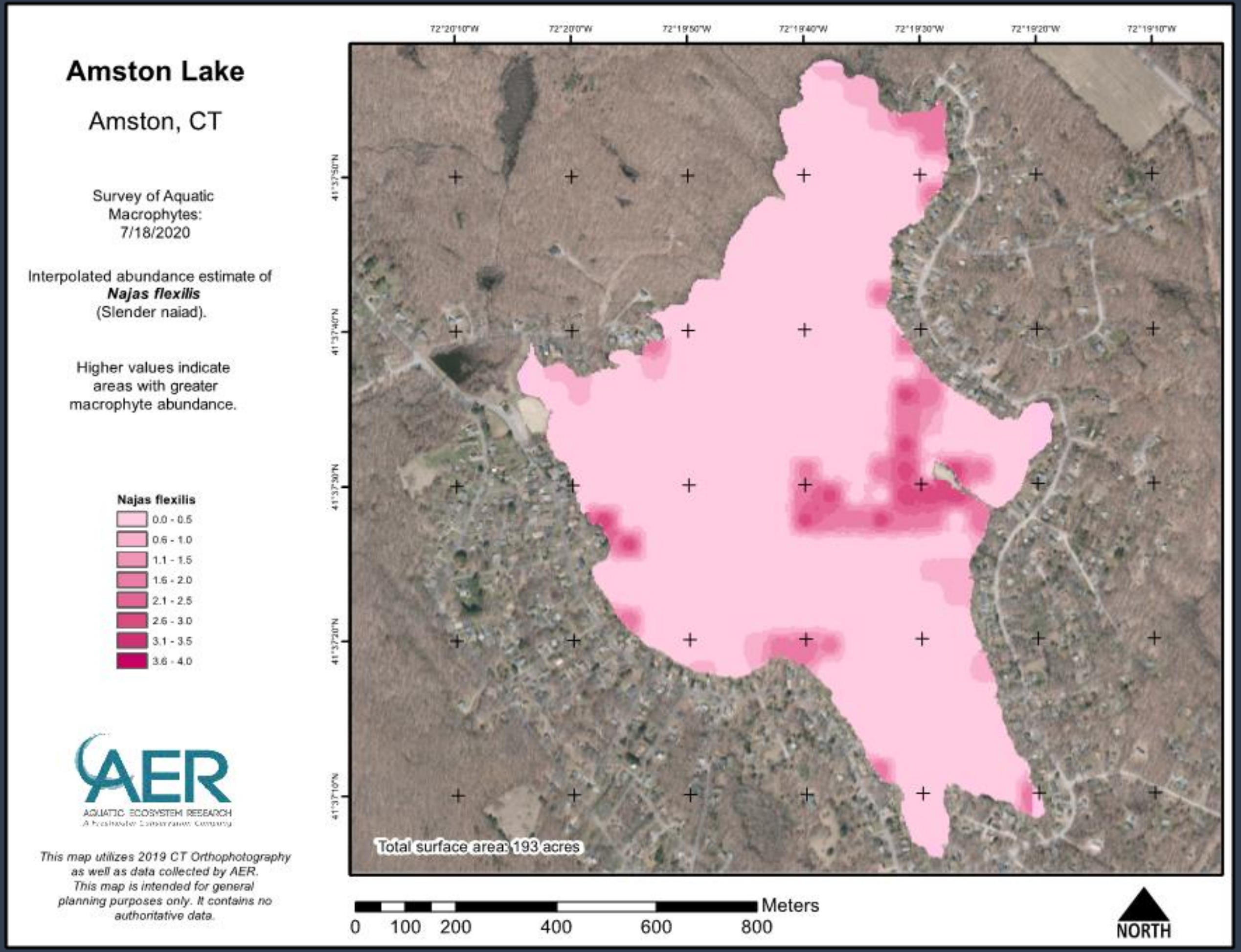


Potamogeton amplifolius



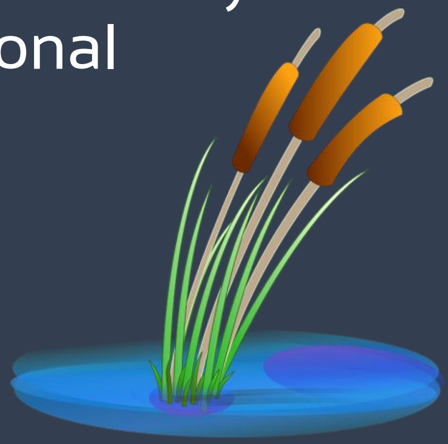


Najas flexilis



Discussion

- Amston Lake's plant community exhibits moderate productivity and is moderately diverse
- The plant community was not found to house any non-native or rare/endangered species
- There were no signs that aquatic macrophytes were impinging upon recreational access in most sections of the lake
- Amston Lake contains a total richness that is greater than the regional average of 13 species, is a community that has resisted invasion from non-native species, and has high average diversity
- The plant community is healthy and ecologically functional

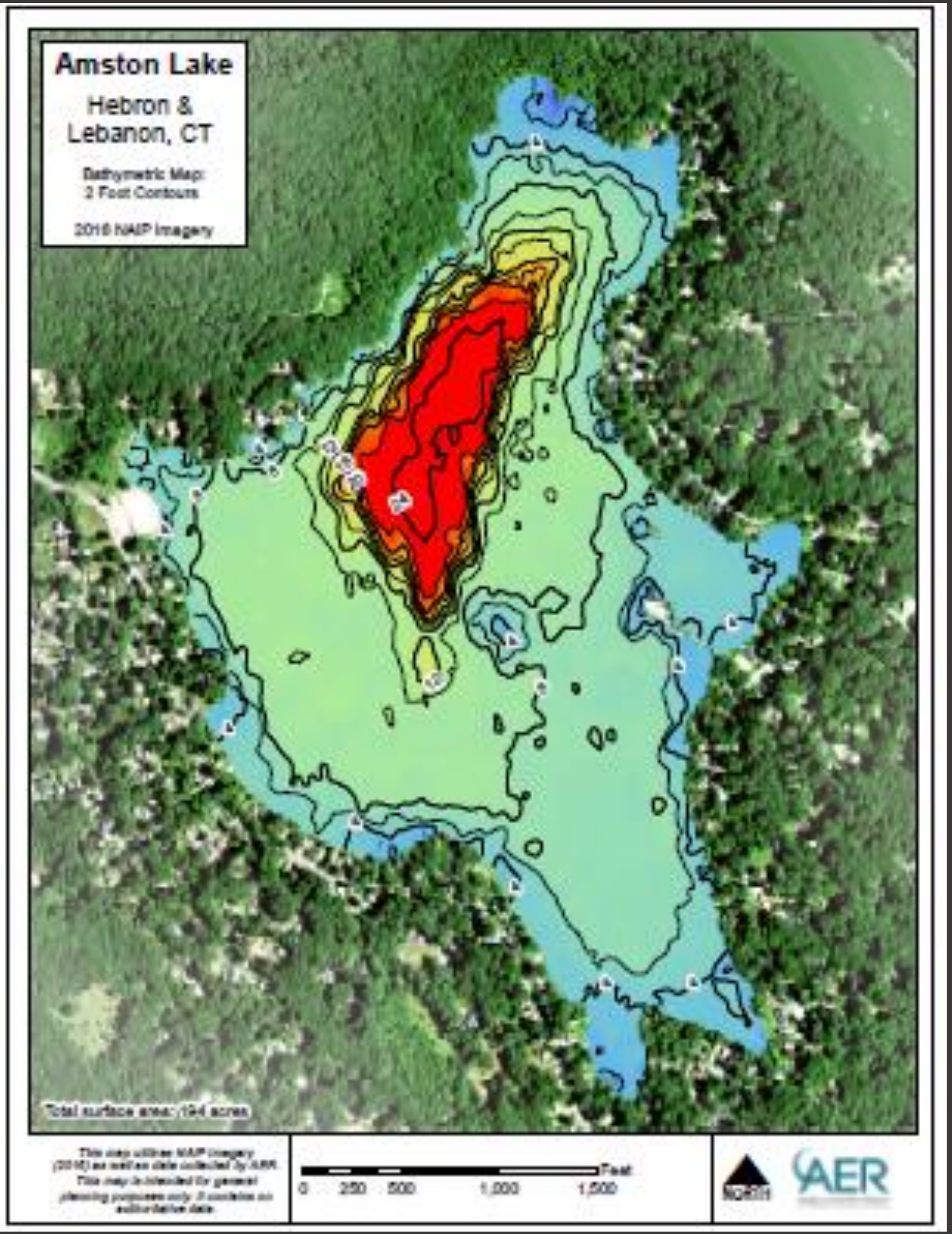


Management Approach

- Amston Lake houses a diverse and rich plant community that has resisted invasion by non-native species
- Any major disturbance to that community could have adverse impacts over the long term
- We would only recommend localized, subtle mechanical management
- For Property Adjacent Swim Areas, Docking Areas, and Resident Beaches we prescribe methods considered less obtrusive and consistent with the regulations of the Amston Lake Ordinances

Lake Bathymetry Project

- Approximately 194 acres
- Maximum depth of just less than 8 meters (7.9 m)
- Mean depth of 2.7 meters
- Contains approximately 2.1×10^{6} cubic meters of water



Thank you.

Questions?