The Last Green Valley Volunteer Water Quality Monitoring Program: Tools for Lake Monitoring, How to Use Them and What Does the Data Mean

Jean Pillo, Watershed Conservation Project Manager

Eastern Connecticut Conservation District

& The Last Green Valley Volunteer Water Quality Monitoring Coordinator

Multi Probe

- In-situ Troll 9500

- Eureka WaterProbes Manta

Parameter	Troll	Manta
Depth	X	X
Temperature	X	X
Dissolved Oxygen	X	X
pH	X	X
Conductivity	X	X
Turbidity	X	X
Phycocyanin		X

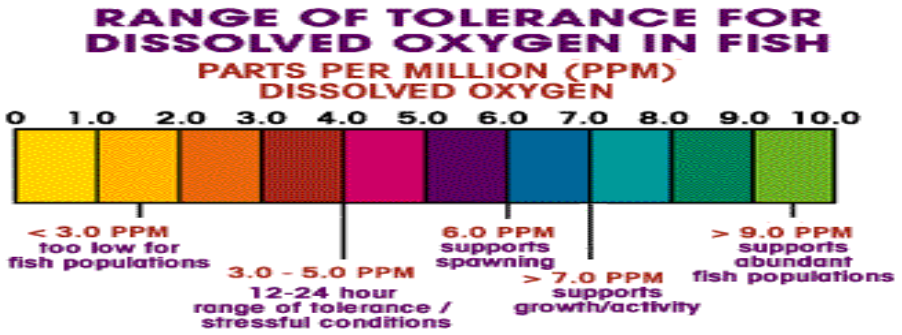
Water Temperature: Why is it important?

- Water temperature influences how much can dissolve in water.
  - Water can dissolve more gasses in it at colder temperatures than warmer temperatures.
- Certain types of algae and plants grow better within temperature ranges.
  - Blue green algae (cyanobacteria) grow better when the water (>77 °F or 25 °C) is warmer than other types of algae

- Fish have different temperature ranges.
  - Trout like cooler water
  - Bass and other panfish prefer warmer temperatures.

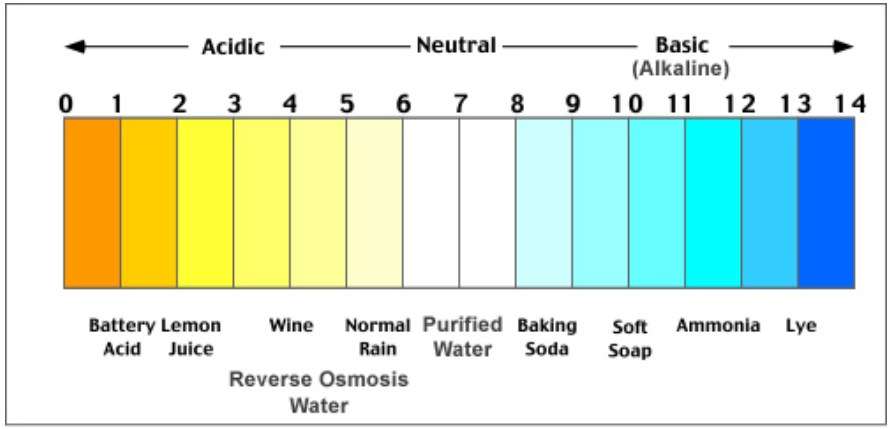
Dissolved Oxygen: Why is it important?

- Oxygen is measured in its gaseous form as dissolved oxygen (DO).
- If more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken, or die.
- Oxygen is needed for decomposition to take place.
- In the lake bottom, a lack of dissolved oxygen may allow nutrients bound to sediment to become released into the water.
- Wastewater from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process.
- Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen.
- MA DEP guidelines for DO
  - Cold water > 6 mg/l is good
  - Warm water > 5 mg/l is good

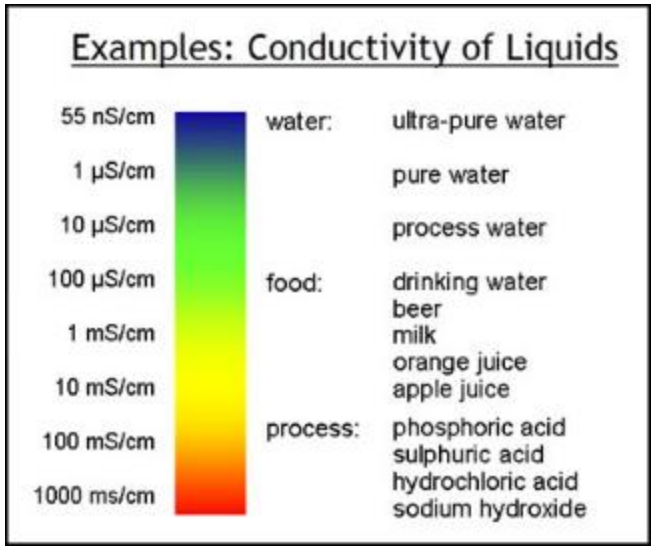


pH: Why is it important?

- pH is an expression of hydrogen ion concentration in water.
- pH affects most chemical and biological processes in water.
- Different species flourish within different ranges of pH, with the optima for most aquatic organisms falling between pH 6.5-8



- Biological Effects
  - Damage to gill epithelium
  - Mucus on gills
  - Decreased growth
  - Reproductive failure
  - Respiratory inhibition
  - Ionoregulatory impacts
  - Reduced number of species and individuals
  - Mortality
  - Replacement of acid-sensitive species with acid-tolerant species
- MA DEP guidelines for pH
  - 6.5- 8.0 Δ 0.5 excellent
  - 6.5 – 8.5 Δ 0.5 good
  - 6.0 – 9.0 Δ 1.0 fair
  - < 6.0 - > 9.0 Δ1.5 poor



What is conductivity and why is it important?

- Conductivity is a measure of the ability of water to pass an electrical current.
- Conductivity in water is affected by the presence of inorganic dissolved solids.
- Conductivity is also affected by temperature: the warmer the water, the higher the conductivity.

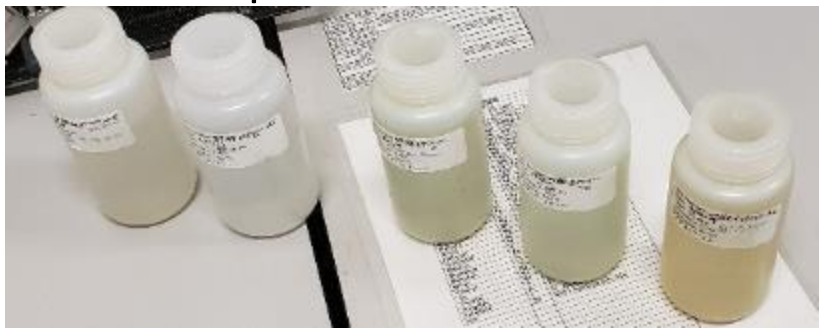
- Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows.
- Discharges into streams can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity.
- Winter road salt in runoff will raise the conductivity.
- MA DEP guidelines for conductivity
  - ≤120 µS/cm is excellent
  - 80% > 120 µS/cm is good
  - 50% > 240 is fair
  - 20% > 360 is poor

Turbidity: Why is it important?

- Turbidity is a measure of the cloudiness of water.
- Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances.
- Turbidity can affect the color of the water.
- Higher turbidity
  - increases water temperatures because suspended particles absorb more heat.
  - reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO.
  - can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development.

- Sources of turbidity include:
  - Soil erosion
  - Waste discharge
  - Urban runoff
  - Eroding stream banks
  - Large numbers of bottom feeders (such as carp), which stir up bottom sediments
  - Excessive algal growth.

- MA guidelines for Turbidity in streams (weekly average)
  - 0-1 NTU is excellent
  - 1 – 5 NTU is good
  - 5 – 10 NTU is fair
  - >10 NTU is poor



Nutrients and Chlorophyll A

- A sampler that can be lowered to discrete depths is used to collect water samples for chemical analysis.
- Water samples are sent to a lab for analysis.

Nutrients – why are they important?

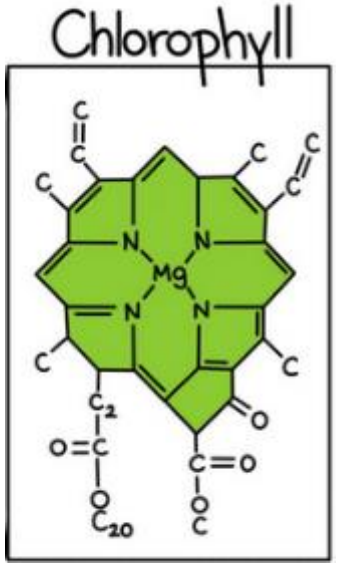
- Primary nutrients of concern are Nitrogen and Phosphorus.
- In fresh water ecosystems, typically phosphorus is the limiting nutrient that controls plant and algae growth.
- Nitrate nitrogen availability may limit the growth of some algae under certain conditions.
- Total Nitrogen is made up of organic nitrogen, nitrite nitrogen, nitrate nitrogen and ammonia nitrogen.

- MA DEP guidelines for nutrients at the lake surface for the F&Q watershed
- Total Phosphorus (TP)
  - TP <15 ug/l is excellent
  - TP 15 – 25 ug/l is good
  - TP 25 – 50 ug/l is fair
  - TP > 50 ug/l is poor
- Total Nitrogen (TN)
  - TN <400 ug/ is excellent
  - TN 400 – 700 is good
  - TN 700 – 1000 is fair
  - TN > 1000 is poor

Chlorophyll A: Why is it important?

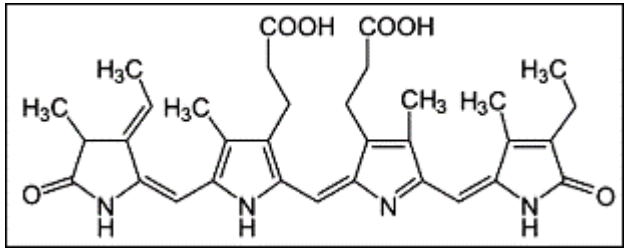
- Chlorophyll a is a measure of the amount of algae growing in a waterbody.
- All types of plants and algae, including cyanobacteria (blue green algae) have chlorophyll A.
- It can be used to classify the trophic condition of a waterbody.
- Although algae are a natural part of freshwater ecosystems, too much algae can cause aesthetic problems such as green scums and bad odors, and can result in decreased levels of dissolved oxygen.
- Some algae also produce toxins that can be of public health concern when they are found in high concentrations.

- Waters with high levels of nutrients from fertilizers, septic systems, sewage treatment plants and urban runoff may have high concentrations of chlorophyll a and excess amounts of algae.
- MA DEP uses different units in their smart charts
- CT DEEP uses the following ranges to determine trophic state of a lake (midsummer).
- 0 – 2 µg/l = oligotrophic
- 2 – 15 µg/l mesotrophic
- 15 – 30 µg/l eutrophic
- >30 µg/l highly eutrophic



New Parameter being monitored Phycocyanin: Why is it important?

- Phycocyanin is a pigment associated with cyanobacteria (blue green algae)
- When measured with chlorophyll, it can tell you the relative abundance of cyanobacteria to other types of algae.
- Not all algae blooms are cyanobacteria blooms



- Certain types of cyanobacteria may produce compounds that are toxic to mammals.
- It is important to avoid contact with water that may have algal toxins in it.
- Algal toxins are typically not filtered out by normal processes at a water treatment plant.
- New Manta probe will be used for this monitoring in 2020.

Harmful Algae Blooms
HAB or HAB Not?

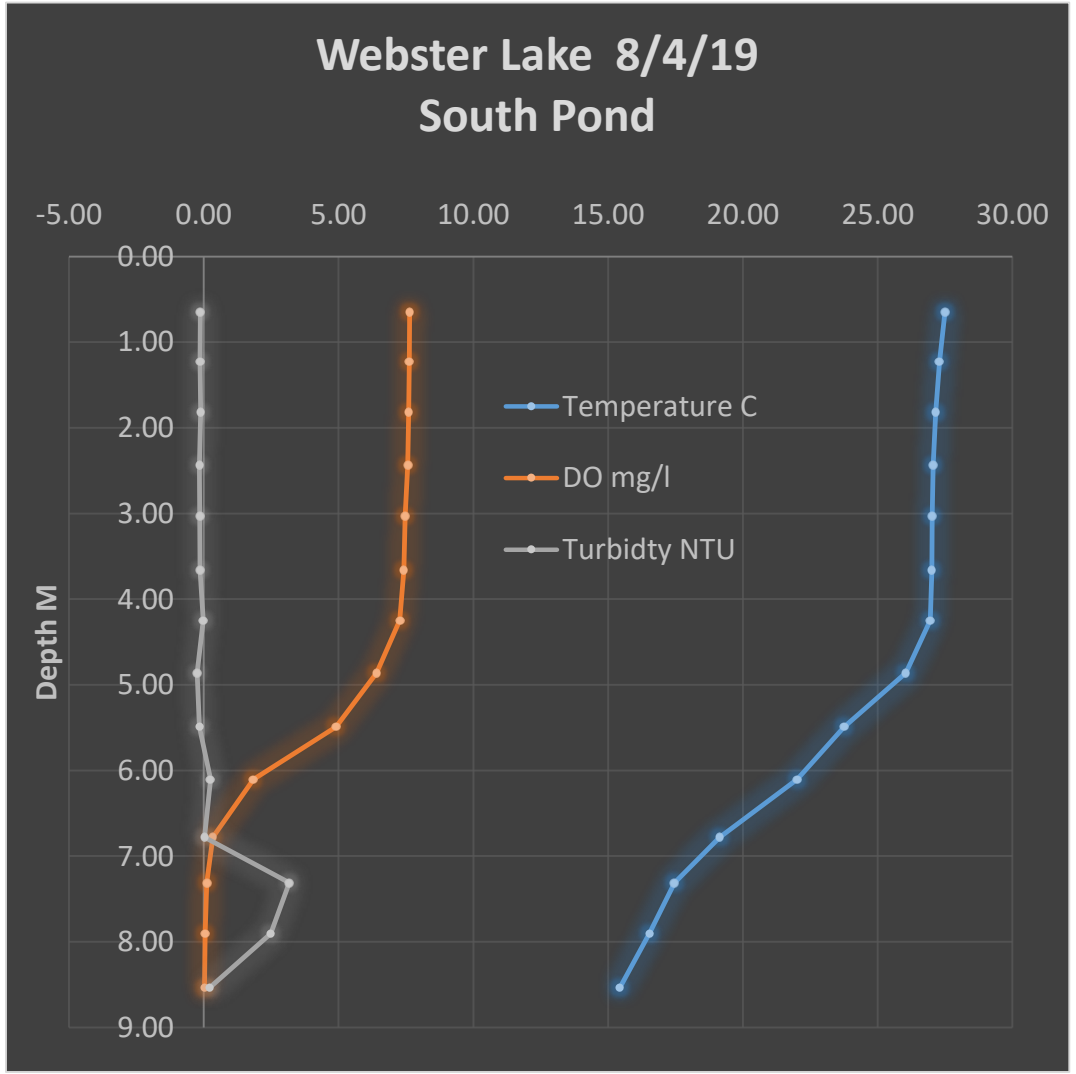
You can’t tell by looking at an algae bloom if it is toxic or not

Secchi Depth: Why is it important?

- A Secchi disk is a black and white disk that is lowered by hand into the water to the depth at which it vanishes from sight.
- It is a tool for measuring water clarity.
- The clearer the water, the greater the distance.
- Water clarity effected by turbidity and algae growth, etc.

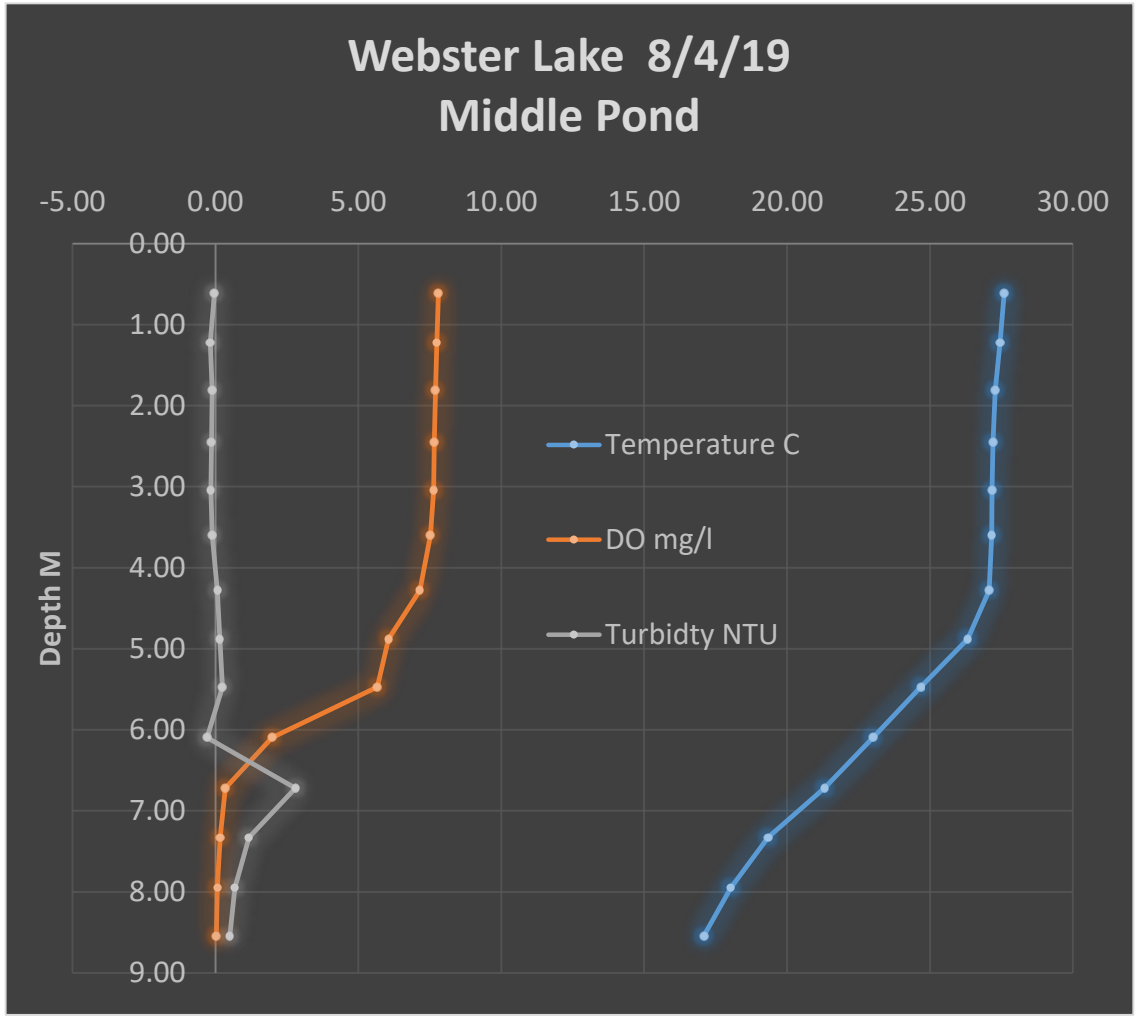
- MA DEP guidance
  - > 15 ft (4.572 M) is excellent
  - 10 -15 ft (3.048 – 4.572 M) is good
  - 4 – 10 feet (1.219 – 3.048 M) is fair
  - <4ft (1.219 M) is poor

South Pond 8/4/19



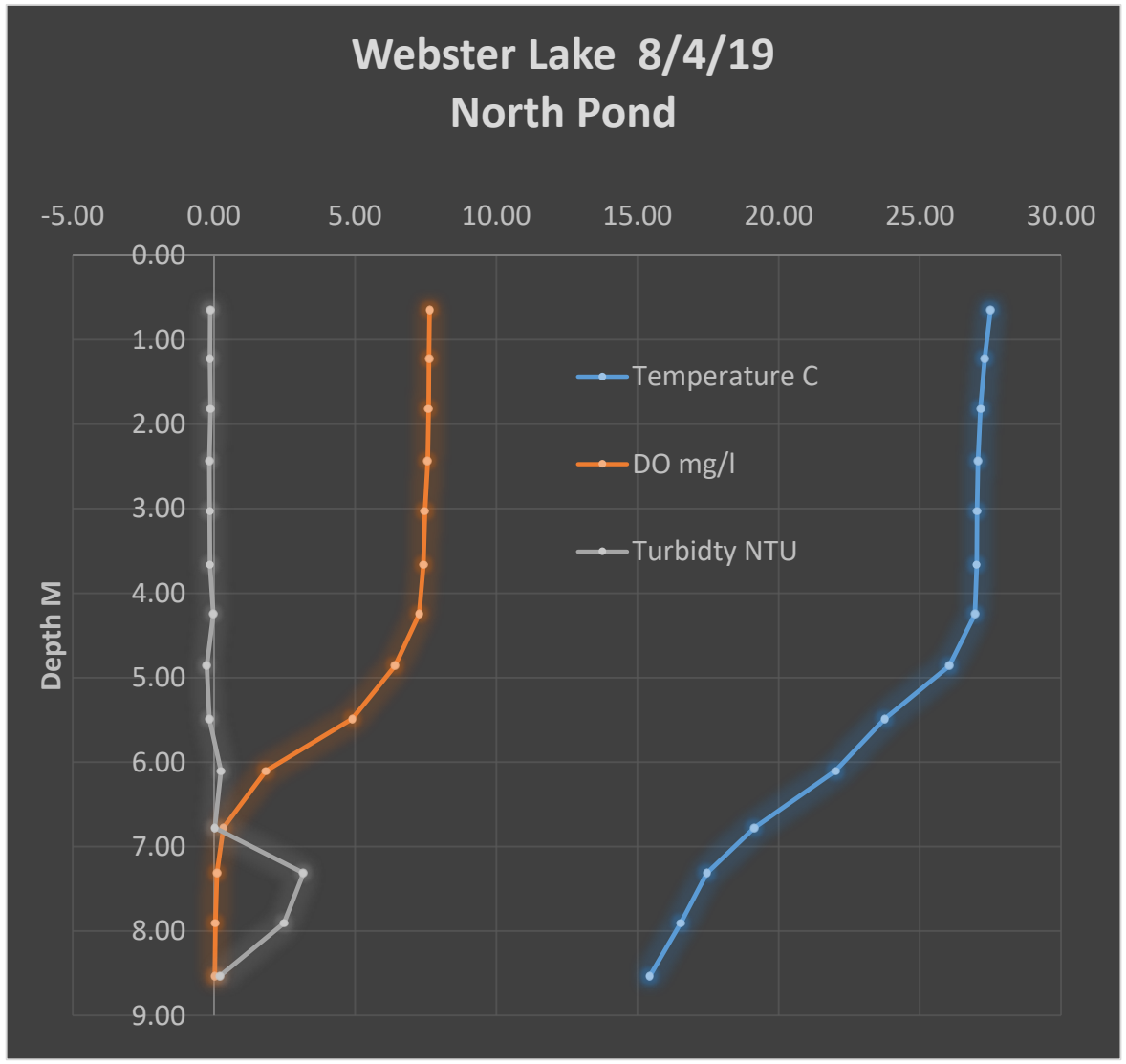
- Water temperature at the surface > 25 °C (77°F)
- Dissolved oxygen is good for fish until 6 M (19.7 feet)
- Turbidity shows water is clear with a minor increase at 24 feet.
- Secchi depth 8 ft is fair
- Chlorophyll A 4.54 ug/l indicates mesotrophic conditions
- Nutrients
  - TP surface = 10.6 µg/l is excellent
  - TP bottom = 39.3 µg/l

Middle Pond 8/4/19



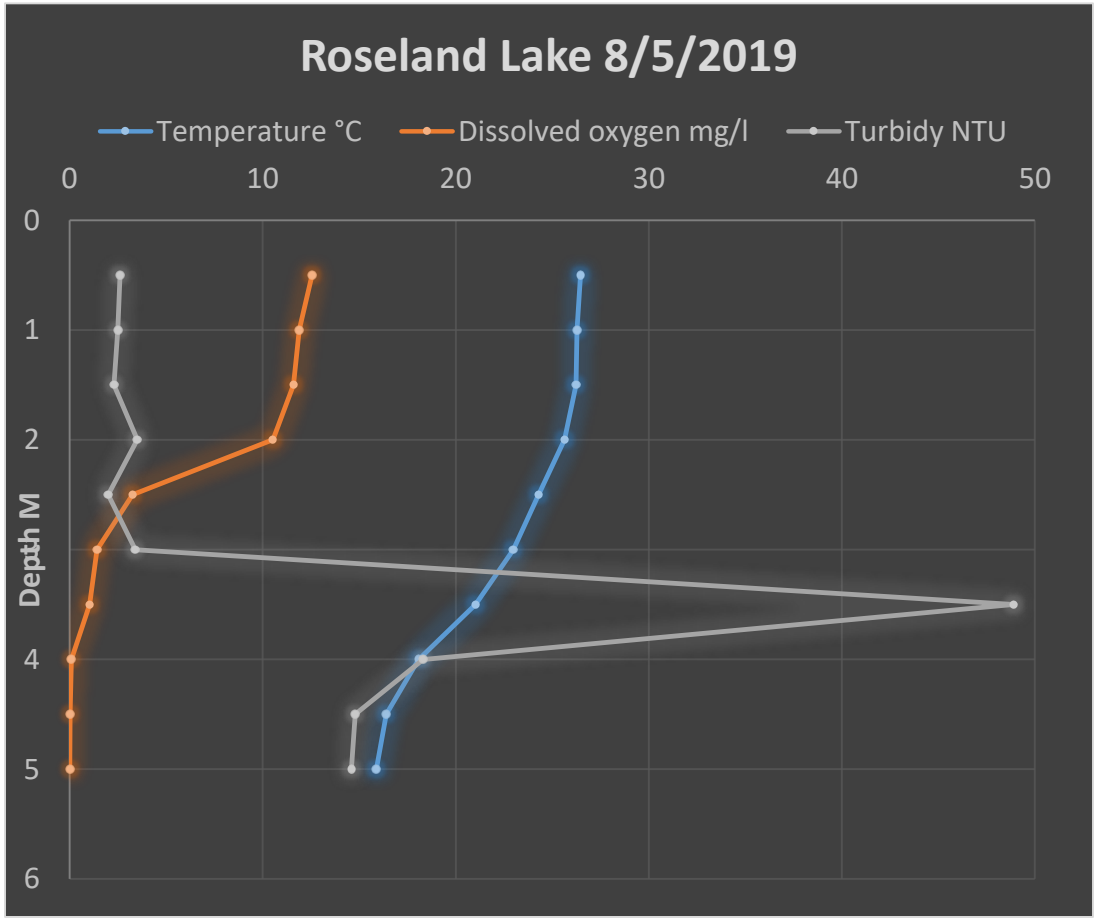
- Water temperature at the surface > 25 °C (77°F)
- Dissolved oxygen is good for fish until 5.5 M (feet)
- Turbidity shows water is clear with a minor increase at 24 feet.
- Secchi depth 10.2 ft is good
- Chlorophyll A 4.0 ug/l indicates mesotrophic conditions
- Nutrients
  - TP surface = 19.1 µg/l is excellent
  - TP bottom = 28.7 µg/l

North Pond 8/4/19



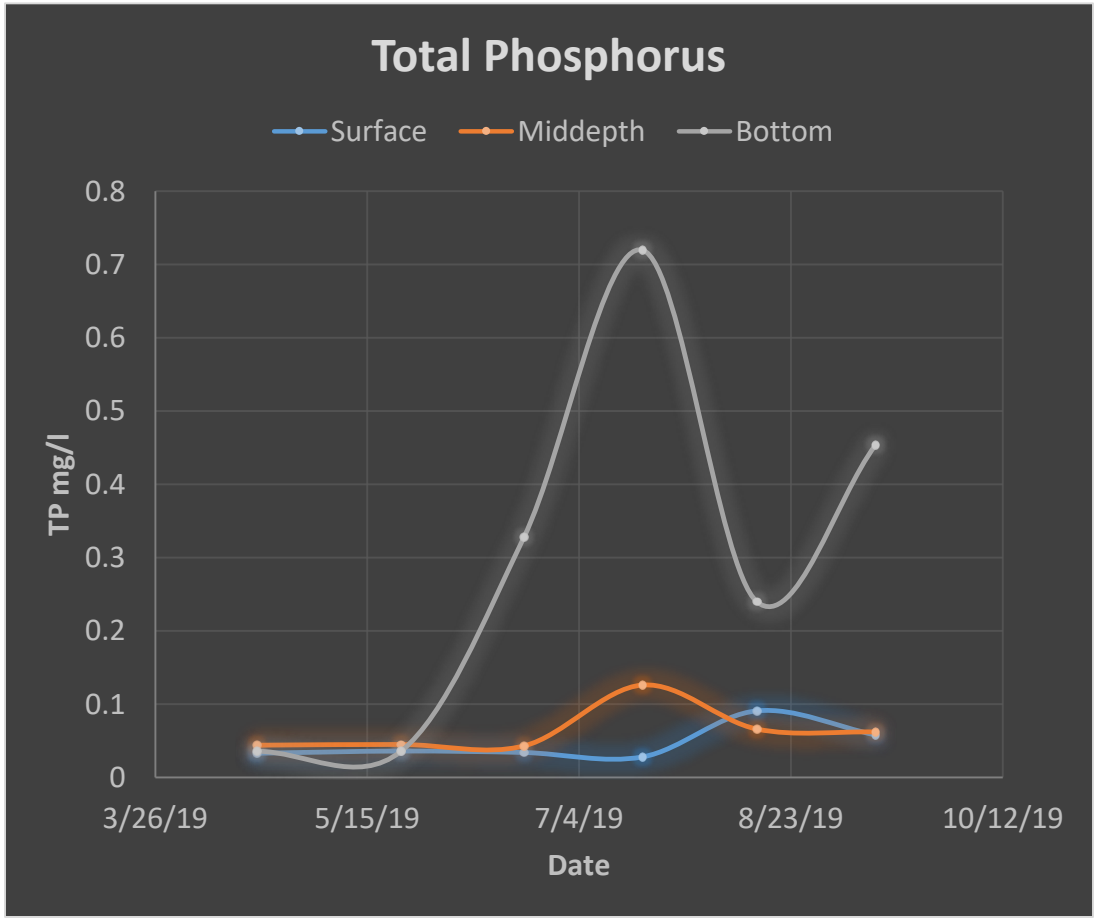
- Water temperature at the surface > 25 °C (77°F)
- Dissolved oxygen is good for fish until 6 M (19.7 feet)
- Turbidity shows water is clear with a minor increase at 24 feet.
- Secchi depth 13.8 ft is good
- Chlorophyll A 2.94 ug/l indicates mesotrophic conditions
- Nutrients
  - TP surface <10.6 µg/l is excellent
  - TP bottom = 17.0 µg/l

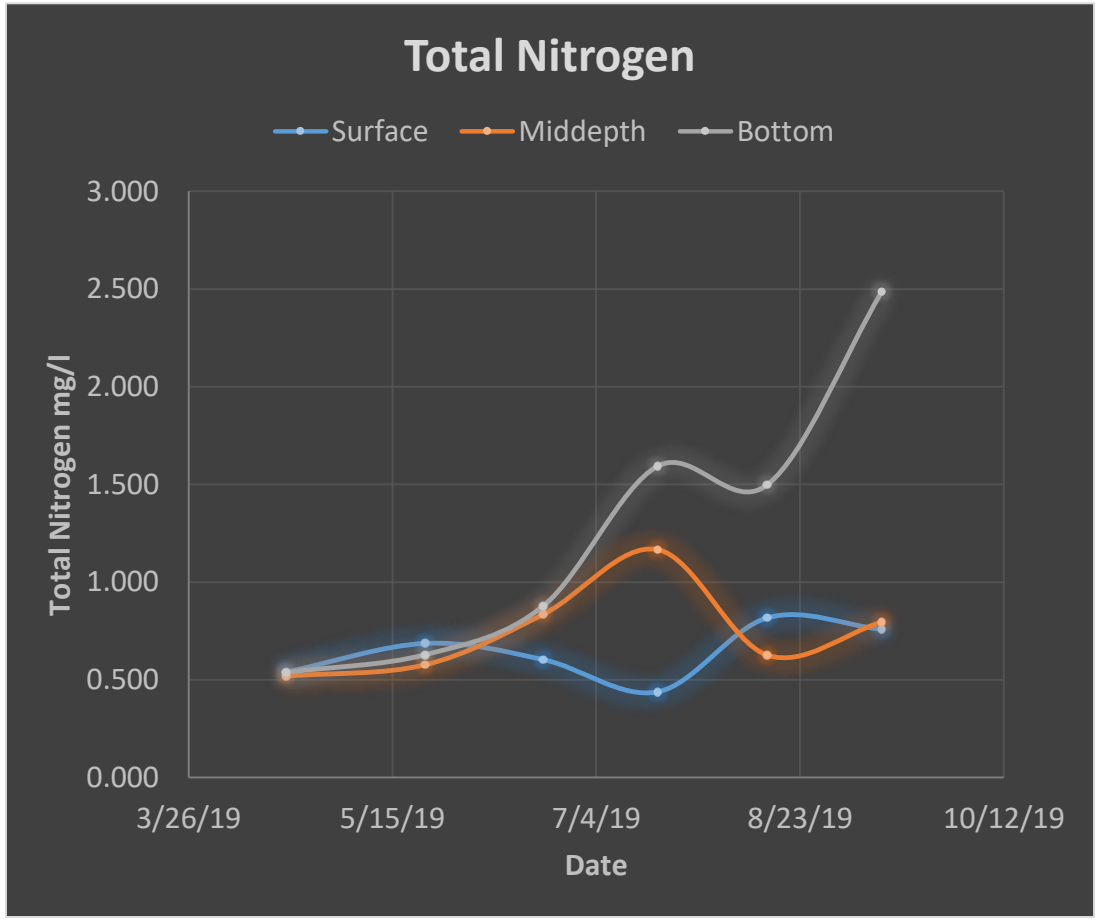
Roseland Lake (Woodstock)
August 5, 2019



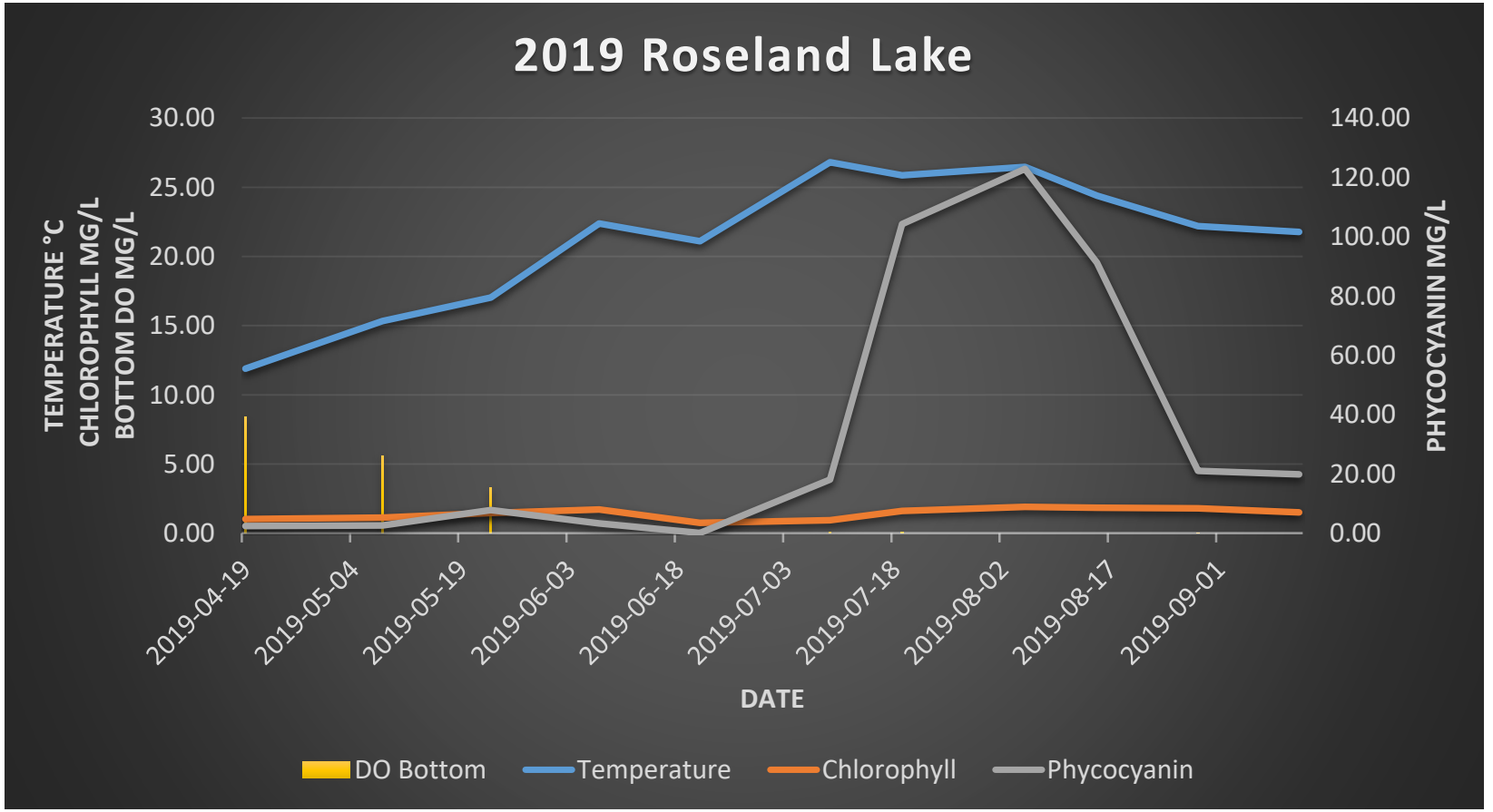
Second copper treatment occurred on this date.

Roseland Lake Nutrients

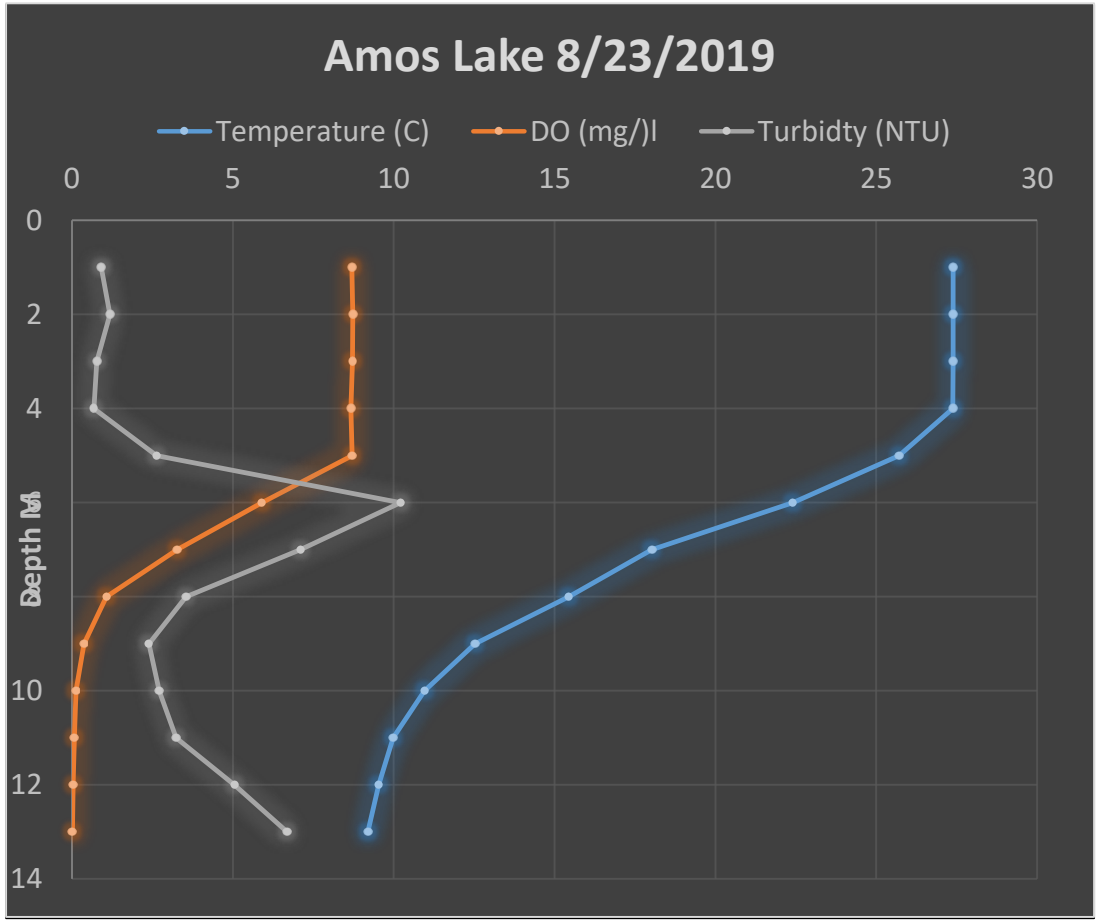




Algal Pigment Response to Surface Water Temperature and DO on the Bottom



Amos Lake 8/23/19



- Lake is stratified with a well defined thermocline
- Secchi depth was 2.59 M
- Bottom is anoxic
- Surface temperature > 25°C.

8/23/2019	TN (µg/l)	TP (µg/l)	Chlorophyll A (µg/l)
Surface	266	15	5.1
6 M	464	41	
13 M	1926	250	

- All surface parameters indicate mesotrophic conditions.
- Notable small turbidity increase at thermocline and near the bottom
- Turbidity increase corresponds to an increase in Manta phycocyanin reading.
  - Phycocyanin in surface 3 M = 5.5 µg/l
  - Phycocyanin at 6 M = 94.13 µg/l

In-situ Troll 9500 vs Eureka Manta

Roseland Lake
July 19, 2019

Depth (M)	Temperature (°C)	DO (mg/l)	Turbidity (NTU)	pH	Conductivity (µS/cm)
0.5	26.09	10.57	2.00	9.20	143.70
1	25.86	10.65	2.70	9.21	147.70
1.5	25.82	10.63	2.70	9.20	143.70
2	25.46	10.21	9.40	9.02	138.50
2.5	24.53	10.48	12.60	8.27	138.80
3	22.29	9.51	4.40	7.59	135.50
3.5	20.73	5.56	26.60	7.04	132.70
4	17.86	1.01	13.20	6.69	145.40
4.5	15.10	0.16	7.50	6.75	166.20
5	13.94	0.04	10.00	6.82	181.20

Depth (M)	Temperature (°C)	DO (mg/l)	Turbidity (NTU)	pH	Conductivity (µS/cm)	Phycocyanin (µg/l)
0.5	25.86	10.68	2.09	9.06	144.00	33.09
1	25.76	10.76	1.91	6.08	143.90	38.35
1.5	25.70	10.90	2.35	9.03	143.90	35.24
2	25.46	10.55	5.31	8.64	140.20	75.22
2.5	23.80	10.85	9.41	9.74	139.20	95.27
3	21.37	8.63	2.80	7.20	135.00	29.30
3.5	19.65	3.24	15.49	6.71	133.40	500.00
4	16.83	1.08	6.30	6.68	146.30	68.90
4.5	14.49	0.47	5.41	6.77	171.40	35.90
5	13.75	0.18	5.63	6.85	181.40	47.61

Thank you to the WLA monitoring team!

- 20 volunteers contributed 250 hours to monitor 7 locations in the Webster Lake watershed

- Thank you especially to Ernie Benoit and Gloria Ricker who participated on the multiprobe replacement committee for The Last Green Valley.

Conclusions