Lake Oscawana 2022 Water Quality & Aquatic Plant Monitoring Report

Prepared for the Lake Oscawana Management Advisory Commission,
Town of Putnam Valley, NY

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Executive Summary: Key Points from the 2022 Monitoring Report

- Secchi disk transparency was very poor (<2m) in April, was good in late May and early June, but declined steadily through July and August to end with poor visibility in September and October.
- Water temperature profiles showed that the lake was mixing in April, with thermal stratification strong by the end of May. The lake remained strongly stratified until October. The lake had isothermal conditions, the same temperature top to bottom, at the end of October.
- The seasonal maximum ascent depth of the anoxic boundary in 2022 was 5.35m below the surface in late June, representing the highest presence of anoxic water in the water column so far detected at Oscawana. Worst case for anoxia in 2021 was 5.77m, and 5.81m in 2020. These values exceed the target threshold of 6.0m.
- The 2022 TP in surface waters was very high in April (25-40 ppb) but decreased to below the 20 ppb target during June and July. TP concentration increased in August and remained elevated during September and October at all three stations. Bottom water TP concentrations were elevated in late summer to fall at Stations 1 and 2, but not at Station 3. The highest bottom water TP was near 1,200 ppb.
- Surface TN concentrations were <400 ppb for most of the year. Concentration was elevated in October due to deep water mixing.
- At this time, no in-lake nutrient-binding strategies are permitted by NYDEC, thus products discussed are for informational purposes only, in case permit structure changes in future years.
- No harvester tracker data was available for the mechanical harveseting performed in 2022.
- Aquatic plant survey results showed a dramatic decrease in Eurasan milfoil in 2022.

Contents

List of Figures

List of Tables

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Description of Monitoring Parameters

All measurements should be taken at the deepest open-water location in a lake.
Large or irregularly shaped lakes often require more than one testing site.

Secchi Disk Clarity

Water clarity measurements use an 8-inch circular **Secchi disk** attached to a measuring tape. The disk should be lowered into the water on the shady side of the boat. Using a view scope to shade out light in one's peripheral vision, the Secchi disk is lowered until it disappears from view in the water column. The depth at which the Secchi disk disappears from view is considered the water clarity measurement. Secchi clarity is dependent on light penetration. Light penetration is affected by phytoplankton, suspended sediments, and microscopic organic matter in the water column. Clearer waterbodies have greater Secchi transparency values. Lakes and ponds experience fluctuations in Secchi clarity throughout the season, typically driven by increases or decreases in nutrients that stimulate phytoplankton growth. Ideally, water clarity should be tracked at least monthly from April to October.

Lake Profile Measurements

Temperature in lakes and ponds in the northeast follows a seasonal pattern of warming and cooling. Following ice-melt in early spring, lakes and ponds will be more or less uniform in temperature from top to bottom. Temperature measurements should be made at one-meter increments from the lake surface to the bottom on a monthly basis. Combined, measurements at all 1-meter depth increments are referred to as a lake profile. Profile measurements change as the sun's rays penetrate into the water column. Clearer water allows for greater sunlight penetration and deeper warming during the summer months. The depth and development of a **thermocline**, or the zone of rapid temperature change, is dependent on water depth, surface area of the lake, climatic conditions, and water clarity. A thermocline effectively isolates top and bottom waters during summer months because warm water at the surface is less dense than the cold water at the bottom of the lake. In the fall, the lake cools off as air temperatures drop, resulting in a weakening thermocline and eventually water "turn-over." Lake turnover simply means that the temperature becomes uniform from top to bottom and that there is no longer a thermocline. In lakes deeper than 20ft in the northeast, this turnover traditionally occurs in the spring and the fall. Shallower lakes are more dependent on weather and may experience multiple thermal mixing events in a season. Very large and deep lakes often have more complicated temperature dynamics that require multiple monitoring sites.

Dissolved oxygen in a lake is essential to aquatic organisms. At the surface of a lake, the water is in direct contact with the air, and atmospheric oxygen is dissolved into the water as a result of diffusion. Water mixing, driven by wind and temperature currents, circulates this oxygen throughout the water column during spring and fall mixing periods. Yet because lakes warm non-uniformly, the thermocline that develops in summer months will temporarily cut off the bottom waters from surface water circulation of oxygen. In lakes with very little decomposing plant material at the bottom, this is not usually a problem because there is enough oxygen to sustain the lake through the summer months. More nutrient-rich lakes, however, can be depleted of oxygen in the bottom waters below the thermocline. This phenomenon results in **anoxic** (<1mg/L) conditions in deeper waters of many lakes. An absence of oxygen changes the bottom chemistry for multiple months. It is critical to track oxygen loss beneath the thermocline and/or the level of the **anoxic boundary**. The anoxic boundary is defined as the depth of water at which dissolved oxygen is depleted in the summer. Anoxia worsens towards the end of summer, just before fall 'turn-over,' which will eventually replenish oxygen to the bottom, even in polluted lakes. Anoxia also tends to worsen over time, increasing incrementally for years and years. Organisms like fish and invertebrates that need oxygen to survive are not able to inhabit deeper waters in many lakes during the summer. Lakes and ponds with severe oxygen problems during summer months also experience increased nutrient levels at the lake bottom. This is the result of changing chemistry between the presence or absence of oxygen.

Lake Nutrients Samples

Water samples should be collected monthly from April to October in at least the deepest part of the lake. The most critical times for sampling are early spring, mid to late summer, and the fall. Sampling depths usually incorporate top, middle, and bottom depths. Deeper lakes may need more samples, and shallower lakes may only need top and bottom samples. Water samples are typically analyzed for total phosphorus, total nitrogen, ammonia nitrogen, and nitrate nitrogen. In baseline assessments, a number of additional parameters are also needed. ***Phosphorus*** and ***Nitrogen*** are the two principal plant nutrients that drive aquatic plant and algae growth. Due to lake temperature stratification, these nutrients are not usually present in the same quantities throughout the lake. Typically, the bottom of the lake has more phosphorus and nitrogen as the summer progresses because bottom-sediments release nutrients when oxygen is depleted. Just as anoxia increases over time, phosphorus and nitrogen also tend to increase over time as a waterbody becomes more eutrophic, or dominated by plants and algae.

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Description of Monitoring Parameters Continued…

Calculated Values

Relative Thermal Resistance to Mixing (RTRM) is a unit-less ratio that describes the difference in water density between each meter. Higher numbers indicate stronger thermal **stratification**. Stratification is the result of density differences as warming surface waters become less dense than cold deeper water. The RTRM is a relative number that distinguishes the intensity and depth of the thermocline. RTRMs describe how the lake is or is not mixing with respect to layers of water at specific depths. RTRMs also show when the lake becomes de-stratified as the result of temperature changes or excessive wind energy that can overcome thermal density boundaries.

Percent Oxygen Saturation is the percentage of dissolved oxygen at a given depth, relative to the water's capacity to hold oxygen, which is based on its temperature. For instance, 50% O_2 saturation means that the water contains only half of the dissolved oxygen that it is able to hold at its current temperature. In essence, anything less than 100% means that the biological oxygen demand, or rate at which oxygen is used up, is depleting the water of oxygen at a rate faster than it can be replenished. A percentage greater than100% is frequently a result of excessive phytoplankton production of oxygen that causes the water to be supersaturated.

Additional Important Profile Measurements

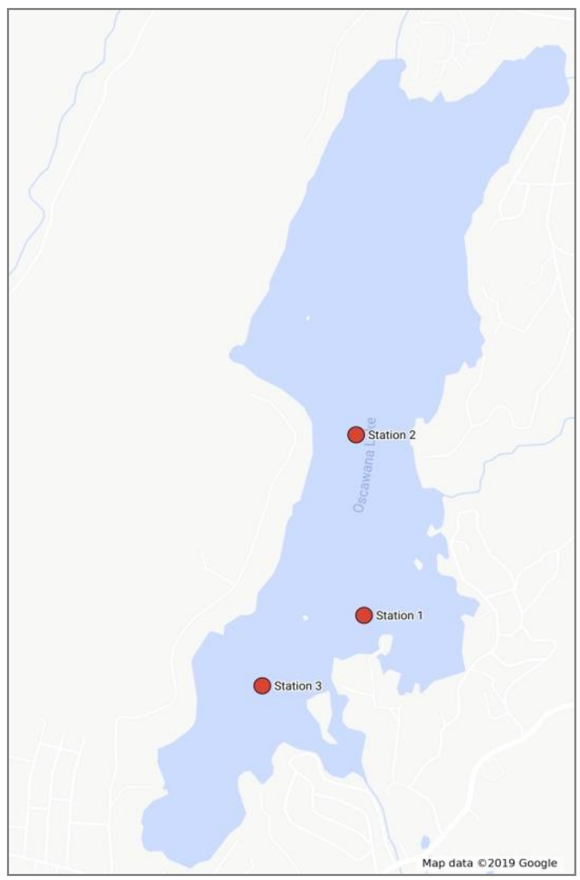
Specific Conductance, also referred to as conductivity, measures the quantity of dissolved ions in water that conduct electricity. Conductivity measurements can also be taken at one-meter increments from surface to lake bottom with calibrated probes. Alternatively only surface samples may also be collected and tested in the lab. Conductivity generally increases with dissolved salt content in the lake, which can be traced to either natural mineral sources or to human inputs from road salting and septic systems.

Station 1: The "Deep Hole" is approximately 35-ft deep and is the primary water quality monitoring site.
(41.39063, -73.84836)

Station 2: The northern monitoring station is located in approximately 27-ft of water.
(41.39553, -73.84824)

Station 3: The southern station is also located in roughly 27-ft of water and represents water quality near some of the most populated and disturbed areas of the lake.
(41.38817, -73.85275)

All water quality monitoring stations are too deep to support aquatic plant growth. All stations lose oxygen from late spring to late summer. The three sites differ substantially depending variable lake conditions.



Water Clarity

The seasonal trends in water clarity at Lake Oscawana for the years 2018-2022 are shown in **Figure 1**. The 2022 water clarity was above the target of 4m briefly at the end of May but declined through June, July, and August to reach poor values of 2.0m in September and October. No water quality monitoring visits occurred in November, but there was a documented cyanobacteria bloom that may have further obscured clarity at that time.

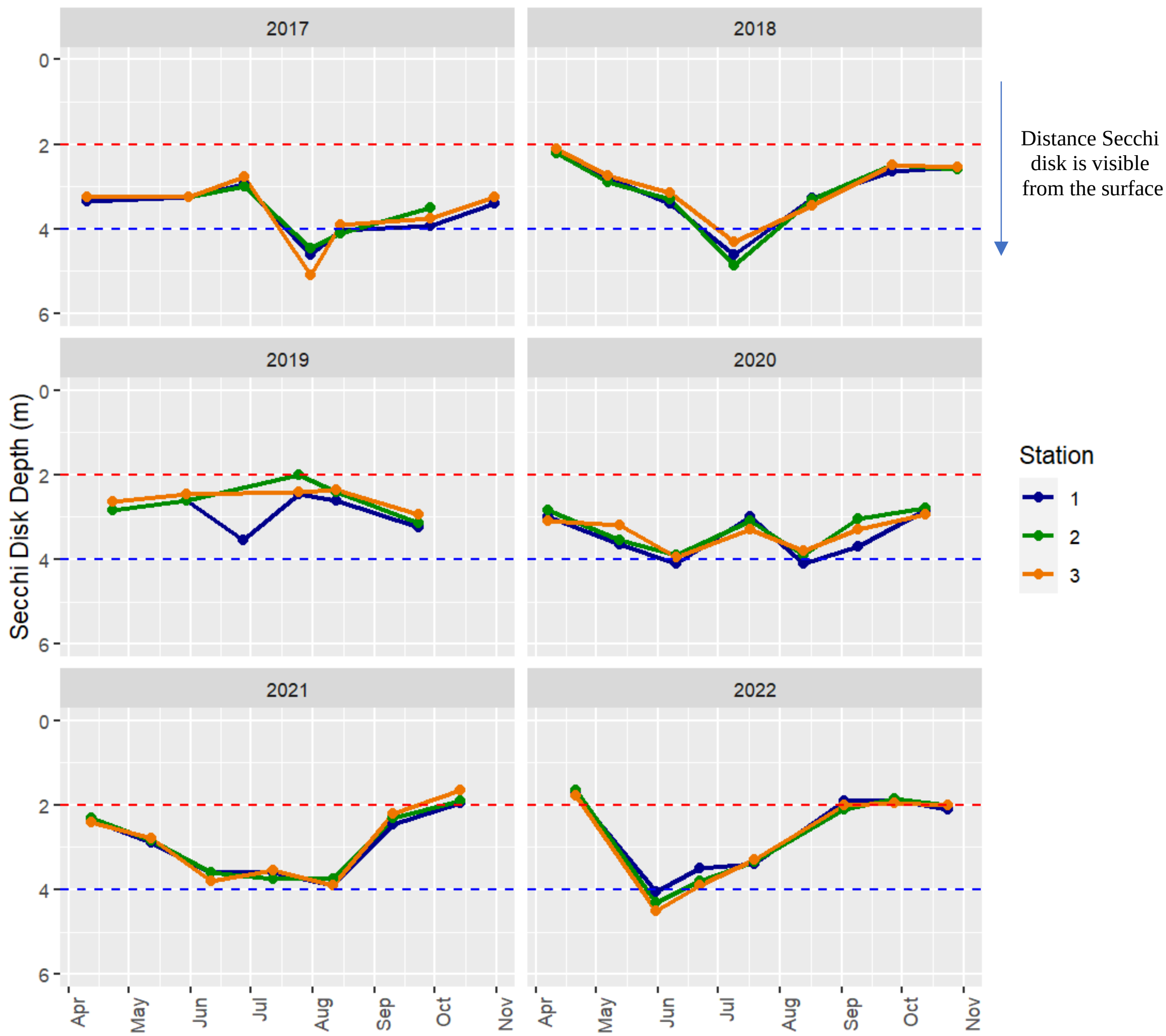


Figure 1. Water Clarity 2017-2022 Seasonal Pattern, St 1-3. Red dashed line shows minimal acceptable clarity, blue dashed line is target clarity.

Water Temperature

The 2022 water temperature profiles measured at Station 1 are shown in **Figure 2**. Profiles collected from Stations 2 and 3 are shown in **Figure 3**. Profiles show the lake thermally stratified by the time of the May sampling visit. The lake formed a stable epilimnion, or mixed layer, between the surface and about 4 meters during June and July. Fall cooling caused the epilimnion to expand downward to 5 meters in early September and 7 meters at the end of September. Water between 7 and 9 meters showed little increase in temperature during June and July but warmed in September. Bottom water deeper than 10 m showed very little increase in temperature over the course of the season. By October, the lake was fully mixed, with nearly consistent temperatures from the top to the bottom of the water column.

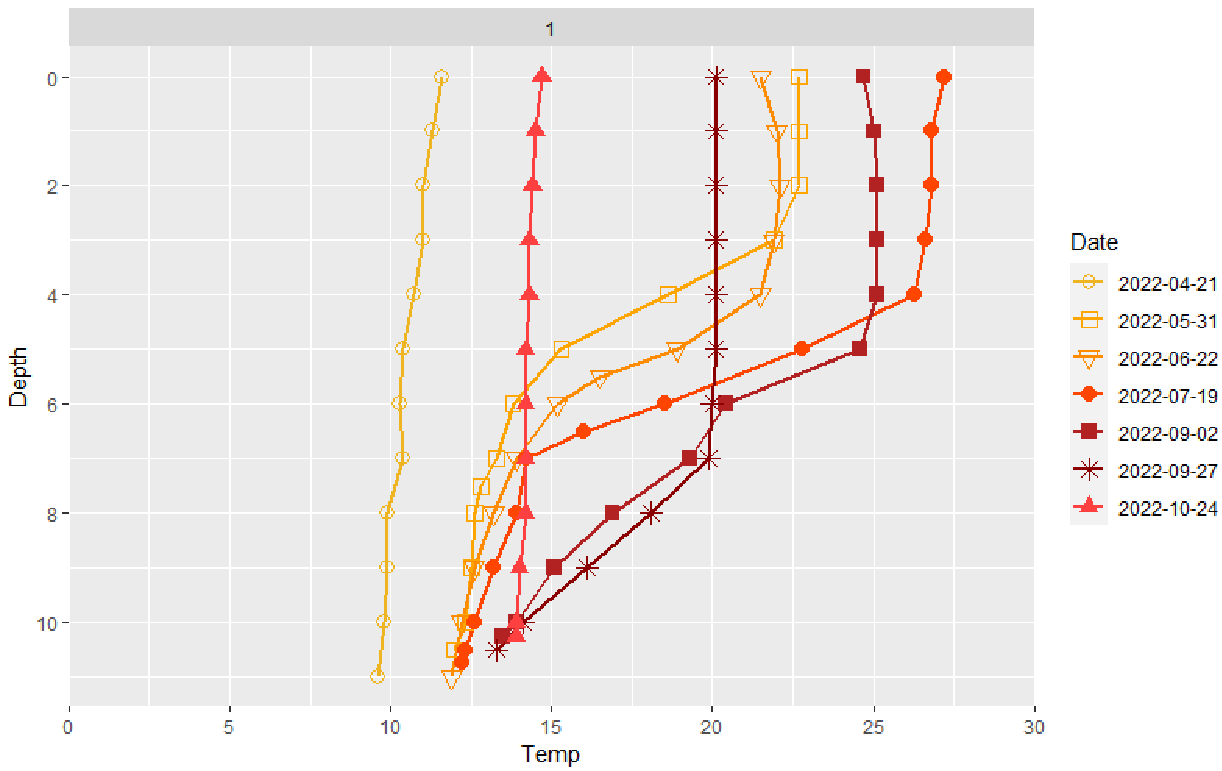


Figure 2. Station 1 Water Temperature (°C) 2022

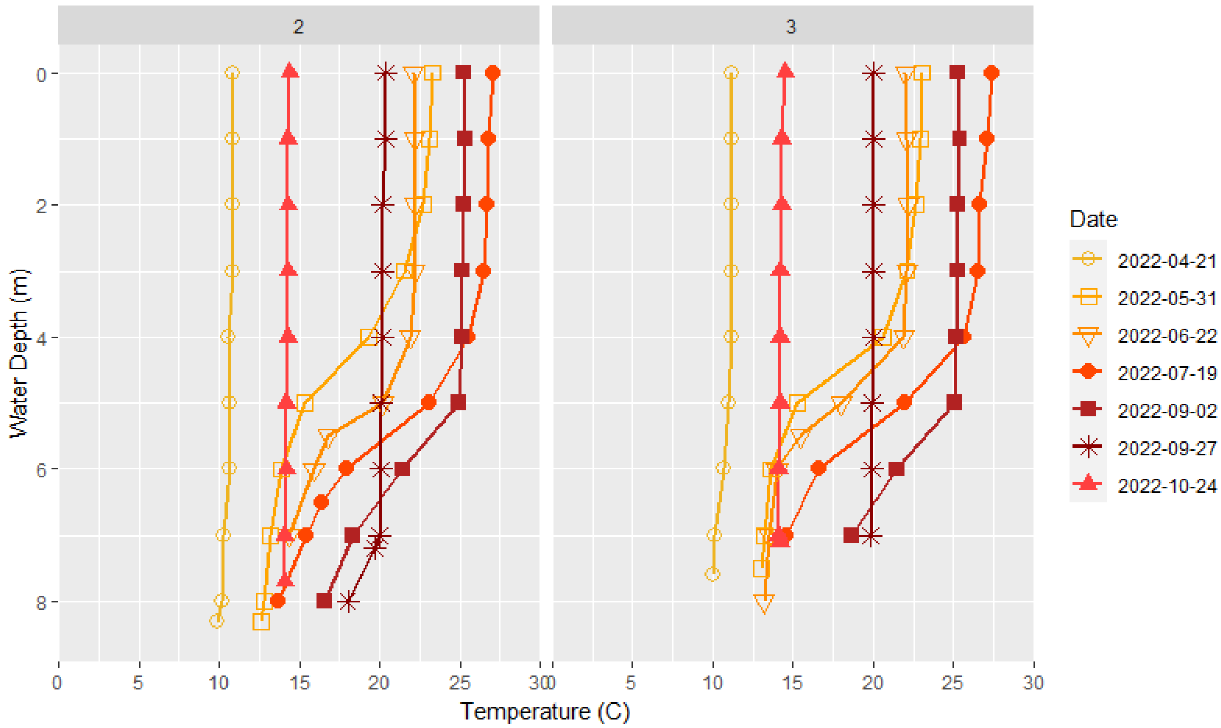


Figure 3. Station 2 & 3 Water Temperature (°C) 2022

The intensity of thermal stratification is quantified using Relative Thermal Resistance to Mixing (RTRM), a dimensionless value calculated using the density differences between 1-meter thick layers of water in the lake. Mixing is defined as taking water from two adjacent meters each with different temperatures and blending them together to get a two-meter-thick layer of the same temperature. The 2022 RTRM values from Station 1 are shown as horizontal bars in **Figure 4**. RTRM values near zero indicate no mixing resistance. RTRM values between 5 and 30 indicate weak resistance to mixing, values between 30 and 60 indicate strong resistance to mixing, and values above 60 indicate very strong resistance to mixing. Tracking the change in RTRM each season allows for understanding of the duration and strength of thermal barriers in the lake, and it defines the location and thickness of the three lake layers during stratification (epilimnion, metalimnion, and hypolimnion).

In 2022, the RTRM values at Station 1 were virtually nonexistent in April and October, indicating the lake was freely mixing at those times. The lake developed mixing resistance in May between 3 and 7 meters. Resistance increased in strength in July to become very strong at 5 and 6 meters, and very strong in September at 6 meters. Water above the RTRM bars is the epilimnion, the layer of water with strong bars is the metalimnion, and deep water without strong bars is the hypolimnion.

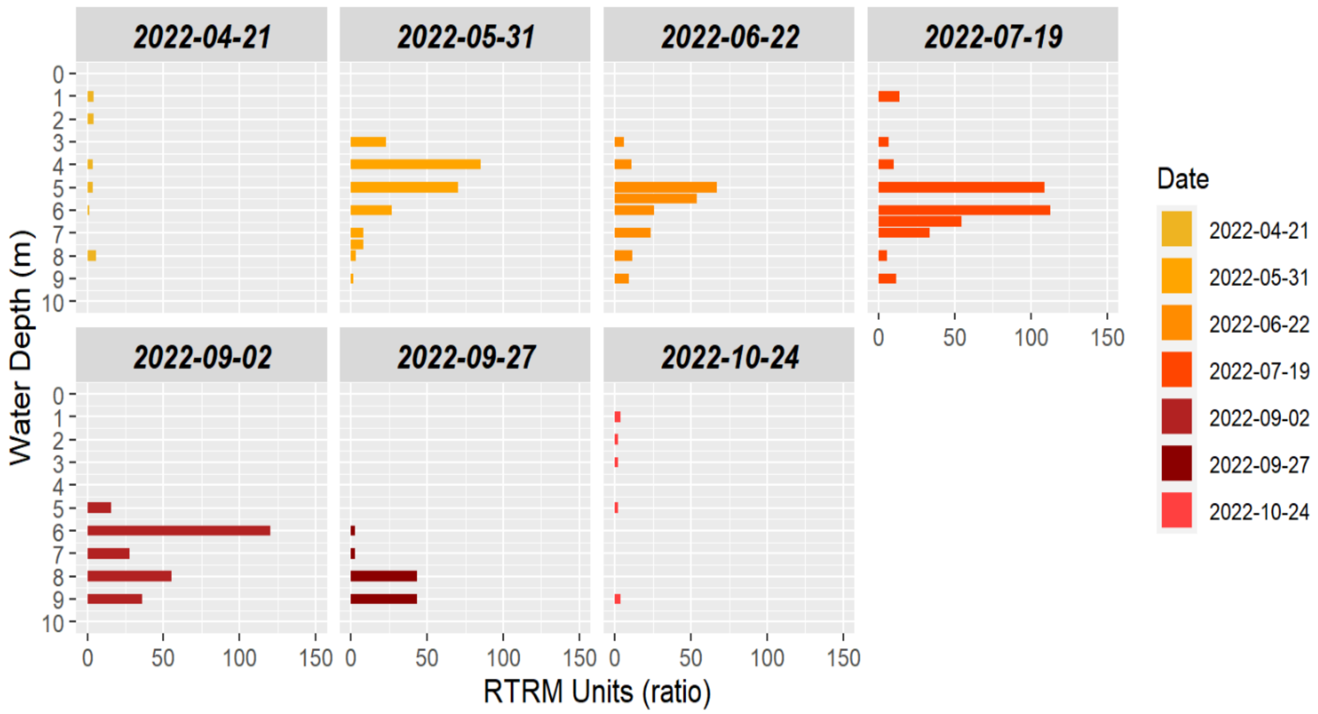


Figure 4. Relative Thermal Resistance to Mixing (RTRM) at Station 1 in Lake Oscawana during 2022.

Dissolved Oxygen

The 2022 dissolved oxygen profiles from Station 1 in Lake Oscawana are shown in **Figure 5**, while Stations 2 and 3 are shown in **Figure 6**. April dissolved oxygen was above 10 mg/L for upper waters. However, below a depth of 6 meters, dissolved oxygen concentration showed significant decline with depth to lowest concentration of 5.97 mg/L at the very bottom. In May, dissolved oxygen concentration was further reduced, and water below 7 meters was devoid of dissolved oxygen (termed anoxic). The bottom waters remained anoxic through September. Dissolved oxygen was fully restored to most depths by October, though water deeper than 8 meters showed low values of dissolved oxygen, indicating active oxidation of reduced materials that had accumulated in the anoxic water during the summer. These materials likely consisted primarily of ammonia, based on the data in **Figure 11**.

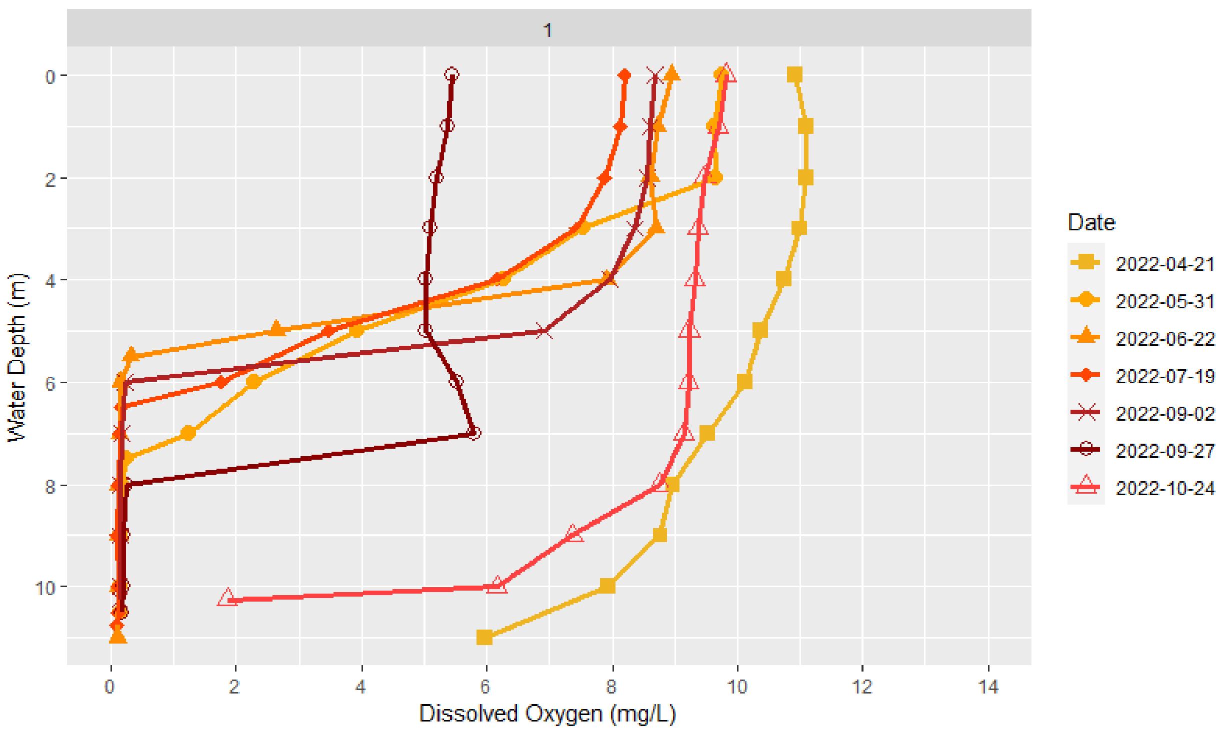


Figure 5. 2022 Dissolved Oxygen profiles from Station 1.

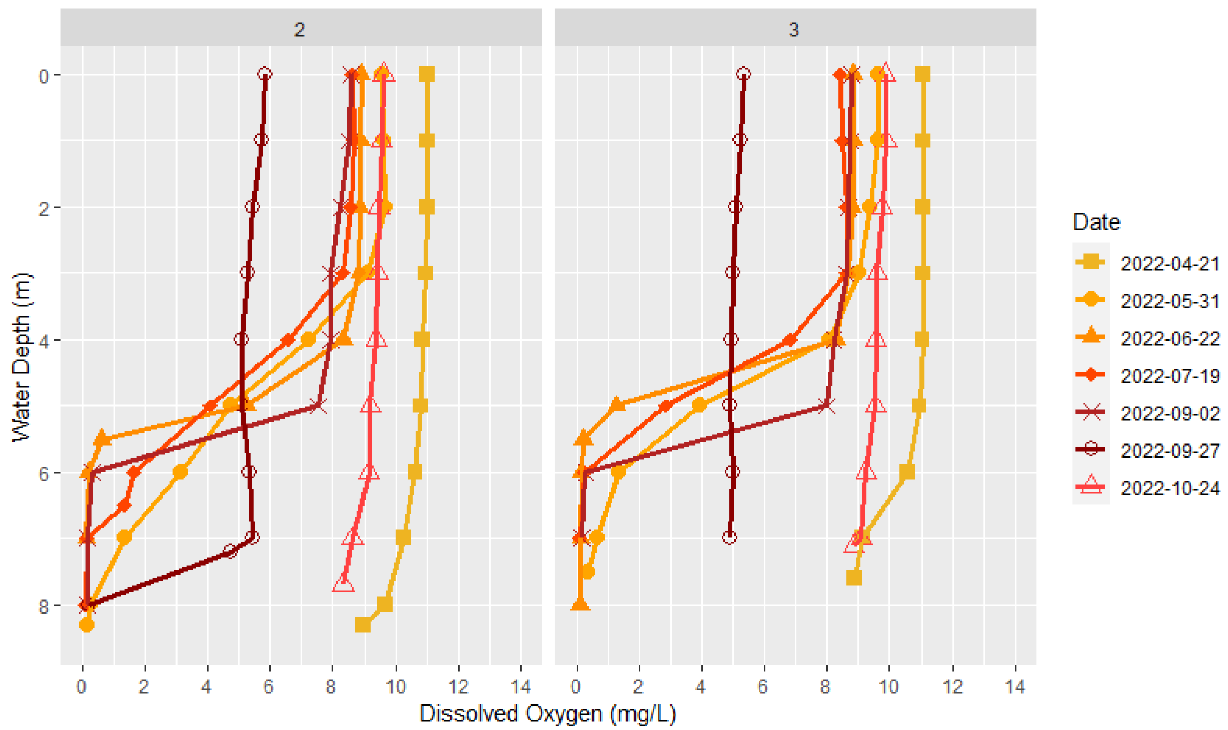


Figure 6. 2022 Dissolved Oxygen profiles from Stations 2 & 3.

The anoxic boundary trends between 2017 and 2022 (**Figure 7**) show the maximum height in 2022 was higher than the prior 5 years. The maximum ascent depth of the anoxic boundary in 2022 was 5.35 meters, occurring in late June. This is possibly the most severe anoxic boundary height recorded thus far. The threshold of concern is anoxic water above 6.0 meters. Ideally, there should be no anoxic water in the lake in April and October.

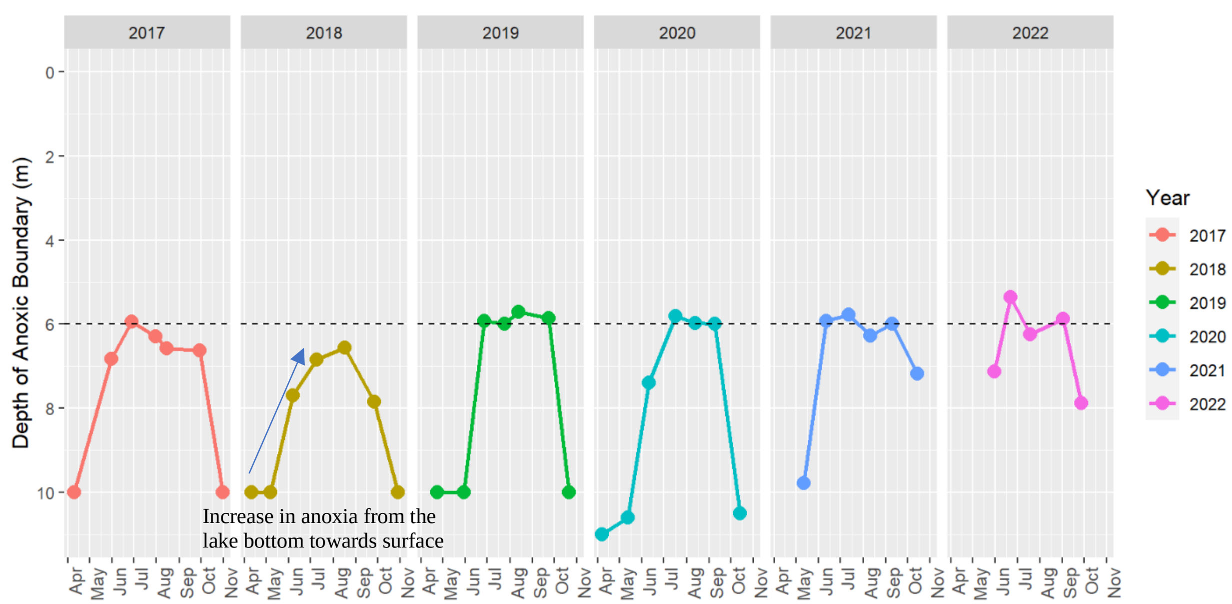


Figure 7. Seasonal Anoxic Boundary Pattern at Station 1 2017-2022

Nutrients

Phosphorus

The total phosphorus (TP) concentration in Lake Oscawana should remain below 20 µg/L in the surface waters for the entire season to minimize the likelihood of harmful cyanobacteria (blue-green algae) blooms. In 2022, TP in the surface waters across all three sampling stations was high to very high on our first sampling visit in April, with Station 2 exhibiting the highest value of 40 µg/L (**Figure 8**). Compared to 2019-2021, the early season values were the highest yet. Surface TP declined to below 20 µg/L during June and July but was elevated at Stations 1 and 2 in early September, while Station 2 remained low. All stations had elevated TP of 25-30 µg/L in late September and October. The surface TP concentrations measured at Station 2 were generally higher in 2022 than in 2021.

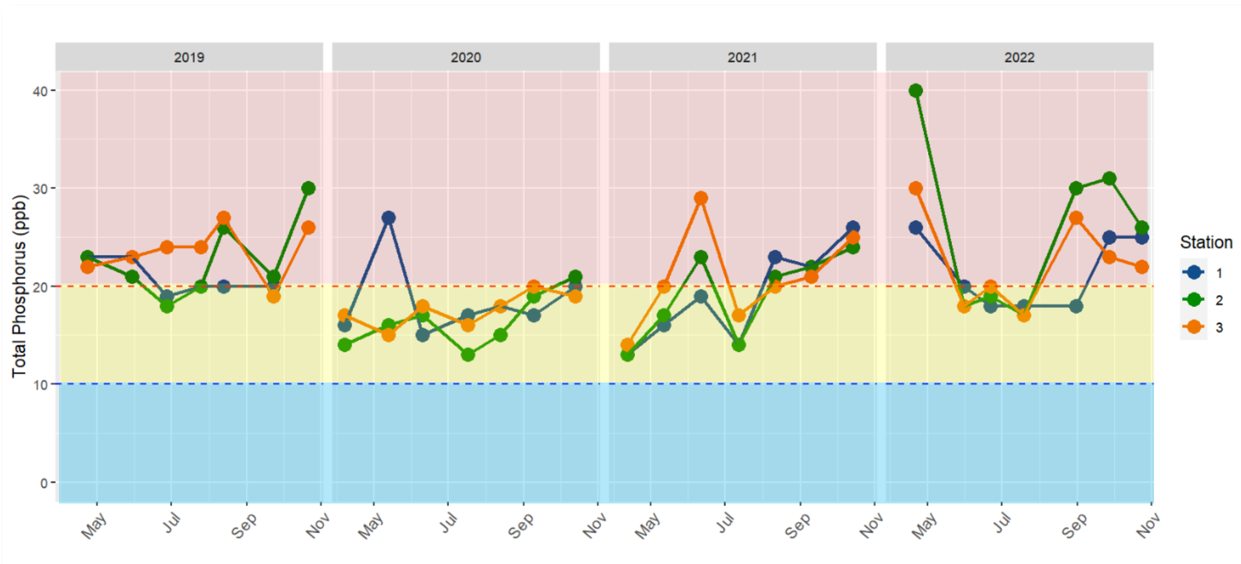


Figure 8. Surface (1m) Total Phosphorus 2019-2022 at all stations

The long term surface phosphorus concentrations, 2008 to 2022, are shown in **Figure 9**.

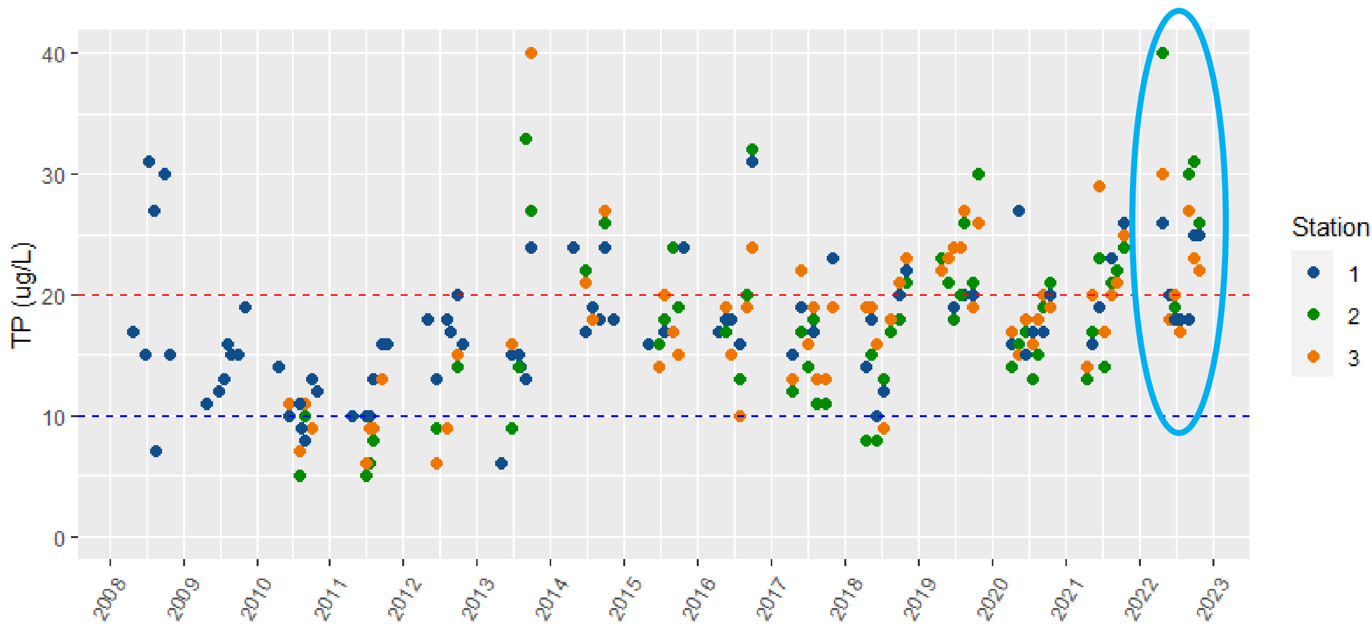
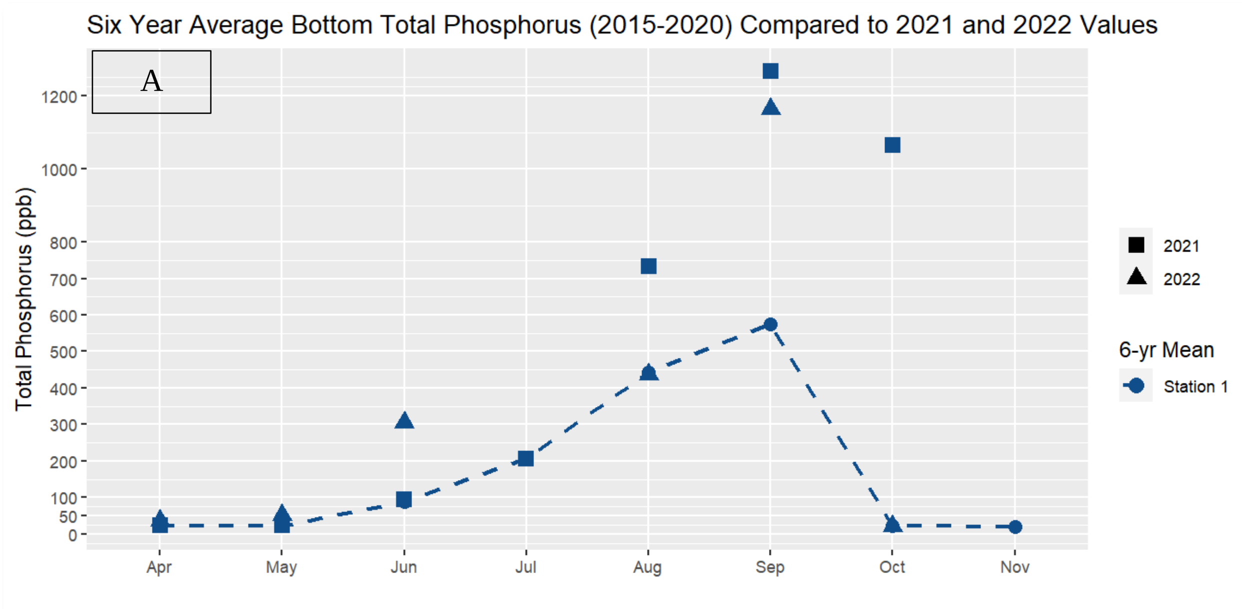


Figure 9. Long-Term Surface Water Total Phosphorus (St.1, 2, & 3)

In **Figure 10** below, the dotted line shows the monthly average bottom-water phosphorus concentrations between 2015 and 2020.



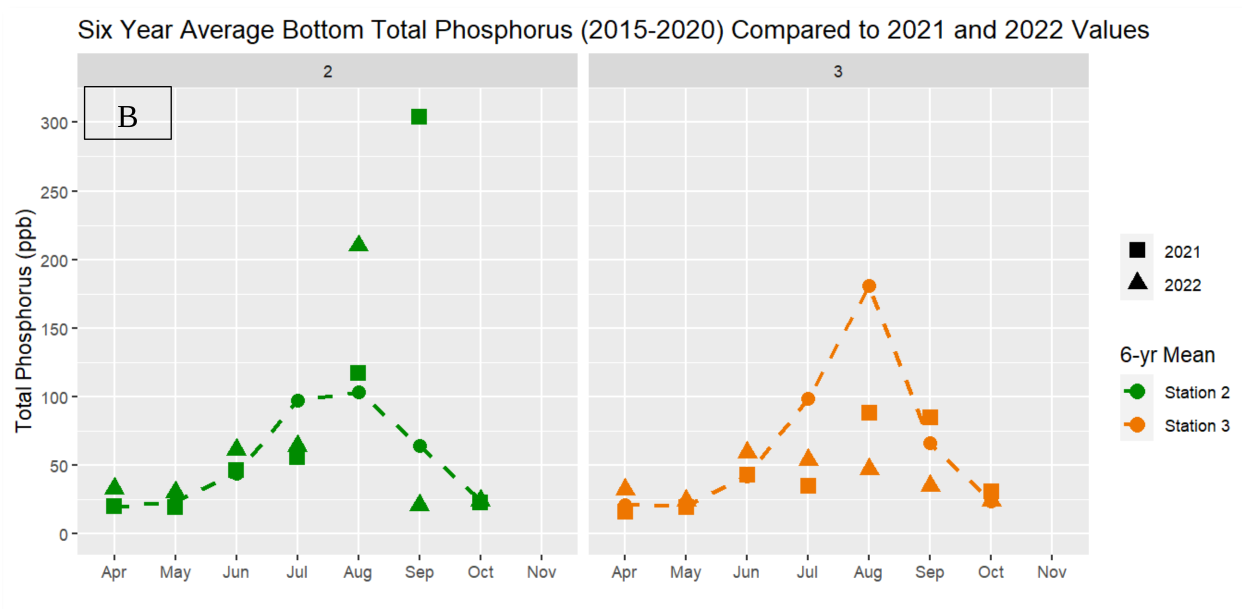


Figure 10. Station 1 (A) & Station 2 & 3 (B) Bottom Total Phosphorus (2015-2020 Mean vs. 2021 & 2022)

Nitrogen

The total nitrogen concentration in 1m water varied between 300 and 400 µg/L for most of the season but spiked at all three stations to a maximum seasonal concentration of 572 µg/L in October (**Figure 11**). This is the highest surface water concentration recorded in the lake since 2012 (**Figure 12**) and was most likely caused by entrainment of ammonia from bottom water that was not yet completely oxidized. The bottom water nutrients total phosphorus, total nitrogen, and ammonia nitrogen are compared in **Figure 13.** Total nitrogen can be seen to consist almost exclusively of ammonia. Total phosphorus release follows the release of ammonia and peaks at the same time.

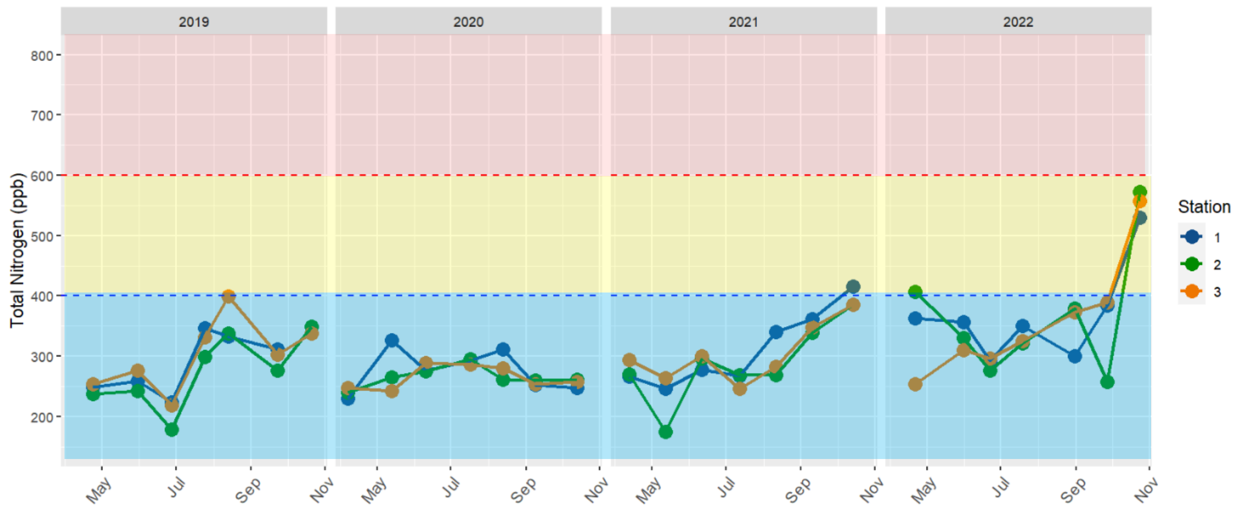


Figure 11. Surface total nitrogen 2019-2022 at all stations

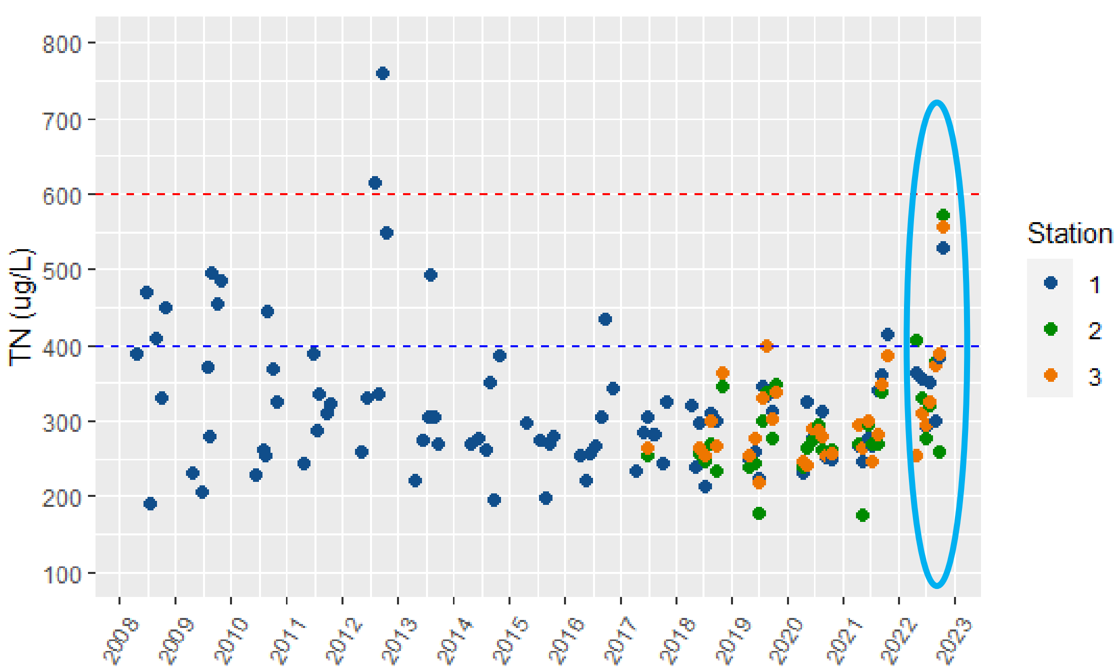


Figure 12. Long-Term Surface Water Total Nitrogen (St.1, 2, & 3)

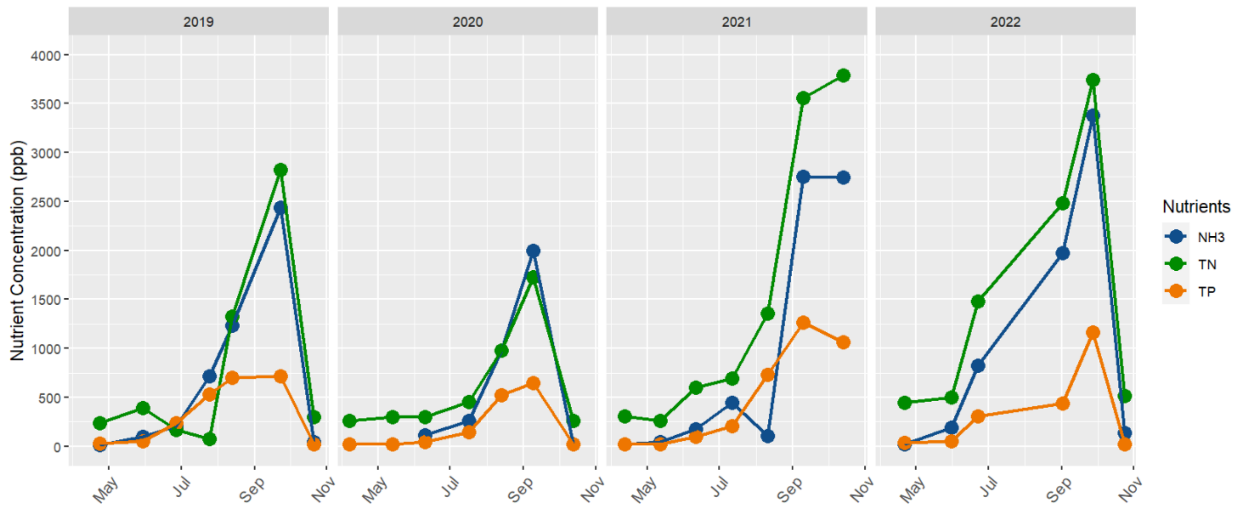


Figure 13. Station 1: 2019-2022 Bottom-water (~9-10m) Nutrients: Ammonia Nitrogen (NH_3), Total Nitrogen (TN), & Total Phosphorus (TP).

Inlet Nutrients & Bacteria

The 2021 and 2022 seasonal inlet nutrient concentrations are displayed for phosphorus in **Table 1** and total nitrogen in **Table 2**. Only inlets 1 and 5 had acceptable levels of phosphorus (20 µg/L). All other inlets had unacceptable phosphorus concentrations at least once during the season, and most had consistently excessively high concentrations.

Nitrogen concentrations of lower than about 200 µg/L are acceptable of lake inlet water; higher values indicate loading of either particulate organic nitrogen, nitrate, or possible ammonia. Total nitrogen exceeding 1000 µg/L is concerning, especially for stormwater events. Baseflow samplings for inlets 2, 3, and 7 were higher than historical values.

In **Table 1** and **Table 2**, blank cells indicate that no sample was collected. Inlet 6 is no longer accessible, and we would like written homeowner approval to cross through the two private residences to access this sampling location in the future.

*Table 1. Inlet **total phosphorus (TP)** concentrations (µg/L) in 2022 (compared to 2021).*

Date	Weather	Inlet 1	Inlet 2	Inlet 3	Inlet 4	Upstream Inlet 4	Inlet 5	Inlet 6	Inlet 7
4/21/22	Baseflow			30	39	3214		NA	880
5/31/22	Baseflow	12	26	73	50	116	16		37
6/22/22	Baseflow			33	46	272			31
7/19/22	Baseflow								
10/24/22	Baseflow	11	39						65
4/12/21	Baseflow	12	13	40	27		13	NA	20
5/12/21	Baseflow	16	22	16	78		20		19
6/11/21	Baseflow	19	44	38	97		21		37
8/12/21	Baseflow				173	955			
9/10/21	Baseflow				56	284			
10/14/21	Baseflow				68	961			

NA = Not Accessible; we need written homeowner permission to access Inlet 6 from private property from now on.

*Table 2. Inlets **total nitrogen (TN)** concentrations (µg/L) in 2022 (compared to 2021)*

	Weather	Inlet 1	Inlet 2	Inlet 3	Inlet 4	Upstream Inlet 4	Inlet 5	Inlet 6	Inlet 7
4/21/22	Baseflow			538	2998	100		NA	22
5/31/22	Baseflow	262	285	855	2137	1911	138		501
6/22/22	Baseflow			767	1868	3302			533
7/19/22	Baseflow								
10/24/22	Baseflow	475	149						207
4/9/20	Baseflow	No samples tested for TN on this date (COC error)							
5/12/21	Baseflow	291	209	515	2275		99	NA	683
6/11/21	Baseflow	400	380	836	1745		137		618
8/12/21	Baseflow				1041	4685			
9/10/21	Baseflow				4130	4382			
10/14/21	Baseflow				2284	5333			

NA = Not Accessible; we need written homeowner permission to access Inlet 6 from private property from now on.

In addition to the nutrient sampling, *Escherichia coli* (*E. coli*) bacteria testing was conducted at the inlets. Samples were collected in-situ by NEAR staff in sterile bottles (provided by the lab) and were delivered to EnviroTest Laboratories, Inc. All *E. coli* bacteria test results are displayed in (**Table 3**) below.

The concentrations from the site upstream of Inlet 4 were generally high in both nutrients and *E. coli* (**Photo 1, Map 1**). Both the very high total nitrogen (**Table 2**) and high *E. coli* (**Table 3, Table 4**) from this pipe indicate that there is a wastewater contamination problem from higher up in the Oscawana watershed than was originally expected. It is still plausible that the Lee Ave homes contribute to elevated groundwater nutrients from onsite wastewater, but it appears that the Inlet 4 issue extends further than previously thought, to homes on and uphill of Sunset Hill Rd. The latitude and longitude coordinates of the bacteria sampling locations are included in the table below, to ensure adequate record keeping.

Photo 1. Sampling Location Upstream of Inlet 4

Map 1. Sampling Location Upstream of Inlet 4

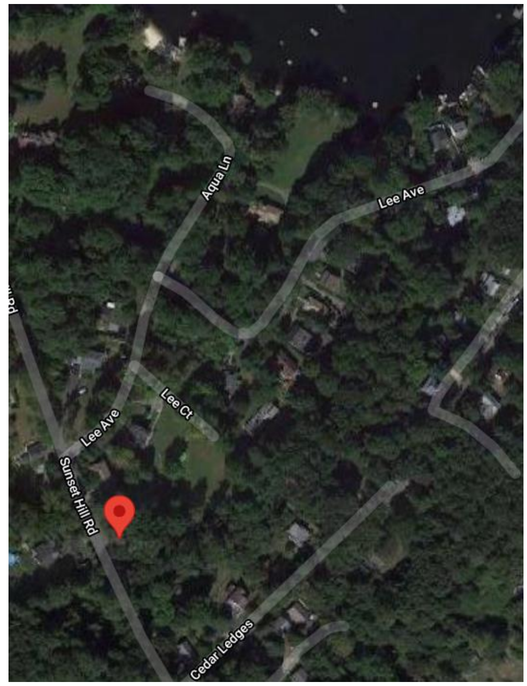


Table 3. All 2022 E. coli samples (Colony Forming Units/100mL)

All baseflow samples	Inlet 3 (41.395986, -73.842008)	Inlet 4 (41.38173, -73.8564)	Inlet 4 Upstream (41.389485, -73.840989)	Inlet 7 (41.38962, -73.84326)
4/21/22	10	20	87,000	20
5/31/22	52	8,700	74	86
6/22/22	95	240	3,300	200
7/19/22	270	88	1,700	440
10/24/22	NS	NS	NS	NS

NS = Not sampled

Table 4. All 2021 E. coli samples (Colony Forming Units/100mL)

All baseflow samples	Inlet 3 (41.395986, -73.842008)	Inlet 3 Upstream (41.397151, -73.833317)	Inlet 4 (41.38173, -73.8564)	Inlet 4 Upstream (41.389485, -73.840989)	Inlet 7 (41.38962, -73.84326)	Inlet 7 Upstream (41.389485, -73.840989)
4/12/2021	11	NS	16	NS	66	
5/12/2021	4	NS	96	NS	38	< 1
6/11/2021	73	30	99	NS	48	64
8/12/2021	NS	NS	330	>2,420	NS	NS
9/10/2021	NS	NS	64	>2,420	NS	NS
10/14/2021	NS	NS	7.4	>2,420	NS	NS

Plankton

Plankton are living organisms that are freely suspended in a lake's water column, including animals (zooplankton) and plants (phytoplankton). Zooplankton are tiny crustaceans (all less than 1/10 of an inch) that swim in open water. Zooplankton have their own form of mobility. Phytoplankton are single cell photosynthetic 'plants' that are suspended in the water column, mostly without mobility. Together, plankton represent the base of the food chain and are connected to everything from water clarity to fisheries populations.

Zooplankton

The most abundant group of zooplankton were the rotifers, whose population was very high in April, crashed in May due to high predation, but dominated for the remainder of the season (**Figure 14**).

Cladoceran Daphnia were present in large numbers in May, with high numbers of large-bodied forms, >0.8mm (**Figure 15**). Small bodied Cladoceran Bosmina (<0.4mm) dominated the Cladoceran populations for the remainder or the season. There were very low numbers of Daphnia present in late September and into October.

Copepods and Cyclopoids also reached peak numbers in May. Cyclopoids are predatory on other zooplankton, especially types of Rotifers and Copepod nauplii. Therefore, the elevated Cyclopoid numbers in May were likely the result of the abundant Rotifer population in April.

There were no Calanoid zooplankton until September and October, when moderate numbers of large bodied Calanoids were present.

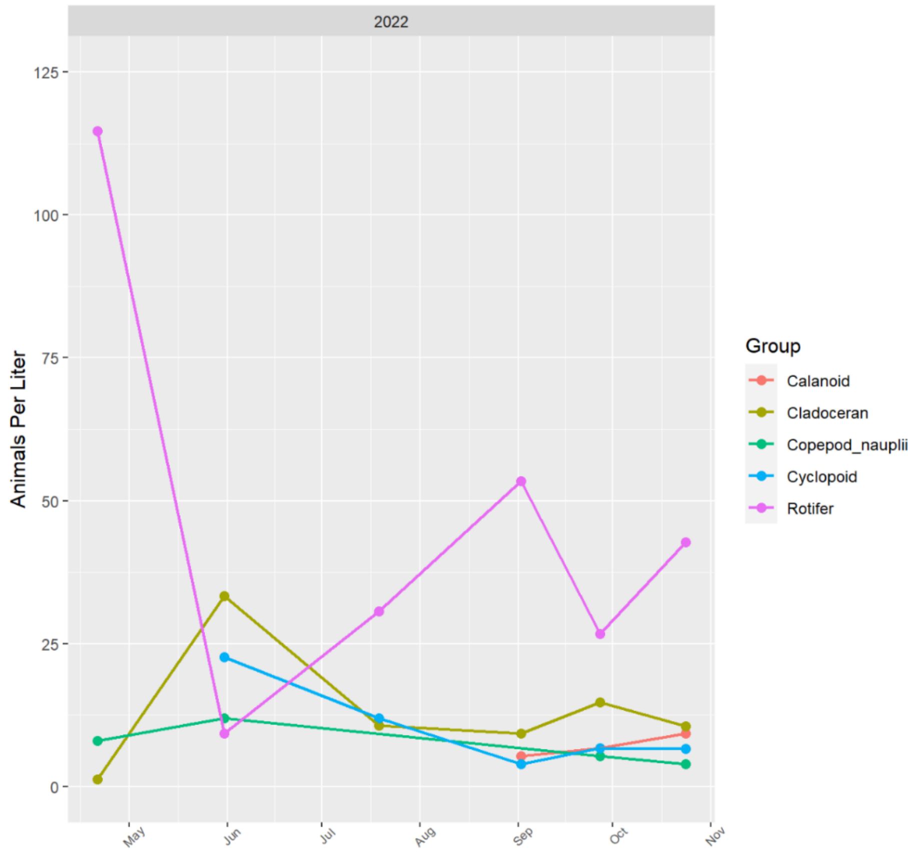


Figure 14. Station 1 Zooplankton Groups in 2022

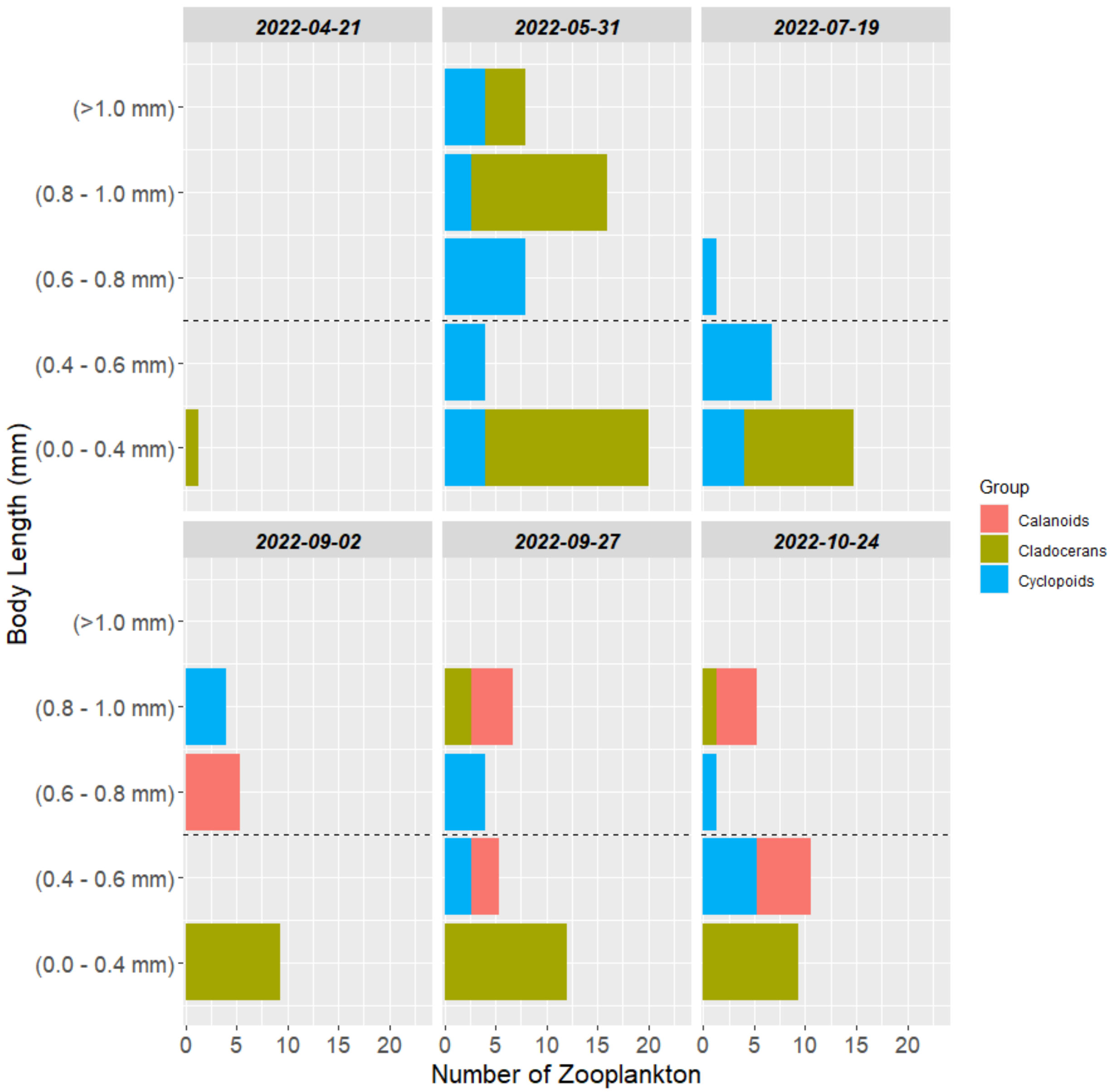


Figure 15. Zooplankton Body Length by Group at Station 1 in 2022. Rotifers and Copepods are generally less than 4mm.

Phytoplankton

Total phytoplankton counts (cells/mL) by group for 2022, 2021, and 2020 are displayed in **Tables 5 & 6**. The lake was dominated by diatoms and cyanobacteria in 2022.

Cyanobacteria, or blue-green algae, can form Harmful Algal Blooms (cyanoHABs) in the presence of high nutrients and calm water. Cyanobacteria prefer late summer conditions and sometimes bloom in the fall, depending on lake temperatures and water density gradients. Oscawana does not have frequent and widespread cyanobacteria blooms every year, primarily because nutrient concentrations remain low enough to prevent dense blooms. Dense surface and shoreline accumulations are generally more common when total phosphorus exceeds 20 ppb (µg/L) in surface waters.

High cyanobacteria cell counts in April and September/October coincided with poor water clarity readings.

Cyanobacteria is a cause for concern because many species produce harmful toxins. At high levels, these toxins pose serious health risks for humans and other animals, such as skin rashes, digestion issues, and/or liver and nervous system damage. One cannot always tell from looking at a cyanobacteria bloom or scum if it is toxic and cell counts are not available immediately upon collection, so it is generally encouraged to minimize exposure for both humans and pets if there is a bloom in the lake. The World Health Organization (WHO) and Environmental Protection Agency (EPA) outline recommended thresholds for cyanobacteria exposure (**Figure 16**).

Table 5. A) Phytoplankton in cells/mL by Group 2022, B) compared to 2021 and C) 2020

A) 2022	**4/21/2022**	**5/31/2022**	**6/22/2022**	**7/19/2022**	**9/2/2022**	**9/27/2022**	**10/24/2022**
Cyanobacteria	33,820	350	875	6,706	30,321	34,054	27,988
Green algae	0	0	0	2,274	0	0	0
Diatoms	9,504	9,330	19,825	2,128	7,697	0	321
Chrysophytes/Golden	292	0	0	0	0	0	0
Dinoflagellates	0	0	0	0	0	0	0
Euglenophytes	0	0	0	0	0	0	0

B) 2021	**4/12/2021**	**4/28/2021**	**5/12/2021**	**6/11/2021**	**7/12/2021**	**8/11/2021**	**9/10/2021**	**10/14/2021**
Cyanobacteria	4,927	6,531	466	379	3,557	10,262	56,647	77,114
Green algae	0	933	146	321	175	0	87	0
Diatoms	4,344	379	4,315	1,720	583	525	525	2,478
Chrysophytes	641	3,061	233	321	0	0	0	0
Dinoflagellates	0	0	0	29	0	0	0	0
Euglenophytes	0	0	0	0	0	0	0	0

C) 2020	4/7/20	5/13/20	6/10/20	7/17/20	8/13/20	9/9/20	10/13/20
Cyanobacteria	8,455	612	0	6,560	2,187	136,565	40,408
Green algae	175	1,224	1,691	1,341	437	4,932	1,224
Diatoms	5,248	6,472	1,895	408	29	2,891	7,755
Chrysophytes	437	204	437	233	15	4,252	204
Dinoflagellates	0	0	0	58	0	0	0
Euglenophytes	0	0	0	0	0	340	0

Table 6. A) Cyanobacteria Genus Counts Monthly A) 2022, B) 2021, C) 2020

A) 2022	4/21/2022	5/31/2022	6/22/2022	7/19/2022	9/2/2022	9/27/2022	10/24/2022
Dolichospermum	0	350	875	0	875	3,499	2,332
Chrysosporum	0	0	0	0	4,956	11,079	22,741
Planktothrix	23,324	0	0	0	4,956	3,499	2,332
Planktolyngbya	10,496	0	0	6,706	19,534	13,994	583
Chroococcus	0	0	0	0	0	0	0
Totals	**33,820**	**350**	**875**	**6,706**	**30,321**	**32,071**	**27,988**

B) 2021	4/12/2021	4/28/2021	5/12/2021	6/11/2021	7/12/2021	8/11/2021	9/10/2021	10/14/2021
Dolichospermum	0	117	0	0	1,953	1,749	1,020	0
Chrysosporum	262	3,499	350	0	1,458	0	36,968	43,294
Planktothrix	4,665	0	0	0	0	0	0	9,329
Planktolyngbya	0	2,915	0	0	0	7,464	18,659	24,490
Chroococcus	0	0	117	379	146	1,050	0	0
Totals	**4,927**	**6,531**	**466**	**379**	**3,557**	**10,262**	**56,647**	**77,114**

C) 2020	4/7/20	5/13/20	7/17/20	8/13/20	9/9/20	10/13/20
Dolichospermum	0	0	6,414	875	3,061	0
Chrysosporum	3,499	612	87	0	0	5,714
Planktothrix	3,790	0	0	0	133,503	22,449
Planktolyngbya	1,166	0	0	1,312	0	12,245
Chroococcus	0	0	58	0	0	0
Totals	**8,455**	**612**	**6,501**	**2,187**	**136,564**	**40,408**

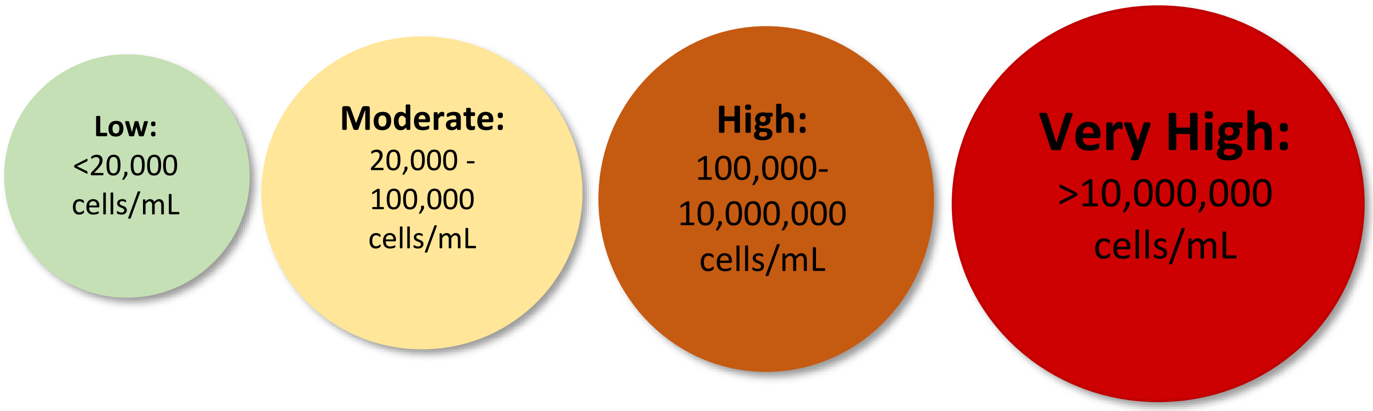


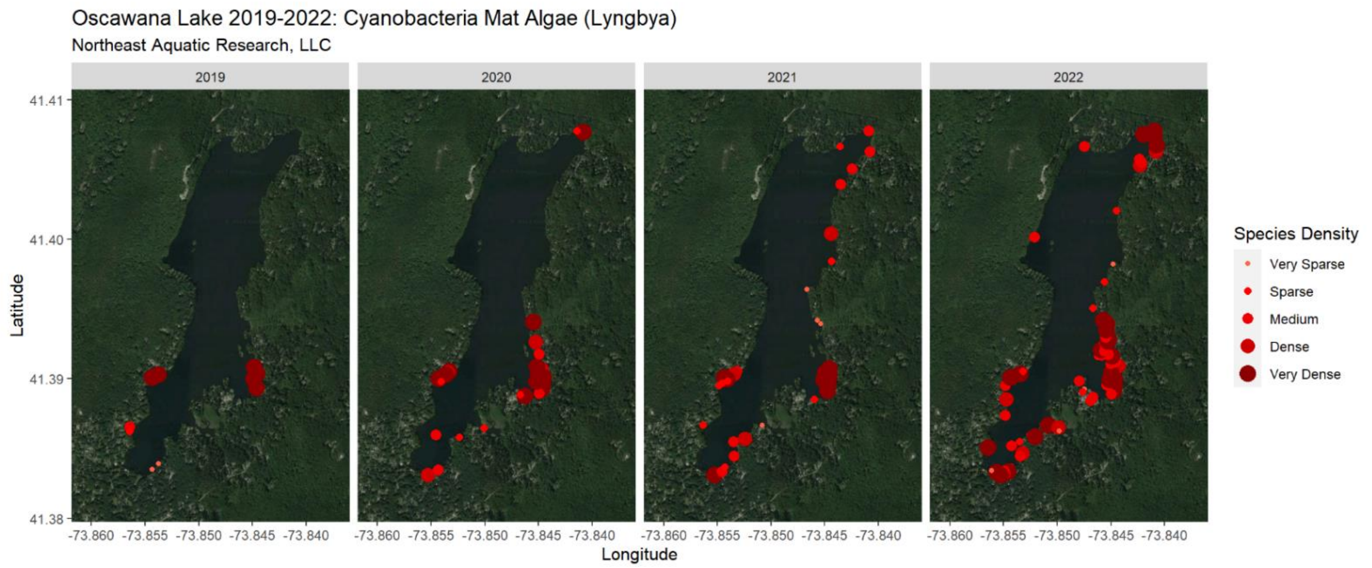
Figure 16. World Health Organization (WHO) probability of health effects based on the number of cyanobacteria present in a water sample.

Photo 2. November 2021 Cyanobacteria bloom near shore

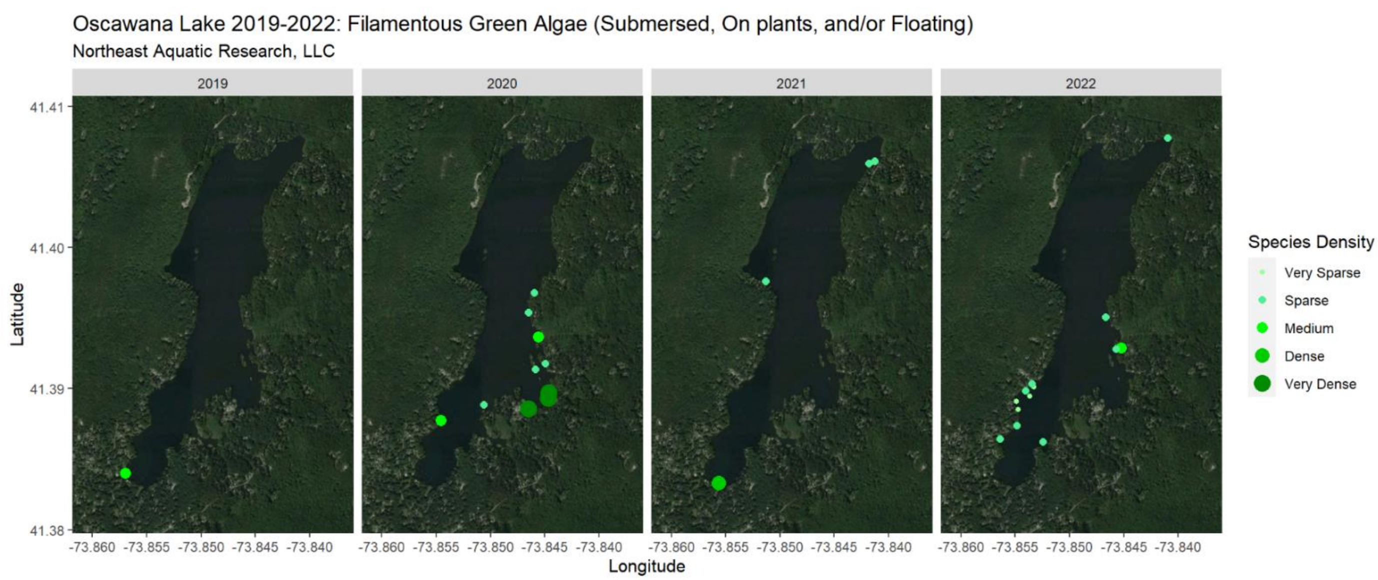
Lake Oscawana residents should be aware that cyanobacteria surface blooms are usually bright to dark green, but a shoreline scum may also appear blue or white. The blue and white coloring occurs as cells become sun-bleached and die. Toxins were not confirmed at the time of the photo, but may still be present in the water even if cells are visibly dead or dying. Residents and their pets should avoid contact with surface scums like in Photo 2. Please do not let your pet drink lake water, particularly if there are any indications of cyanobacteria blooms.

There are also non-phytoplankton types of algae in the lake. Filamentous green algae and filamentous cyanobacteria mats often grow in shoreline areas in Wildwood Cove and, to a lesser extent, in the northern coves and where Inlet 4 flows into the lake at the south end.

Map 2. Cyanobacteria locations, 2019-2022.



Map 3. Green Filamentous algae locations as noted during 2019-2022.



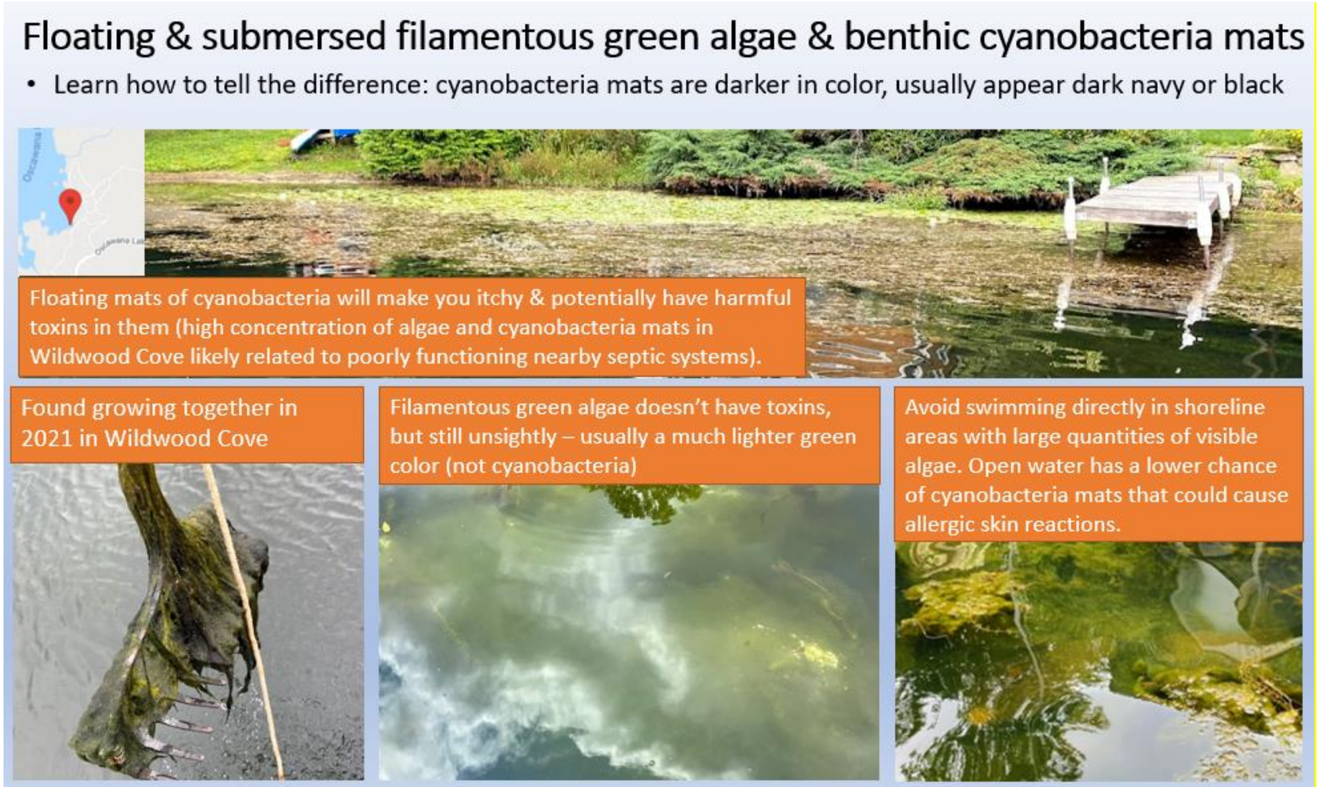


Figure 177. Filamentous Cyanobacteria Mats vs. Filamentous Green Algae (modified slide from presentation).

Aquatic Plant Management

Lake Oscawana was surveyed for aquatic plants on July 20th, 2022. Frequency values for all species in 2019, 2020, 2021, and 2022 are compared in **Table 7**. The following maps provide species density data at all observation points throughout the littoral zone.

The abundance and density of Eurasian watermilfoil decreased dramatically in 2022. This decline is visible in **Map 4**, where only sparse or very sparse beds were recorded in areas that previously had dense beds.

The most dominant species in Oscawana were large-leaf pondweed *(Potamogeton amplifolius)* and coontail (*Ceratophyllum demersum*) (**Map 5, Map 6**). Coontail was found more frequently in 2022 than in 2021. However, the declining frequency of large-leaf pondweed recorded in 2021 was seen again in 2022 (49% in 2021 to 35% in 2022).

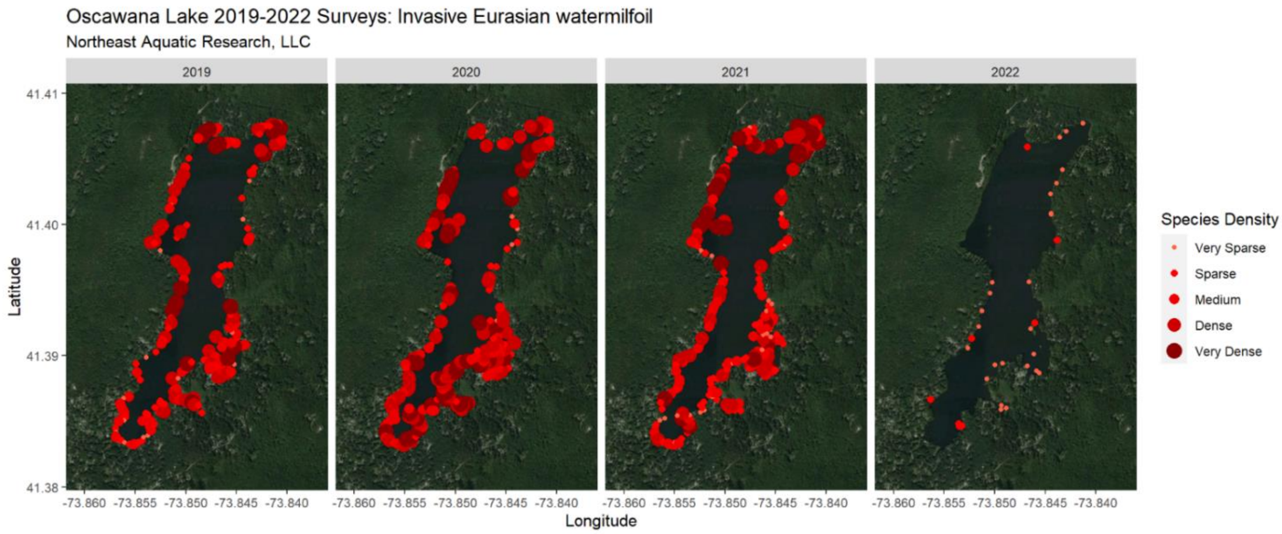
The filamentous green algae *Spirogyra* was present at 5% of waypoints, a slight increase from 2021. The frequency of cyanobacteria mats (*Lyngbya* sp.) doubled from 2021 to 2022. *Lyngbya* sp. is a nuisance species that is not palatable to grass carp. This increase could be caused by a declining population of native macrophyte competitors. *Lyngbya* may also be responding to higher groundwater imput of nitrogen and phosphorus. The map shows cyanobacteria mats increasing in magnitude and denseity in areas of dense cluster housing.

The frequency and density of Robbin's pondweed (*Potamogeton robbinsii*) has steadily dimished over the last few years to be almost nonexistant in the lake in 2022 (**Map 7**). Tapegrass (*Vallisneria americana*) did not change appreciably in 2022 (**Map 8**). The very small populations of invasive brittle naiad (*Najas minor*) and curly-leaf pondweed (*Potamogeton crispus*) reported in 2021 was not found during the 2022 survey.

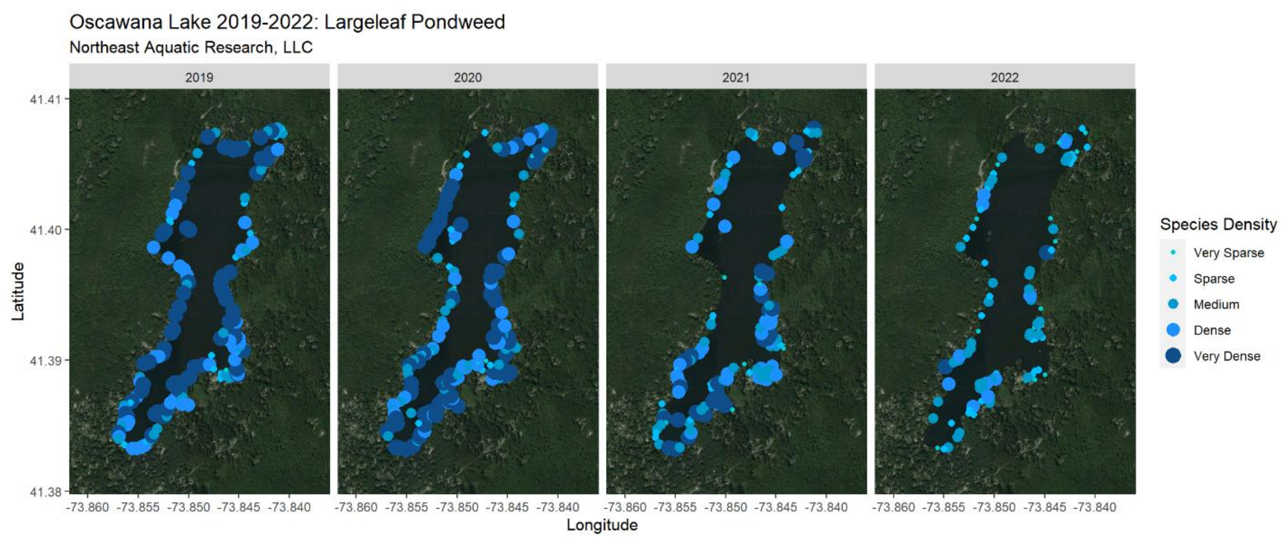
Table 4. Aquatic plant species present in Lake Oscawana during July 2022 survey.

2022				
Scientific Name	**Common Name**	**Year**	**Frequency %**	**Avg. Density %**
Potamogeton amplifolius	Large-leaf Pondweed	2022	35	26
Ceratophyllum demersum	Coontail	2022	35	29
Nymphaea odorata	White Water Lily	2022	33	42
Vallisneria americana	Eel Grass / Tapegrass	2022	27	38
Lyngbya sp.	Cyanobacteria mats	2022	26	51
Myriophyllum spicatum	Eurasian Watermilfoil	2022	12	6
Spirogyra sp.	*Filamentous Green algae*	2022	5	10
Sagittaria graminea	Grassy Arrowhead	2022	3	14
Nuphar variegata	Yellow Water Lily	2022	2	22
Potamogeton robbinsii	Robbins Pondweed	2022	1	4
Elodea nuttallii	Western Waterweed	2022	1	5
Brasenia schreberi	Watershield	2022	<1	10
Najas flexilis	Common Naiad	2022	<1	5
Utricularia minor	Lesser Bladderwort	2022	<1	5

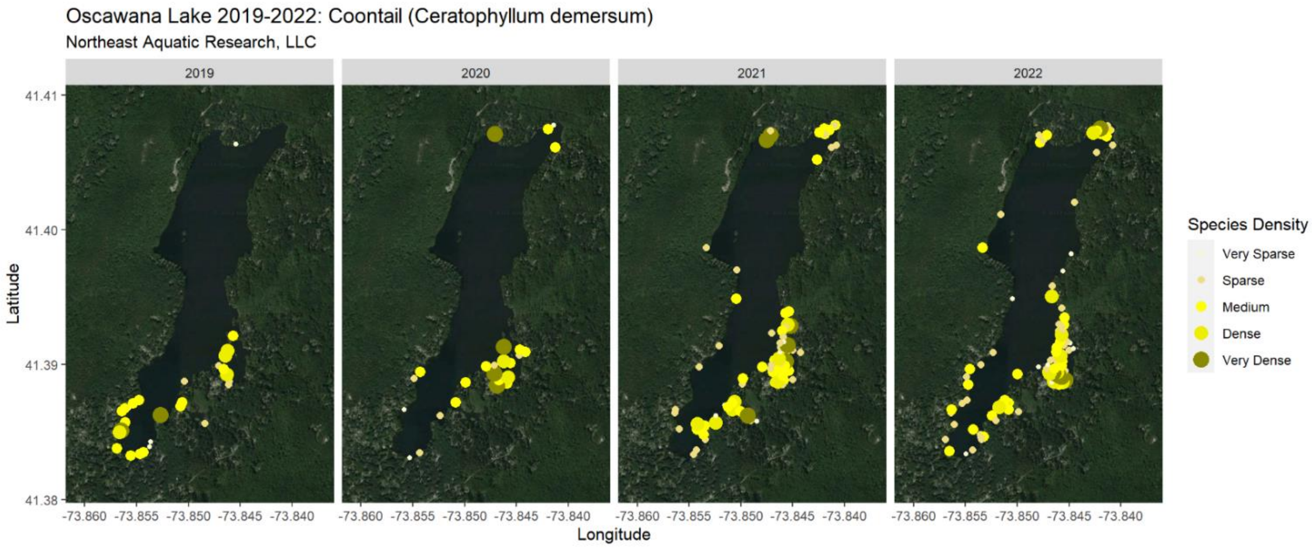
Map 4. Invasive Eurasian Milfoil (Myriophyllum spicatum) 2019-2022 Comparison.



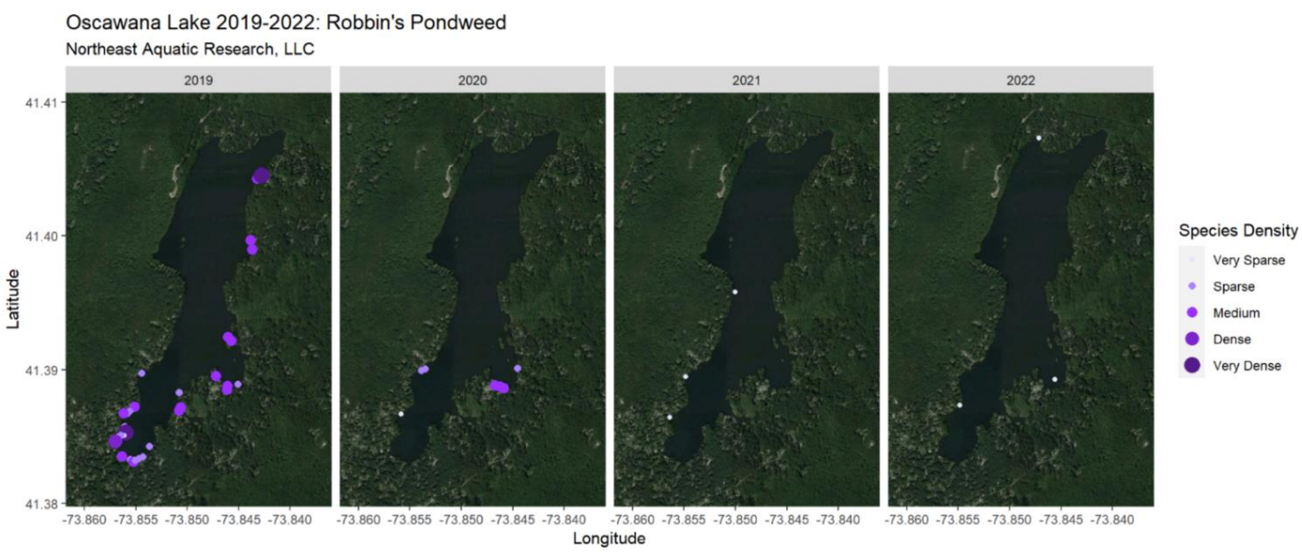
Map 5. Large-leaf Pondweed (Potamogeton amplifolius) 2019-2022 Comparison.



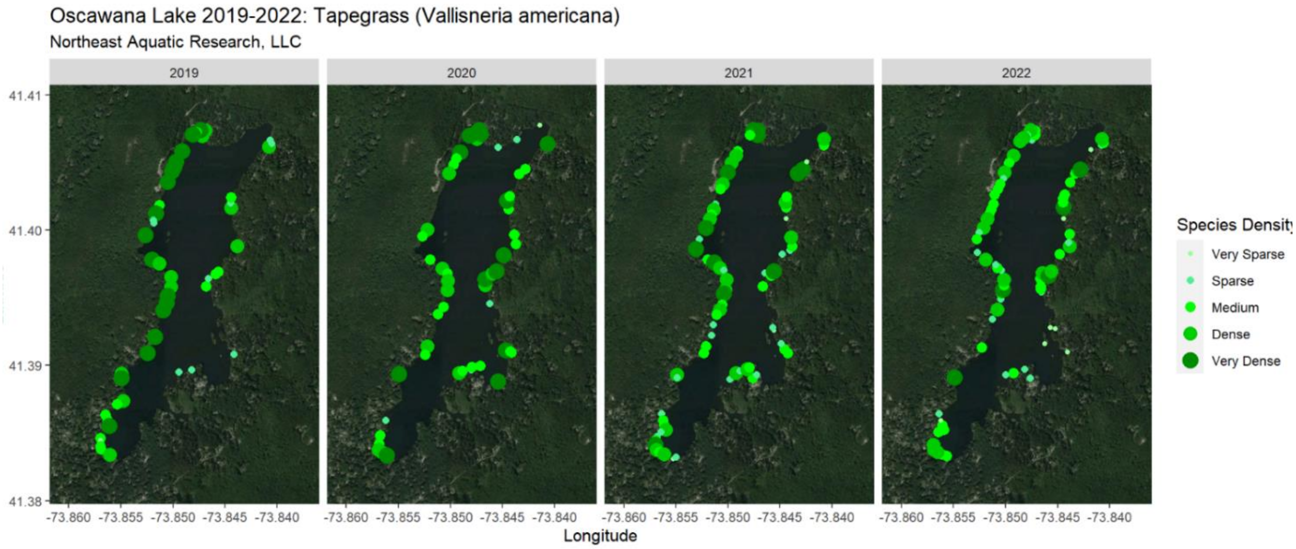
Map 6. Coontail (Ceratophyllum demersum) 2019-2022 Comparison.



Map 7. Robbin's Pondweed (Potamogeton robbinsii) 2019-2022 Comparison.



Map 8. Tapegrass (Vallisneria americana) 2019-2022 Comparison.



Conclusions & Recommendations

Water clarity was very poor in April, while total phosphorus was excessively high, suggesting watershed loading during the winter. By the end of May, when water draining the drainage basin should have dwindled, total phosphorus declined and water clarity improved. However, water clarity steadily declined again during the summer, to end the season with poorest clarity and highest cyanobacteria. Increase in cyanobacteria numbers during the summer and fall is moslty likely due to excessivly high bottom water phosphorus and nitrogen concentrations, in 2022 – maximum TP was over 1,000 ppb, while maximum TN was over 3,000 ppb.

The lake was not fully oxygenated in October, suggesting residule presence of reduced material from the summer anoxia. This suggests that redox componants in the anoxic water may be getting more concentrated. The anoxic boundary occurred almost a meter above the 6 meter depth threshold in 2022, indicating a higher amount of chemical oxygen demand in the anoxic water such that it requires more dissolved oxygen from the mixed layer to quench.

Surface TP was generally acceptable during the summer (<20ppb) but increased to 26-30ppb in early September at Stations 2 and 3. Station 1 remained below 20ppb. This is most likely due to the influence of internal loading at the shallower stations because of weaker and more direct contact of the epilimnion water (the layer of water represented by the surface sample) with the anoxic bottom water. TP concentration increased at Station 1 in late September after the epilimnion mixed down to the anoxic boundary at that station.

- Nutrient loading from most of the inlets is excessive. The water flows associated with grab samples should be measured so that the mass of nutrient loading can be calculated.

- Septic systems have been a long-time contributor of nutrient pollution to Lake Oscawana, and LOMAC and NEAR have been communicating with Town officials and Putnam County health officials to continue efforts in septic pump-outs and upgrades in the watershed features.
- Inlet nutrient data from 2022 continue to indicate a significant wastewater contamination uphill from Inlet 4. The Town should continue to record septic pump-outs through the building department and this information should be copied over into LOMAC files that are stored in Town Hall. The Putnam County Department of Health (PCDOH) is currently following up with potential failed septic systems that were identified during watershed monitoring. Residents may be eligible for up to a $10,000 reimbursement and should reach out to the PCDOH. Continue to ensure catch basin filters located near Chippewa Rd and Winnebago Rd are regularly cleaned and maintained by the Town to prevent the potential release of captured material into the lake.
- Additional grass carp (453) stocked in 2021 had a profound impact on Eurasian watermilfoil (EWM) and certain other native species as of 2022. The native species Robbins pondweed has almost completely disappeared from the lake, while large-leaf pondweed is declining in occurrence and density. The existing carp will need to switch to other remaining species once the EWM has been grazed. The fish consumption rate is likely to increase as they grow larger over the next several years.
- If the level of EWM in the lake continues to be low in future years, it is unlikely that the Town will need to resort to aquatic herbicides. It is uncertain what the 2023-2025 plant surveys will show, but the goal is to maintain native species in moderate levels throughout the lake, though this may be a difficult balance to achieve. If needed, swim areas can still be maintained by a combination of benthic barriers, hand fragment removals, and mechanical harvesting.
- No harvester tracker data was recorded in 2022. A harvester tracking device is recommended as it is difficult to discern the impacts of grass carp without information on where and when mechanical harvesting is being performed.
- The increasing abundance of Cyanobacteria mats is worrisome and needs to be monitored closely. Benthic/floating cyanobacteria mats and filamentous green algae will be a constant problem in Wildwood Cove unless septic systems are upgraded. A decrease in plant density may exacerbate the problem.
- The NYDEC is continuing to evaluate the effectiveness of in-lake phosphorus reduction. In late 2022, Honeoye Lake in Ontario County became the third lake to receive a pilot alum treatment. The results of this study may help establish criteria for utilizing phosphate-binding products (Phoslock, Eutrosorb-WC, or Alum) as a treatment option in the future. Presently the use of these products is hindered by the NYDEC permitting process.
- Water temperature data loggers were deployed in spring of 2023. These daily temperature readings will give a more precise seasonal timing of anoxia and potentially provide data that explains why any surface cyanobacteria accumulations may form.
- Lake monitoring should continue into November to track continuing increases of cyanobacteria and the oxygenation of bottom water.

Appendix

Raw Water Quality Data 2022

Appendix Table 1. 2022 raw nutrient data

Blank rows indicate samples were not run for that analysis.
"ND" indicates the nutrient concentrations was below the detection limit (non-detect).

Date	Station	Secchi (m)	Depth (m)	TP (µg/L)	NH_3 (µg/L)	TN (µg/L)
4/21/2022	1	1.75	1	26		363
4/21/2022	1		4	35		368
4/21/2022	1		6	27		362
4/21/2022	1		10.2	37		442
4/21/2022	2	1.65	1	40		407
4/21/2022	2		7	33		310
4/21/2022	3	1.775	1	20		254
4/21/2022	3		7	32		294
5/31/2022	1	4.05	1	20		356
5/31/2022	1		4	31		419
5/31/2022	1		6	18		302
5/31/2022	1		9.5	53	190	501
5/31/2022	2	4.3	1	18		330
5/31/2022	2		7.3	30		338
5/31/2022	3	4.5	1	18		310
5/31/2022	3		6.5	24		367
6/22/2022	1	3.5	1	18		293
6/22/2022	1		4	21		313
6/22/2022	1		6	39		418
6/22/2022	1		10.2	306	821	1479
6/22/2022	2	3.8	1	19		276
6/22/2022	2		7.5	61		366
6/22/2022	3	3.9	1	20		296
6/22/2022	3		7.2	59		410
7/19/2022	1	3.4	1	18		350
7/19/2022	1		4	22		353
7/19/2022	2	3.35	1	17		321
7/19/2022	2		7	64		578
7/19/2022	3	3.3	1	17		325
7/19/2022	3		6.2	54		683
9/2/2022	1	1.9	1	18		300
9/2/2022	1		4	16		261
9/2/2022	1		6	36		608
9/2/2022	1		9.25	438	1976	2484

9/2/2022	2	2.1	1	30		379
9/2/2022	2		7	210		815
9/2/2022	3	2	1	27		373
9/2/2022	3		6	47		465
9/27/2022	1	1.875	1	25		384
9/27/2022	1		4	23		434
9/27/2022	1		6	26		436
9/27/2022	1		10	1163	3379	3744
9/27/2022	2	1.85	1	31		258
9/27/2022	2		7.5	21		357
9/27/2022	3	1.95	1	23		389
9/27/2022	3		7.2	35		501
10/24/2022	1	2.1	1	25		530
10/24/2022	1		4	25		556
10/24/2022	1		6	24		543
10/24/2022	1		10	23	133	517
10/24/2022	2	2	1	26		572
10/24/2022	2		7.5	24		525
10/24/2022	3	2	1	22		557
10/24/2022	3		7	24		510

Appendix Table 2. 2022 raw profile data

Date	Station	Depth (m)	Temp (°C)	O_2 mg/L	O_2 Sat %	Conductivity µs/cm
4/21/2022	1	0	11.6	10.93	100.9	230
4/21/2022	1	1	11.3	11.09	100.9	230
4/21/2022	1	2	11	11.1	100.3	231
4/21/2022	1	3	11	11	99.1	230
4/21/2022	1	4	10.7	10.75	96.3	231
4/21/2022	1	5	10.4	10.37	92.4	231
4/21/2022	1	6	10.3	10.12	89.7	231
4/21/2022	1	7	10.4	9.53	84.2	234
4/21/2022	1	8	9.9	8.97	79	231
4/21/2022	1	9	9.9	8.77	77.2	231
4/21/2022	1	10	9.8	7.93	69.6	231
4/21/2022	1	11	9.6	5.97	52.2	234
4/21/2022	2	0	10.9	11.03	99.6	230
4/21/2022	2	1	10.9	11.03	99.4	230
4/21/2022	2	2	10.9	11.01	99.2	229
4/21/2022	2	3	10.9	10.97	98.7	229
4/21/2022	2	5	10.7	10.81	96.9	229

4/21/2022	2	6	10.7	10.64	95.1	230
4/21/2022	2	4	10.6	10.86	97.6	230
4/21/2022	2	7	10.3	10.28	91.3	230
4/21/2022	2	8	10.2	9.68	85.4	230
4/21/2022	2	8.3	9.9	8.97	78.9	230
4/21/2022	3	0	11.2	11.09	101	229
4/21/2022	3	1	11.2	11.08	100.7	228
4/21/2022	3	2	11.2	11.08	100.6	228
4/21/2022	3	3	11.2	11.08	100.6	228
4/21/2022	3	4	11.2	11.05	100.1	227
4/21/2022	3	5	11	10.95	98.9	227
4/21/2022	3	6	10.7	10.59	94.7	227
4/21/2022	3	7	10.1	9.11	80.5	227
4/21/2022	3	7.6	10	8.89	78.4	227
5/31/2022	1	0	22.7	9.75	114.9	232
5/31/2022	1	1	22.7	9.63	113.6	233
5/31/2022	1	2	22.7	9.65	113.8	234
5/31/2022	1	3	21.9	7.53	110.8	233
5/31/2022	1	4	18.6	6.27	68.2	233
5/31/2022	1	5	15.3	3.94	40	230
5/31/2022	1	6	13.8	2.29	22.5	231
5/31/2022	1	7	13.3	1.25	12.2	233
5/31/2022	1	7.5	12.8	0.26	2.5	234
5/31/2022	1	8	12.6	0.18	1.7	236
5/31/2022	1	9	12.5	0.16	1.5	239
5/31/2022	1	10	12.3	0.15	1.5	232
5/31/2022	1	10.5	12	0.14	1.4	260
5/31/2022	2	0	23.3	9.56	114.2	228
5/31/2022	2	1	23.1	9.61	114.2	229
5/31/2022	2	2	22.7	9.66	114	229
5/31/2022	2	3	21.5	9.11	105.1	229
5/31/2022	2	4	19.3	7.25	80.1	230
5/31/2022	2	5	15.3	4.73	48.1	227
5/31/2022	2	6	13.9	3.17	31.3	229
5/31/2022	2	7	13.2	1.36	13.2	231
5/31/2022	2	8	12.8	0.24	2.3	240
5/31/2022	2	8.3	12.6	0.18	1.8	245
5/31/2022	3	0	23	9.61	114.1	234
5/31/2022	3	1	22.9	9.61	114.1	234
5/31/2022	3	2	22.6	9.39	110.5	233
5/31/2022	3	3	22.1	9.04	105.6	234
5/31/2022	3	4	20.6	8.07	91.5	230

5/31/2022	3	5	15.3	3.95	40.1	229
5/31/2022	3	6	13.6	1.37	13.4	231
5/31/2022	3	7	13.2	0.66	6.4	233
5/31/2022	3	7.5	13	0.37	3.5	265
6/22/2022	1	0	21.5	8.95	102.9	237
6/22/2022	1	1	22	8.73	101.4	238
6/22/2022	1	2	22.1	8.61	100.2	235
6/22/2022	1	3	21.9	8.7	100.9	236
6/22/2022	1	4	21.5	7.92	91.2	235
6/22/2022	1	5	18.9	2.65	29	234
6/22/2022	1	5.5	16.5	0.32	3.4	231
6/22/2022	1	6	15.2	0.16	1.6	235
6/22/2022	1	7	13.9	0.14	1.3	243
6/22/2022	1	8	13.2	0.13	1.3	260
6/22/2022	1	9	12.6	0.13	1.2	266
6/22/2022	1	10	12.2	0.12	1.2	277
6/22/2022	1	11	11.9	0.11	1.1	392
6/22/2022	2	1	22.2	8.87	103.5	235
6/22/2022	2	2	22.2	8.86	103.5	235
6/22/2022	2	3	22.2	8.84	103.2	234
6/22/2022	2	0	22.1	8.91	103.7	235
6/22/2022	2	4	21.9	8.33	96.5	233
6/22/2022	2	5	20.2	5.25	59	232
6/22/2022	2	5.5	16.8	0.63	16.8	232
6/22/2022	2	6	15.9	0.2	2	230
6/22/2022	2	7	14.4	0.13	1.3	235
6/22/2022	3	2	22.2	8.82	102.7	235
6/22/2022	3	1	22.1	8.83	102.9	235
6/22/2022	3	3	22.1	8.66	100.8	234
6/22/2022	3	0	22	8.85	102.9	236
6/22/2022	3	4	21.9	8.29	96.1	233
6/22/2022	3	5	18	1.27	13.6	227
6/22/2022	3	5.5	15.5	0.21	2.1	230
6/22/2022	3	6	14	0.15	1.5	245
6/22/2022	3	7	13.5	0.14	1.3	246
6/22/2022	3	8	13.2	0.12	1.2	315
7/19/2022	1	0	27.2	8.2	105.8	255
7/19/2022	1	1	26.8	8.13	104.2	259
7/19/2022	1	2	26.8	7.88	101	259
7/19/2022	1	3	26.6	7.45	95.1	272
7/19/2022	1	4	26.3	6.16	78.2	272
7/19/2022	1	5	22.8	3.48	41.5	293

7/19/2022	1	6	18.5	1.77	19.4	260
7/19/2022	1	6.5	16	0.18	1.8	275
7/19/2022	1	7	14.2	0.14	1.4	292
7/19/2022	1	8	13.9	0.12	1.2	319
7/19/2022	1	9	13.2	0.11	1.1	326
7/19/2022	1	10	12.6	0.12	1.2	340
7/19/2022	1	10.5	12.3	0.12	1.1	354
7/19/2022	1	10.75	12.2	0.11	1.1	355
7/19/2022	2	0	27.1	8.61	111.2	265
7/19/2022	2	1	26.8	8.69	111.5	264
7/19/2022	2	2	26.7	8.56	109.5	264
7/19/2022	2	3	26.5	8.34	106.5	263
7/19/2022	2	4	25.5	6.6	82.7	261
7/19/2022	2	5	23.1	4.11	49.2	256
7/19/2022	2	6	17.9	1.66	18	252
7/19/2022	2	6.5	16.4	1.36	14.3	250
7/19/2022	2	7	15.4	0.17	1.8	260
7/19/2022	2	8	13.7	0.12	1.2	320
7/19/2022	3	0	27.4	8.41	109	264
7/19/2022	3	1	27.1	8.49	109.5	263
7/19/2022	3	2	26.6	8.64	110.6	263
7/19/2022	3	3	26.5	8.61	109.9	263
7/19/2022	3	4	25.6	6.83	85.8	261
7/19/2022	3	5	22	2.84	33.3	254
7/19/2022	3	6	16.6	0.26	2.7	254
7/19/2022	3	7	14.6	0.13	1.4	404
9/2/2022	1	0	24.7	8.68	105.2	
9/2/2022	1	1	25	8.6	104.7	
9/2/2022	1	2	25.1	8.55	104.3	
9/2/2022	1	3	25.1	8.37	102.2	
9/2/2022	1	4	25.1	7.96	97.1	
9/2/2022	1	5	24.6	6.91	83.6	
9/2/2022	1	6	20.4	0.22	2.4	
9/2/2022	1	7	19.3	0.18	1.9	
9/2/2022	1	8	16.9	0.16	1.7	
9/2/2022	1	9	15.1	0.15	1.5	
9/2/2022	1	10	13.9	0.14	1.4	
9/2/2022	1	10.25	13.5	0.14	1.3	
9/2/2022	1	0	20.1	5.45	61.2	
9/2/2022	1	1	20.1	5.37	60.4	
9/2/2022	1	2	20.1	5.19	58.3	
9/2/2022	1	3	20.1	5.1	57.3	

9/2/2022	1	4	20.1	5.03	56.5	
9/2/2022	1	5	20.1	5.02	56.3	
9/2/2022	1	6	20	5.52	61.9	
9/2/2022	1	7	19.9	5.8	64.9	
9/2/2022	1	8	18.1	0.26	2.8	
9/2/2022	1	9	16.1	0.21	2.2	
9/2/2022	1	10	14.1	0.19	1.8	
9/2/2022	1	10.5	13.3	0.17	1.7	
9/2/2022	2	1	25.3	8.54	104.3	
9/2/2022	2	0	25.2	8.59	105.2	
9/2/2022	2	2	25.2	8.25	101	
9/2/2022	2	3	25.1	7.94	97.1	
9/2/2022	2	4	25.1	7.92	96.5	
9/27/2022	2	5	24.9	7.52	91.6	
9/27/2022	2	6	21.4	0.32	3.6	
9/27/2022	2	7	18.3	0.17	1.8	
9/27/2022	2	8	16.6	0.14	1.4	
9/27/2022	2	0	20.4	5.85	66.2	
9/27/2022	2	1	20.4	5.74	64.8	
9/27/2022	2	2	20.2	5.44	61.4	
9/27/2022	2	3	20.2	5.27	59.4	
9/27/2022	2	4	20.2	5.1	57.4	
9/27/2022	2	5	20.1	5.09	57.3	
9/27/2022	2	6	20.1	5.35	60.2	
9/27/2022	2	7	20	5.43	61	
9/27/2022	2	7.2	19.7	4.75	53	
9/27/2022	2	8	18	0.22	2.4	
9/27/2022	3	1	25.4	8.72	107.2	
9/27/2022	3	0	25.3	8.78	107.7	
9/27/2022	3	2	25.3	8.7	106.8	
9/27/2022	3	3	25.3	8.61	105.7	
9/27/2022	3	4	25.2	8.21	100.7	
9/27/2022	3	5	25.1	7.97	97.6	
9/27/2022	3	6	21.5	0.29	3.3	
9/27/2022	3	7	18.7	0.16	1.7	
9/27/2022	3	0	20	5.36	60.1	
9/27/2022	3	1	20	5.25	59	
9/27/2022	3	2	20	5.11	57.4	
9/27/2022	3	3	20	4.98	55.9	
9/27/2022	3	4	20	4.96	55.6	
9/27/2022	3	5	19.9	4.92	55.1	
9/27/2022	3	6	19.9	4.98	55.8	

9/27/2022	3	7	19.8	4.88	54.5	
10/24/2022	1	0	14.7	9.82	97	
10/24/2022	1	1	14.5	9.7	95.4	
10/24/2022	1	2	14.4	9.48	93	
10/24/2022	1	3	14.3	9.37	91.9	
10/24/2022	1	4	14.3	9.32	91.3	
10/24/2022	1	5	14.2	9.23	90.3	
10/24/2022	1	6	14.2	9.22	90.2	
10/24/2022	1	7	14.2	9.15	89.5	
10/24/2022	1	8	14.2	8.76	85.7	
10/24/2022	1	9	14	7.37	71.9	
10/24/2022	1	10	13.9	6.16	59.9	
10/24/2022	1	10.25	13.9	1.86	18	
10/24/2022	2	0	14.4	9.62	94.5	
10/24/2022	2	1	14.3	9.56	93.7	
10/24/2022	2	2	14.3	9.47	92.8	
10/24/2022	2	3	14.3	9.42	92.3	
10/24/2022	2	4	14.3	9.38	91.9	
10/24/2022	2	5	14.2	9.18	89.8	
10/24/2022	2	6	14.2	9.16	89.6	
10/24/2022	2	7	14.1	8.62	84.2	
10/24/2022	2	7.7	14.1	8.32	81.3	
10/24/2022	3	0	14.5	9.86	97.1	
10/24/2022	3	1	14.3	9.87	96.8	
10/24/2022	3	2	14.3	9.76	95.6	
10/24/2022	3	3	14.2	9.6	93.9	
10/24/2022	3	4	14.2	9.56	93.5	
10/24/2022	3	5	14.2	9.55	93.3	
10/24/2022	3	7.1	14.2	8.86	86.7	
10/24/2022	3	6	14.1	9.24	90.3	
10/24/2022	3	7	14.1	9.1	88.9	

References:

Wetzel, R.G. 2001. Limnology: lake and river ecosystems. 3rd ed. San Diego (CA): Academic Press.