Ball Pond

2025 Water Quality Monitoring Report

Ball Pond Advisory Committee
New Fairfield, CT

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I. Executive Summary

Overview

Ball Pond is an 89-acre glacial lake in New Fairfield, Connecticut, serving as a vital ecological, recreational, and economic resource. The lake and its 245-acre watershed have experienced significant land use changes over the past century, shifting from predominantly agricultural to mostly residential and wooded areas. These changes have influenced water quality and ecosystem dynamics.

2025 Water Quality Findings

- **Trophic Status**: Ball Pond was classified as mesotrophic to eutrophic in 2025, indicating moderate to high algal productivity. While summer Secchi disk transparency and chlorophyll-a levels suggested mesotrophic conditions, total phosphorus and nitrogen concentrations in the upper water column were characteristic of eutrophic lakes.

- **Nutrient Dynamics**: Phosphorus remains the primary limiting nutrient for algal growth. Epilimnetic (surface) phosphorus averaged 35 µg/L, while hypolimnetic (deep water) phosphorus increased exponentially through the season, reaching 945 µg/L by October. Nitrogen concentrations were also elevated, with hypolimnetic ammonia comprising up to 84% of total nitrogen by late season.

- **Algae and Cyanobacteria**: Algal community assessments revealed periodic cyanobacteria (blue-green algae) blooms, especially along the shoreline. Most cyanobacteria cell concentrations at the deep-water site were within the “little-to-no risk” category for public health, except for a moderate-risk event in late April. Cyanobacteria were most abundant just below the thermocline, driven by internal phosphorus loading.

- **Cyanotoxins**: Microcystin levels at the public beach remained well below the EPA’s recreational threshold of 8 µg/L. Saxitoxin, a neurotoxin associated with Lyngbya sp., was detected at levels near or just below the Ohio advisory threshold (0.8 µg/L) at two shoreline sites, but well below the much higher Washington State threshold.

- **Water Chemistry**: Ball Pond’s specific conductance remains high compared to other Connecticut lakes, reflecting both natural geology and anthropogenic influences such as road salt. pH and alkalinity levels were stable and within ranges that support aquatic life, though high pH and calcium facilitate phosphorus coprecipitation and cycling.

Key Trends and Issues

- **Internal Phosphorus Loading**: Anoxic (oxygen-depleted) conditions in deep water promote the release of phosphorus from sediments, fueling cyanobacteria blooms. The area affected by internal loading may be expanding, now possibly exceeding 43 acres.

- **Cyanobacteria Blooms**: Blooms continue to occur seasonally along the northeastern and southern shorelines, driven by internal nutrient cycling and wind-driven surface accumulation.

- **Management Complexity**: Standard water quality indicators sometimes reflect different trophic states due to phosphorus coprecipitation with calcite, complicating management and assessment.

Recommendations

1. **Continue Monitoring**: Maintain and expand water quality and cyanotoxin monitoring programs to track trends and emerging risks.

2. **Phosphorus Inactivation Planning**: Conduct sediment phosphorus analyses and alum titration studies to develop a targeted alum treatment plan for internal phosphorus sequestration. Secure funding for these pretreatment steps before considering a full-scale alum application.

3. **Watershed-Based Planning**: Treatment with alum is a regulated activity and require State permits. Permit applications that can demonstrate promoting, planning, and implementing best management practices and education in the watershed are looked upon more favorably. These can include public education on invasive species prevention and support watershed-based initiatives (e.g., storm drain maintenance, septic management) to reduce external phosphorus inputs.
4. **Explore Ultrasound for Bloom Control**: Investigate the feasibility and costs of ultrasound technology to manage shoreline cyanobacteria blooms, including outreach to manufacturers and pilot testing.

5. **Community Education and Watershed Initiatives**: Enhance public education on invasive species prevention and support watershed-based initiatives (e.g., storm drain maintenance, septic management) to reduce external phosphorus inputs.

6. **Collaborative Research**: Continue partnerships with academic institutions for advanced monitoring (e.g., data loggers) and participate in regional symposia to stay informed on best practices.

Conclusion

Ball Pond's water quality in 2025 reflects ongoing challenges from both historical and current nutrient loading, with internal phosphorus cycling driving seasonal cyanobacteria blooms. Continued monitoring, targeted management interventions, and community engagement are essential to protect and improve the ecological health and recreational value of Ball Pond.

II. Introduction

A. Lake Characteristics

Ball Pond is an 89-acre natural kettle lake located in New Fairfield, CT (Canavan and Siver 1995, Frink and Norvell 1984). The lake's origins are glacial in nature and a result of the retreat of the Laurentide Ice Sheet some *ca* 10,000 to 12,000 years before present. Ball Pond is now an important ecological, economic, and recreational asset to the Town of New Fairfield. Stewardship of the lake is largely led by the Town's Ball Pond Advisory Committee (BPAC) and by the Friends of Ball Pond, a not-for-profit advocacy organization. The Connecticut Department of Energy and Environmental Protection maintains a public boat ramp on the lake, annually stocks the lake with trout (Jacobs and O'Donnell 2004), and performs other environmental services (e.g., fish surveys).

Ball Pond is largely spring, or groundwater fed, but also receives some stormwater runoff from its watershed. Based on Connecticut's Water Quality Standards, Ball Pond is classified as AA. This designation allows for existing or proposed drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, and water supply for industry/agriculture (NFPC 2014). The lake has a maximum depth of 51 feet (15.4 meters) and a mean depth of 24 ft (7.3 meters).

B. Watershed Characteristics

The 245-acre watershed is relatively small and was reported to lie within the Connecticut Marble Valley geological formation, which consists largely of metamorphosed calcium carbonate (Canavan and Siver 1995, Jacobs and O'Donnell 2002). Local experts have conversely described the bedrock as metamorphic but of a granitic composition, over a billion years old, and with possible influences of glacial erratic deposits high in carbonate minerals that may give Ball Pond water chemistry characteristics like those of lakes in the Connecticut Marble Valley (J. Mellett, personal communication, December 4, 2021).

An analysis of historical land cover in the Ball Pond watershed (Field et.al. 1996) is presented in Table 1. This analysis relied on interpretation of land use using aerial photography from three different dates beginning in 1934. In summary, changes in the watershed between 1934 to 1990 included an overall increase in wooded/forested and residential cover at the expense of the agricultural cover that – in 1934 – accounted for over half of the watershed area. Field et. al. also applied empirical models developed for lakes in Connecticut to estimate total phosphorus (Norvell et. al. 1979) and total nitrogen (Frink 1991) concentrations in the lake based on land cover. The estimated levels for 1934, 1970, and 1990 are also included in Table 1. Jacobs and O'Donnell (2004) more recently described the watershed as mostly residential.

Last year, Bawley Consulting Group (BCG) performed an analysis of recent land coverage in the Ball Pond watershed using digital satellite imagery (Fig. 1). This analysis relied on computer interpretation of land covers using bands of color in the electromagnetic spectrum (color spectrum). Results included percent coverage for impervious, developed open space, and mixed forest of 13.6%, 21.6%, and 28.4%, respectively (see Appendix A for all percent coverage data). Watersheds with greater than 20% impervious coverage are generally considered to be degraded. The first two land cover percentages were generally high, while the forest cover was generally low compared to most Connecticut Lakes suggesting potentially high nutrient and pollutant loading from the watershed. The relatively small watershed to lake area ratio of 2.8 likely lessens the impact of a developed watershed.

Table 1. Percent of residential, agricultural, wooded (ka forested), and water (including the lake) coverage of the Ball Pond watershed. Also provided are estimated total phosphorus (eTP) and estimated total nitrogen (eTN) levels predicted from land cover.

Year	Residential (%)	Agriculture (%)	Wooded (%)	Water (%)	*e*TP (µg/L)	*e*TN (µg/L)
1934	4	52	9	35	15	417
1970	25	18	24	33	25	506
1990	37	15	15	33	32	600

C. Historical Research

In addition to the Field et.al. study, Ball Pond has been included in several state-wide surveys of Connecticut lakes (Deevey 1940, Frink & Norvell 1984, Canavan and Siver 1994, 1995). Siver et.al. (1996) summarized historical changes in 42 lakes, including Ball Pond, using data from those surveys. That study revealed that the average Ball Pond Secchi disk transparency in the lake decreased by 0.1 meter (m) between the 1930s and the early 1990's. Total phosphorus levels increased by 28µg/L between 1934 and the early 1990s, with 19µg/L of that increase occurring since the early 1970s. Canavan and Siver (1995) described Ball Pond as late mesotrophic to eutrophic with total phosphorus levels like those of Bantam Lake in Morris and Litchfield, CT and Lake Waramaug in Kent, Warren, Washington and Litchfield, CT.

Ball Pond was also one of 23 Connecticut lakes used in a paleolimnological study where past water quality was estimated (Siver et.al. 1999). The historical conditions were based on assemblages of fossil bearing microalgae chronologically layered in the lake sediments and highly significant inference models. Water quality reconstructions targeted the *ca* 1890 and *ca* 1990 layers of a sediment core that was dated with a lead-210 isotope dating method. In that study, 100-year changes in water quality were correlated with land use changes between 1934 and 1990. Those correlations revealed that lakes with watersheds that have remained over 80% forested have not significantly changed, whereas those that have become over 25% residential have experienced the greatest amount of adverse change.

Ball Pond exhibited some of the highest increase in specific conductance (dissolved salt levels) of all 23 lakes in the study (Fig 2). The lake also ranked highly for increased pH and trophic score. Siver et.al. (1999) also reported a 29% increase in residential land cover between 1934 and 1990. That land-use change was one of the highest for percent increase in residential land cover over the 66-year period. The 1990 Ball Pond watershed forest cover was only estimated at 48%.

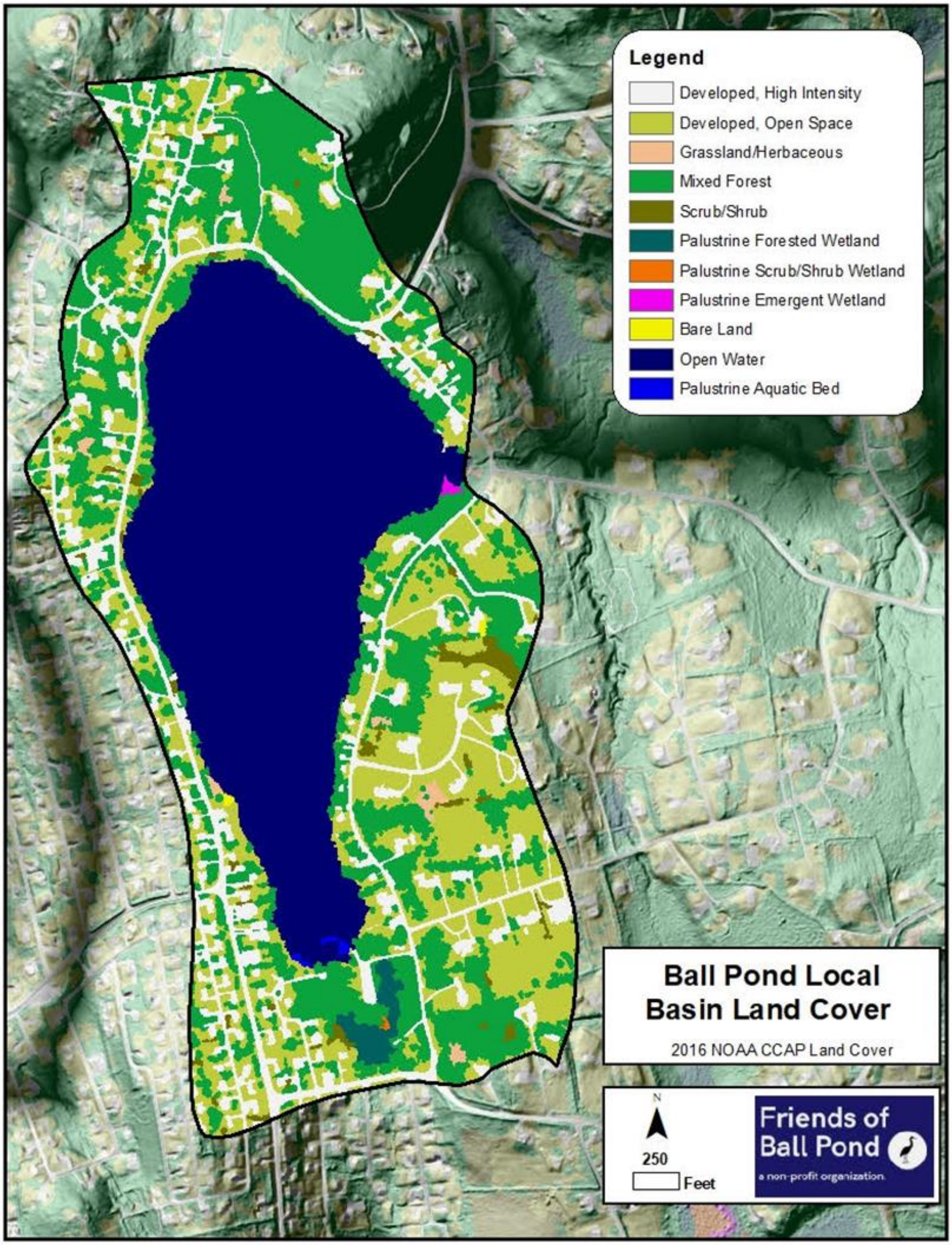

Figure 1. Analysis of the Ball Pond watershed using 2016 satelite imagery from the National Oceanic and Atmospheric Administration Coastal Change Analysis Program (NOAA CCAP). See Appendix A for results in a tabular format.

Last year, we characterized Ball Pond as a mesotrophic to late-mesotrophic lake, i.e., moderate algal productivity. However, the lake experiences localized cyanobacteria blooms along the shoreline, a characteristic of lakes that are eutrophic, i.e. have high algal productivity. Additionally, we reported that much of the aquatic vegetative cover has been dramatically reduced, presumably by the stocking of triploid grass carp, although there are cases in scientific literature where a lake's plant community that is dominated by Eurasian watermilfoil, was decimated by a microscopic pathogen (e.g. Elser 1967, Shearer 1994).

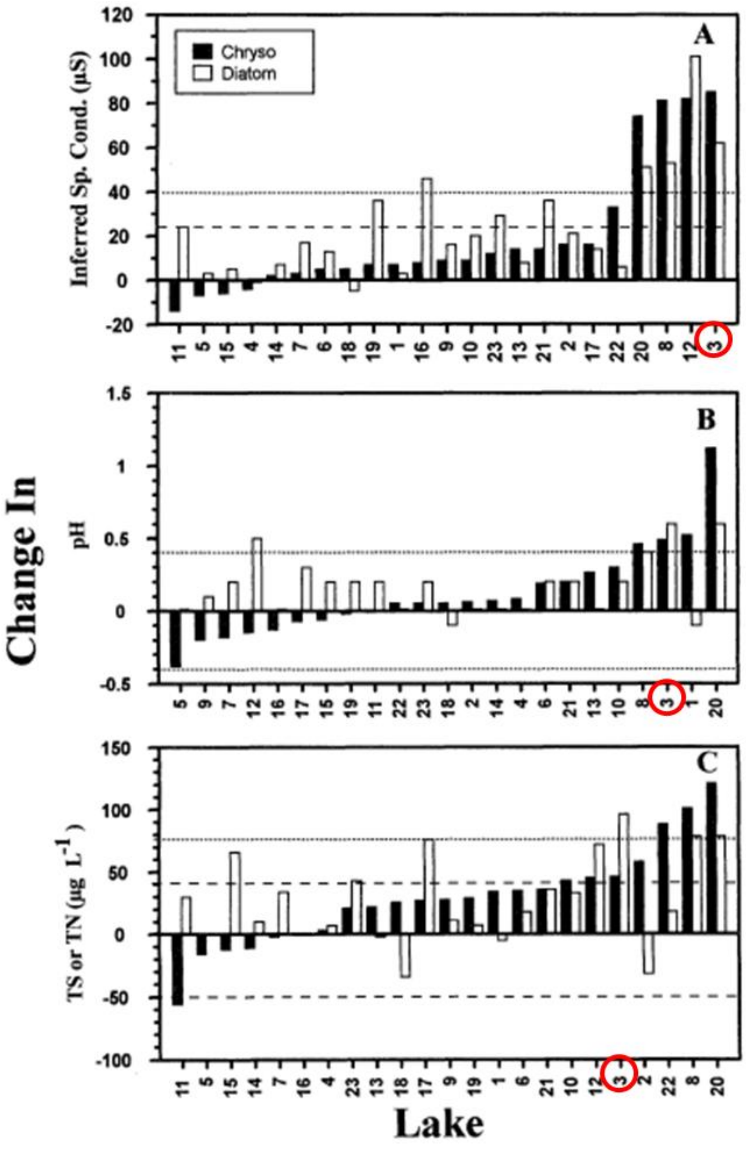

Figure 2. A comparison of 100-yr changes in inferred specific conductivity (A), pH (B), trophic score (C), and total nitrogen (C) of 23 Connecticut lakes based on scaled chrysophyte (solid bars) and planktonic diatom (open bars) remains. Both organismal groups were used to infer specific conductivity 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. Ball Pond is #3 and circled in red in each panel. The figure is directly out of Siver et.al. 1999

Brawley Consulting Group LLC was contracted by the Ball Pond Advisory Committee to perform water quality monitoring in the 2025 season. Data collected was used in conjunction with historical data to understand the water quality trajectories and develop future lake management plans.

III. Methods

A water quality monitoring program was supported by the Town of New Fairfield and the BPAC, which included having Brawley Consulting Group (BCG) collect field data and water samples at Ball Pond monthly between the months of April and October. The sampling dates were April 27th, May 24th, June 22nd, August 2nd, August 23rd, September 28th, and October 19th. Monthly sampling consisted of visiting one deep-water site (41.46286071, -73.52371949; Fig. 3) where the following field data were collected:

- Site maximum depth measured in meters with a weighted field tape

- Secchi disk transparency measured in meters (m) with a standard 20cm Secchi disk
- Temperature (°C), dissolved oxygen (mg/L), percent oxygen saturation (%), specific conductance (µS/cm), pH (SU), and relative phycocyanin concentration (µg/L) measured at 0.5m below the surface, and at each meter from 1m to 15m of depth with a Eureka Manta Multiprobe II

Water samples were collected with a horizontal Van Dorn water sampler at 1m below the surface (epilimnion), and at approximately ½ m above the sediment-water interface (hypolimnion). Additional intermediate depth (metalimnion) samples were collected at the approximate depth of the thermocline (see below). Samples were kept at approximately 3°C in an ice-cooler.

Samples collected for nutrient and chemical analyses were brought back to BCG facilities and frozen until delivered to the UCONN Center for Environmental Science and Engineering (CESE) in Storrs, CT. Concentrations of total phosphorus, total nitrogen, ammonia, and alkalinity were analytically determined. Epilimnetic samples were also tested for base cations and anions. Those included sodium, potassium, calcium, magnesium, and chloride.

Samples were also collected to evaluate chlorophyll-*a* concentrations and the phytoplankton community structure and cell concentrations. For those samples, a weighted tube sampler was used to collect an integrated sample of the top three meters of the water column. The chlorophyll-*a* samples were prepared at BCG facilities by filtering a known volume through a 25 mm diameter filter with 0.7 µm pore size using a vacuum pump/filtration flask system. Filters were then stored in labelled aluminum foil envelopes and kept frozen until delivered to the UCONN CESE laboratory.

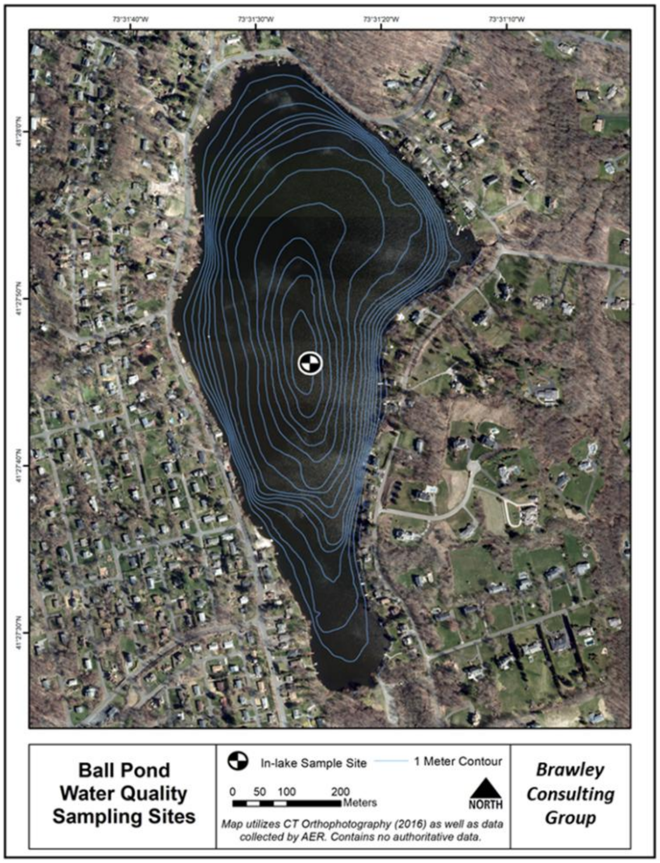

Figure 3. Location of deep-water monitoring site on Ball Pond in 2025.

Samples collected for algae / cyanobacteria counts were treated in the field with Lugol's solution for preservation. At BCG facilities, volumes of those samples were treated with hydrostatic pressure to the collapse the gas vesicles within the cyanobacteria cells (Lawton et al. 1999). Known volumes of hydrostatically treated samples were concentrated into smaller volumes with centrifugation and a vacuum pump/filtration flask system. Portions of those concentrates were transferred to a counting chamber. Genus-level algal cell enumerations were then performed by counting cells in a subset of the chamber's fields using an inverted Nikon Diaphot research microscope; those counts were then corrected to be reflective of the whole water samples.

For a qualitative assessment of the open water phytoplankton community, a 10µm mesh plankton net was used to collect a concentrated algae sample in the field from the top three meters of the water column. Those samples were examined, and important genera photographed in BCG facilities using a Wolfe DigiviTM CVM Microscope with Motic Images Plus 3.0 software.

Water temperature data were utilized to determine thermal resistance to mixing scores, which were used to determine the position of the metalimnion and characterize the strength of the thermocline. Resistance to mixing, which is an assessment of the ability of two different water volumes – that differ in temperature and density – to mix, was calculated using the Relative Thermal Resistance to Mixing (RTRM) formula:

$$(D_1 - D_2)/(D' - D^o),$$

where D_1 is the density of upper water volume, D_2 is the density of the lower water volume, D' is the density of water at 5 °C and D^o is the density of water at 4°C. RTRM scores of <30 mean that layers are mixed; scores of ≥ 30 between strata are characteristic of the transitional metalimnion layer. RTRM scores of ≥ 80 between strata characterizes strong resistance to mixing (Siver et.al. 2018).

IV. Temperature and Oxygen Profiles

Much of the data collected throughout the water column, e.g., temperature, has been displayed as *isopleths* in the following report sections. Levels of water quality variables were displayed as shades of colors throughout the water column at each depth and for all applicable collection dates. Values were then interpolated between depth and dates. Variables of the same value (and color) were connected between dates regardless of depth to create a theoretical representation of changes throughout the water column over time.

The water temperature and oxygen profile data and isopleth charts provided a visual into the thermal and oxygen dynamics of the lake and seasonal stratification resulting from temperature/density differences between depths. In shallow New England lakes, or shallow sites in deep lakes, stratification can occur. When a lake is thermally stratified, a middle transitional layer (known as the metalimnion) separates the upper warmer mixed layer (epilimnion) from lower colder mixed waters below (hypolimnion). Within the boundaries of the metalimnion is the thermocline, which is the stratum where the temperature/density change and resistance to mixing are the greatest. This stratification may be short in duration in shallow sites because wind energy can mix the water column. In deeper lakes, like Ball Pond, stratification is not easily broken by wind energy.

An oxygen concentration of 5mg/L is generally considered the threshold that delineates favorable conditions for most aerobic organisms in freshwater systems. As concentrations decrease below that threshold, conditions become stressful for aquatic organisms. Minimum oxygen requirements for fisheries in Connecticut's lakes and ponds range from 4 to 5mg/L for cold-water fish (e.g., trout), 2mg/L for cool-water fish (e.g., walleye), and 1 to 2mg/L for warm-water fish (e.g., bass and panfish; Jacobs and O'Donnell 2002).

The loss or absence of oxygen at the bottom of the water column modifies the chemical environment compared to conditions where oxygen is present. These anoxic conditions result in the dissolution of compounds (e.g., iron phosphate) in the sediments that can then dissolve in the interstitial waters and eventually diffuse into the waters above the sediments.

The Ball Pond water column was stratified and stable throughout the 2025 season. Resistance to mixing at the thermocline was very strong (RTRM>80) from June through October.

Epilimnetic (upper water column) waters in late April were 14-15 °C. By late June, temperatures recorded at the top meter of the water column had increased to approximately 25 °C and reached season highs of nearly 26 °C by early August. By mid-October, epilimnetic temperatures were again between 14-15°C (Fig. 4).

The strong resistance to mixing at the thermocline prevented most of heat transfer from warmer upper waters to the lower hypolimnetic waters. Hypolimnetic waters only varied from approximately 6 to 9.5°C for the season. A metalimnetic layer characterized by a rapid decrease in temperature with depth was positioned between the epilimnion and hypolimnion strata. That metalimnetic layer trended downward over the season.

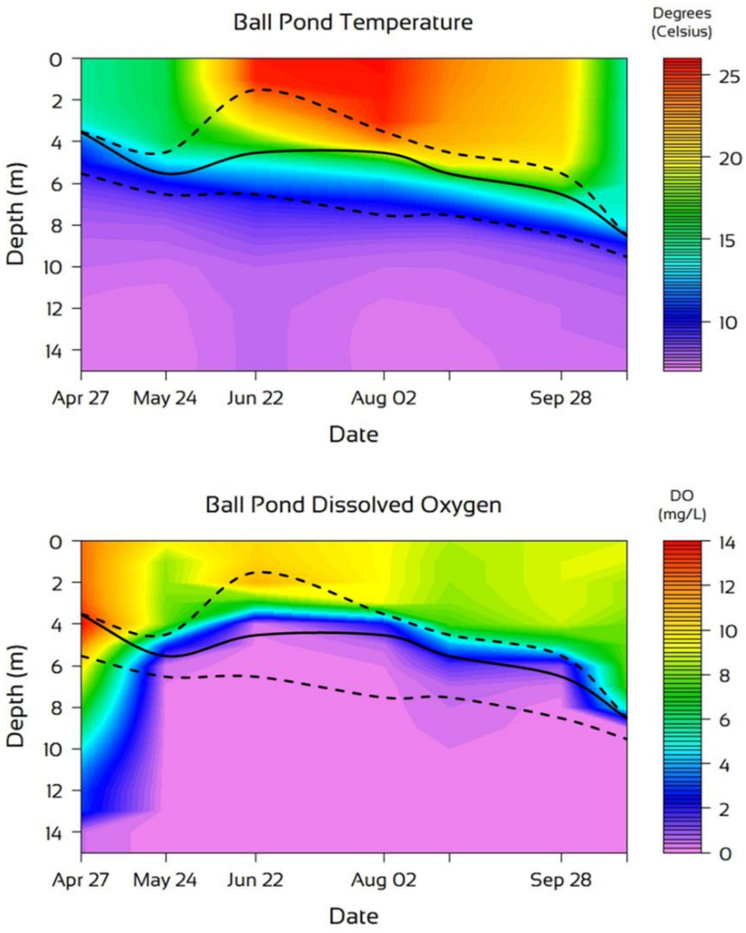

Figure 4. Temperature (top) and oxygen (bottom) isopleth charts for the Ball Pond water column in 2025. The dashed lines represent the position of the upper and lower metalimnetic boundaries; the solid black lines represent the position of the thermocline

In late April, oxygen concentrations of <1 mg/L were only observed at the very bottom of the water column (Fig. 4). But by late May, those conditions were observed from 6 meters of depth to the bottom. By late June, only the top three meters of the water column had concentrations >1 mg/L. The upper boundary of the anoxic zone descended to 9 meters by mid-October. Except for April, the upper boundary of the anoxic zone largely paralleled the thermocline and, on some occasions, may have extended above it.

V. Trophic Characteristics

Several of the water quality parameters measured were used to assess the trophic status of Ball Pond. A lake's trophic status is based on the level of primary productivity it can support and is determined with variables that limit or are related to algal productivity, including phosphorus concentration, Secchi disk transparency, and chlorophyll-*a* concentrations (See Table 2). Lakes supporting low levels of algal productivity are typically clear and are referred to as oligotrophic lakes; lakes supporting high levels of productivity are more turbid and are termed eutrophic or highly eutrophic. It is generally those eutrophic or highly eutrophic lakes that experience regular and intense algal blooms. Lakes with characteristics between oligotrophic and eutrophic conditions can lie within several categories of mesotrophic conditions. Mesotrophic and even oligotrophic lakes can experience algal blooms but those are generally much less intense and infrequent.

Based on the sampling data and classification criteria in Table 2, the trophic status of Ball Pond in 2025 was mesotrophic to eutrophic**.** All trophic, chemical, and field data were compiled in Appendix B.

Table 2. Trophic classification criteria used by the Connecticut Experimental Agricultural Station (Frink and Norvell, 1984) and the CT DEEP (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 Disk 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

A. Secchi Disk Transparency

Secchi disk transparency is a measure of how much light is transmitted through the water column. Light transmission is influenced by several variables including the quantity of inorganic and organic particulate material in the water column that absorbs or reflects light. In the open water environment, Secchi disk transparency is inversely related to algal productivity, i.e., the more algae in the water, the less Secchi transparency will be; the less algae in the water, the greater Secchi transparency will be.

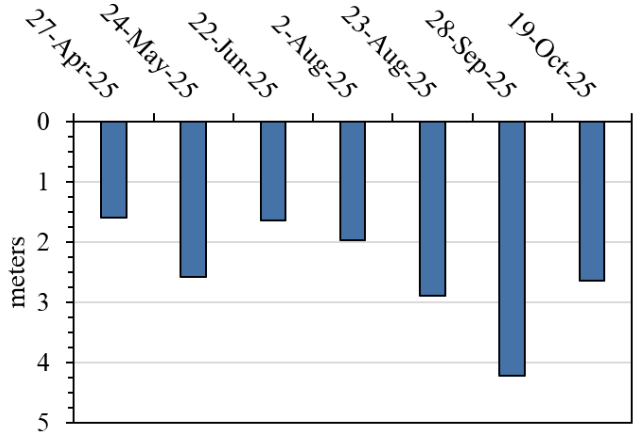

Figure 6. Secchi disk transparencies measured at Ball Pond in the 2025 season.

Light in lakes is important for several reasons, particularly for its role in open water photosynthesis and algal productivity. As light diminishes with depth, so does photosynthetic potential. Since photosynthesis decreases with depth, there is a depth where oxygen produced from algal photosynthesis is equal to the oxygen consumed via algal cellular respiration. That is referred to as the Compensation Point and is estimated by multiplying the Secchi disk transparency by 2.

In the first four months of the 2025 season, all but one of the Secchi transparency measurements were <2 meters, with season lows of 1.60 and 1.64 meters in April and June (Fig. 5). The latter part of the season saw improved Secchi transparency, with a season high of 4.22 meters in September. The season average was 2.51 meters while the summer months (July – September) average was 3.03 meters. Based on the summer month average, Ball Pond exhibited mesotrophic algal productivity in 2025.

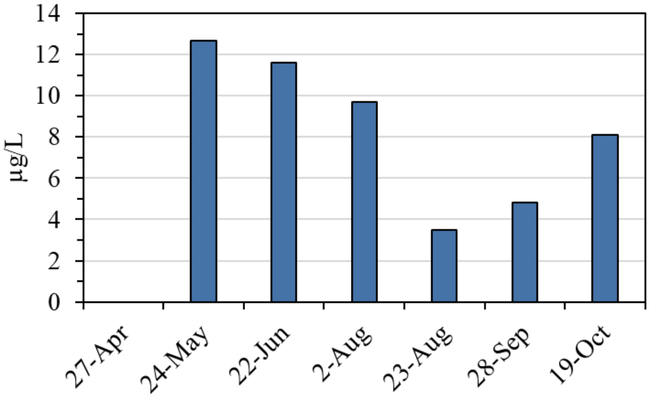

Figure 6. Chlorophyll-*a* concentrations measured in the 2025 monitoring season at Ball Pond.

B. Chlorophyll-a Concentrations

Chlorophyll-*a* is the photosynthetic pigment common to all freshwater algae and cyanobacteria, and a useful surrogate measurement for algal biovolume in the water. Concentrations reported here were reflective of the algal productivity in the top three meters of the water column (see Methods).

Concentrations ranged from highs of 12.7 and 11.6 µg/L in late May and late June to a season low of 3.5 µg/L in early August (Fig. 6). The summer month (July – September) average was 6.0 µg/L while the season average was 8.4 µg/L. Based on the summer month average, Ball Pond was a mesotrophic lake in 2025 (Table 1). Seasonally, concentrations decreased through late August before increasing through mid-October.

C. Total Phosphorus

Algae and cyanobacteria require a variety of micro- and macronutrients to survive. In most freshwater systems, phosphorus is the nutrient that limits algae growth (i.e., the limiting nutrient). Therefore, total phosphorus (the sum of particulate and dissolved forms of phosphorus) also serves as a measure of productivity in lake assessments.

The average epilimnetic total phosphorus concentration for 2025 was 35 µg/L which is characteristic of eutrophic conditions. Season highs were measured in late May and June at 58 and 48 µg/L, respectively. Season lows of 23 and 22 µg/L were measured in late August and late September, respectively. In general, early season levels were greater than late season levels.

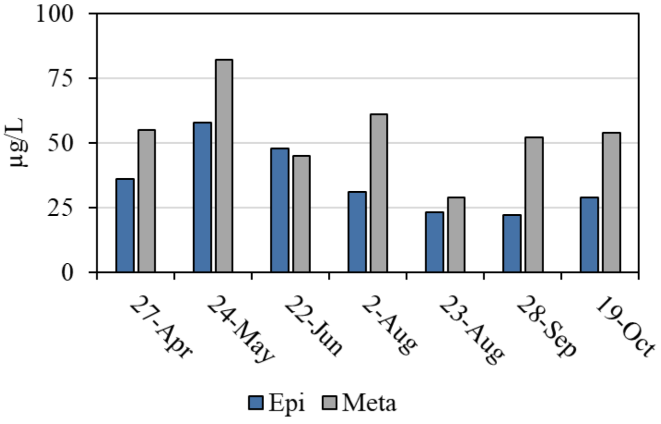

Figure 7. Epilimnetic (Epi) and metalimnetic (Meta) total phosphorus levels in Ball Pond in 2025.

The average metalimnetic total phosphorus concentration was 54 µg/L and significantly greater than the epilimnetic average based on a paired t-test ($p<0.001$). Apart from late June and late August, metalimnetic concentrations were notably greater than epilimnetic levels (Fig. 7). The season high of 82 µg/L was measured in late May while the season low of 29 µg/L was measured in late August.

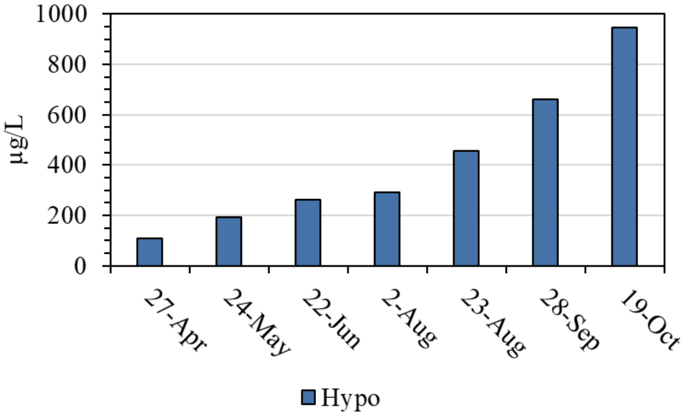

Figure 7. Hypolimnetic (Hypo) total phosphorus levels in Ball Pond in 2025.

The hypolimnetic average of 417 µg/L was significantly greater than both the epilimnetic and metalimnetic averages ($p<0.005$). Hypolimnetic concentrations <u>exponentially</u> increased between late April and mid-October.

D. Total Nitrogen and Ammonia

Nitrogen is typically the second most limiting nutrient for algae growth in freshwater systems and also useful for assessing trophic conditions in lakes. It can be present in several forms in lake water. Ammonia – a reduced form of nitrogen – is important because it can affect the productivity, diversity, and dynamics of algal and plant communities. Ammonia levels near the bottom can be indicative of internal nutrient loading since bacteria will utilize forms of nitrogen oxide compounds (e.g., nitrite and nitrate) in lieu of oxygen for cellular respiration under anoxic conditions, resulting in ammonia enrichment of the hypolimnion.

Total nitrogen accounts for all forms of nitrogen in the water including reduced forms like ammonia, organic proteins, nitrate and nitrite. Nitrate and nitrite are rarely detected above minimum detection limits due to those being quickly used up by algae and plants. Below we discuss total nitrogen and ammonia and graphically represent total nitrogen as that measured as ammonia and that which is not ammonia.

Epilimnetic total nitrogen concentrations were on average lower than metalimnetic concentrations, but averages for the two layers were not statistically different. In the epilimnion, early season concentrations were between 701 and 827 µg/L but were only between 537 and 665 from August through October. The epilimnetic season average of 665 µg/L was characteristic of eutrophic conditions. The maximum epilimnetic ammonia concentration of 95 µg/L was measured in the May sample; all other epilimnetic concentrations were between 4 and 13 µg/L.

The April and May metalimnetic total nitrogen concentrations were 958 and 1,048 µg/L, respectively, with 173 µg/L of the May concentration in the form of ammonia (Fig. 9). Late June to late September total nitrogen concentrations were all lower, between 550 and 780 µg/L, with very small ammonia fractions. October metalimnetic total nitrogen levels were 1,191 µg/L with 532 µg/L in the form of ammonia.

Hypolimnetic total nitrogen increased as the season progressed, and except for the May sample, was mostly in the form of ammonia (Fig. 9). The initial early May hypolimnetic total nitrogen concentration of 1,474 µg/L increased to 4,210 µg/L by mid-October. The season average of 2,785 µg/L was significantly higher than epilimnetic and metalimnetic averages ($p<0.001$). The fraction of hypolimnetic total nitrogen that was ammonia generally increased as the season progressed. In May, 41% of the hypolimnetic total nitrogen was in the form of ammonia. By mid-October, ammonia had increased to 84% of the nitrogen total.

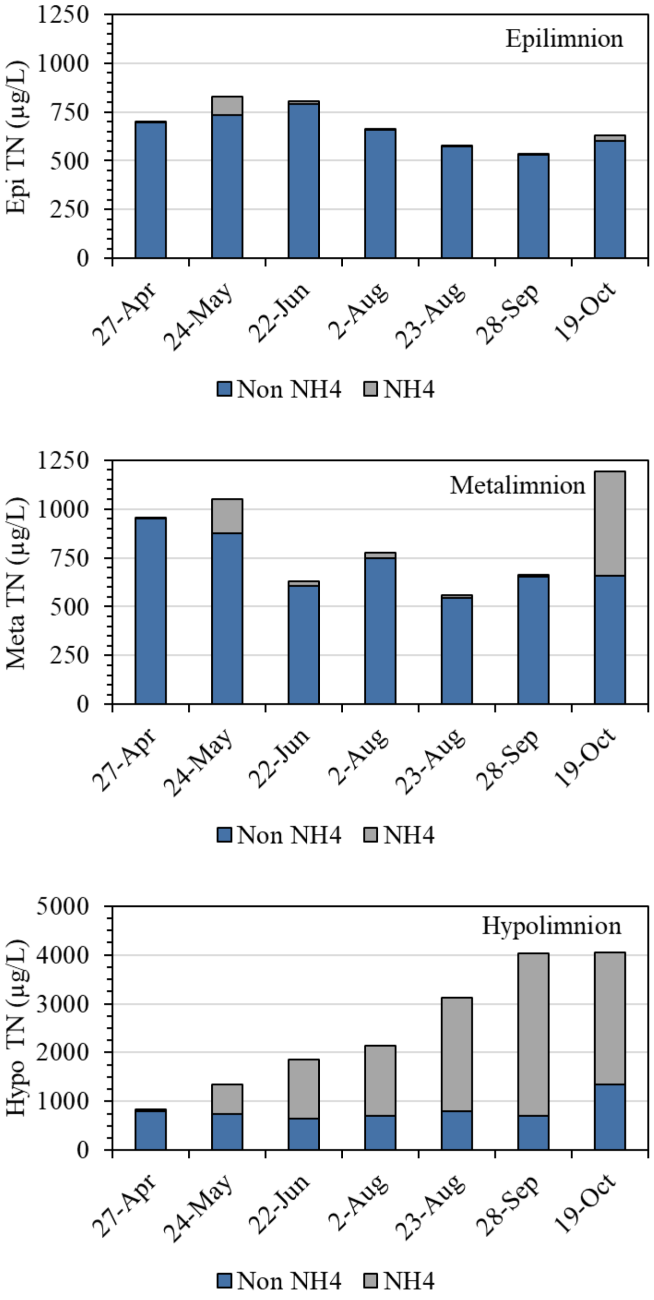

Figure 8. Total nitrogen displayed as ammonia (NH4) and nitrogen not measured as ammonia (non NH4) in the epilimnion (top), metalimnion (middle), and hypolimnion (bottom) of Ball Pond in 2025.

E. Redfield Ratios

Limnologists frequently use the Redfield ratio of 16 (16:1 nitrogen to phosphorus) to determine whether nitrogen or phosphorus is the most limiting nutrient in a freshwater system (Redfield 1958). The ratio is molarbased and when converted to mass, 7.2 µg/L is the threshold. Values lower than the threshold are indicative of nitrogen limitation while ratios above 7.2 µg/L indicate phosphorus limitations. Nitrogen limitation favors cyanobacteria productivity due to the ability of some cyanobacteria to harvest elemental nitrogen dissolved into the water from the atmosphere, aka nitrogen fixation. Other algae taxa do not possess this ability.

Redfield ratios were determined for all dates and strata. Epilimnetic ratios ranged from 19 to 25 and averaged 20.2, while metalimnetic ratios ranged from 13 to 22 and averaged 14.8. Both were indicative of phosphorus limitation. Hypolimnetic ratios ranged from only 4 to 8 and averaged 7.0 which is indicative of nitrogen limitation.

VI. Algae Community Dynamics

Algae have been used in ecological assessments of lakes for over 100 years (Stevenson 2014). The compositions, concentrations, and biomasses of assemblages of algae in the water column (i.e., phytoplankton) can be diagnostic of environmental conditions in a lake. For example, a lake dominated by Cyanophyta (aka cyanobacteria or blue-green algae) with high cell concentrations and high biomass often have high nutrients concentrations. High concentrations of cyanobacteria can form harmful algal blooms, which can present public health risks due to toxins that some cyanobacteria can produce (CT DPH & CT DEEP 2024). Algae communities that are more diverse and include species from the Bacillariophyta (aka diatoms), Chrysophyta (aka golden algae), and Chlorophyta (aka green algae), with lower cell concentrations and lower biomasses, are reflective of lower nutrient conditions. Those algal taxa are not toxigenic.

A. Algae and Cyanobacteria Cell Concentrations and Relative Abundance

Total algae cell and cyanobacteria cell concentrations were generally low at the deep-water site except for the late April sample. That sample exhibited season maximums for both total cell and cyanobacteria cell concentrations at 38,873 and 35,197 cells/mL, respectively (Fig. 10). The next highest cyanobacteria cell concentrations were 15,038 and 10,430 cells/mL from the late June and early August samples, respectively.

Total cell concentrations on all other sampling dates were between 3,900 and 7,400 cells/mL. For those samples collected in late May, late August, and late September, cyanobacteria cell concentrations were between 1,900 and 4,500 cells/mL. The seasonal low cyanobacteria cell concentration of 116 cells/mL was from the mid-October sample.

For comparison, the CT DPH and CT DEEP (CT DPH 2024) equate cyanobacteria cell concentrations of 0 to 20,000 cells/mL as presenting little to no risk to public health from blooms. Cyanobacteria cell concentrations of 20,000 to 100,000 cells/mL present moderate risk, and cell concentrations of >100,000 cells/mL present high risk to public health. All cyanobacteria cell concentrations except the late April samples, collected at the sampling site, were within the *little-to-no risk* category. The late April concentration was in the moderate risk range.

The percentage of counted cells that were cyanobacteria fluctuated greatly. In late April, late June and late August, cyanobacteria comprised between 75% and 91% of all cells counted. In late May, early August, and late September, cyanobacteria percent abundances were between 44% and 56%. In late October, only 1.6% of all cells counted were cyanobacteria.

Chlorophyta (aka green algae) were the second most important group with relative abundances between 20% and 26% for all but one sampling event between late May and late September (Fig. 10). Bacillariophyta (aka diatoms) attained their greatest relative abundance of 17 to 21% in early August and mid-October. Chrysophyta (aka golden algae) reached a maximum relative abundance of 74% in mid-October but were also important in late May and late September, as well. All algae and cyanobacteria data has been compiled in Appendix C.

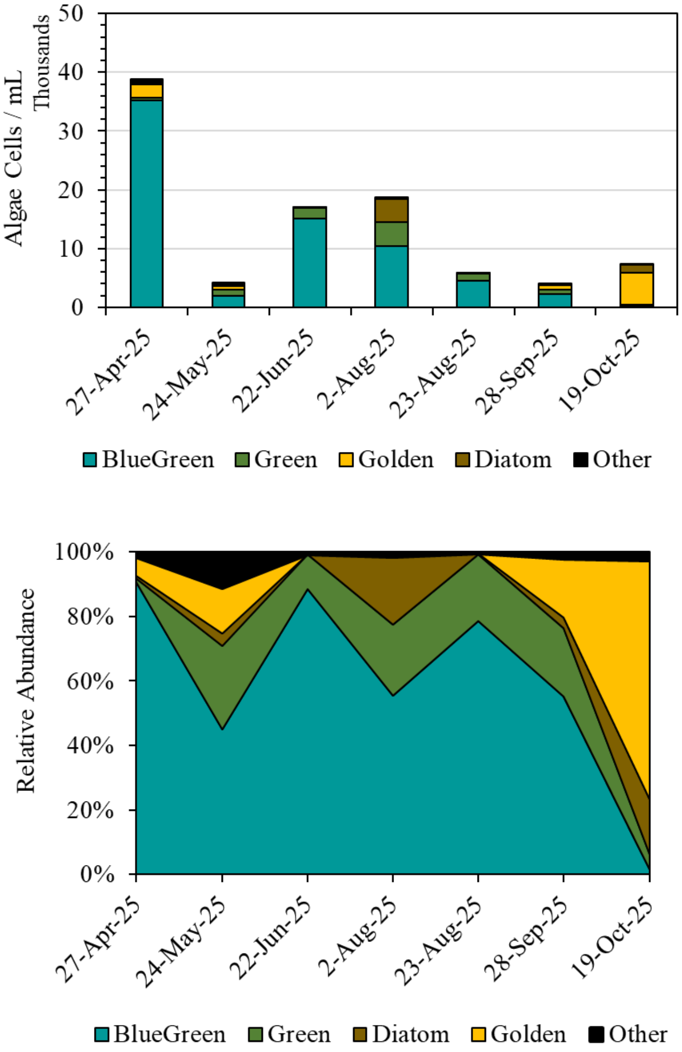

Figure 9. Monthly cell concentrations by taxonomic group (top) and relative abundance of those groups during the 2025 season at Ball Pond.

B. Algal Taxa and Genera

Fifty-one algal genera were identified from the plankton net and whole water samples collected for the algae analyses. Those genera were unequally distributed among seven taxonomic groups. The group with the greatest richness (greatest number of different genera) was the green algae with 25 genera identified. Cyanobacteria had the next highest richness with 12 genera. Five genera of diatoms and four genera of golden algae were identified. Pyrrhophyta (aka dinoflagellates), Euglenophyta, and Cryptophyta were less abundant and represented by three or less genera.

C. Cyanobacteria Spatial and Temporal Distribution

In the same manner chlorophyll-*a* is used as a surrogate for total algae biomass, phycocyanin provides a means of assessing cyanobacteria biomass. Phycocyanin is an auxiliary photosynthetic pigment unique to cyanobacteria and relative concentrations were measured with a fluorimeter incorporated into the sensor array of the Eureka Manta II multiprobe. Fluorimeters work on the principle that a particular substance fluoresces at a specific wavelength when light of another wavelength is directed on that substance. The fluorimeter in our instrumentation emits a wavelength that interacts with phycocyanin. This sensor is not calibrated with known concentrations of phycocyanin, so measurements are not quantitative; instead, the measurements are qualitative, i.e., relative to other measurements in the water column and to measurements on other dates.

Relative phycocyanin concentrations were measured throughout the water column on each sampling date. From that data, a relative phycocyanin concentration isopleth chart was created to display the spatial and temporal distribution of cyanobacteria biomass during the 2025 season (Fig. 11). Concentrations were low in the epilimnion, i.e., depths closest to the surface, for most of the season and highest within the metalimnion, i.e., middle layer, and typically generally below the thermocline.

The late April and late May cyanobacteria distributions were notable with highs near the thermocline at 5 to 6 meters of depth and elevated levels extending down deep into the water column. In late June, the highest concentration on that day were just below the upper metalimnetic boundary, which was high in the water column due to rapid warming of the surface waters. The highest relative concentrations of the season were observed at 8 meters of depth in late August through late September and were approximately 8 to 12 times higher than the average relative concentration in the top 3 meters of the water column on those respective days.

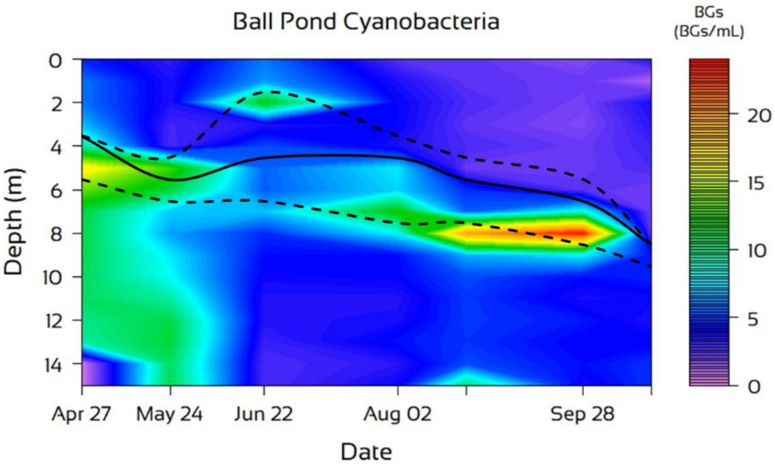

Figure 10. Relative phycocyanin concentration isopleth chart for the Ball Pond water column in 2025. The dashed lines represent the position of the upper and lower metalimnetic boundaries; the solid black lines represent the position of the thermocline.

D. Cyanotoxin Testing

As noted above, some populations of cyanobacteria produce one or more of several cyanotoxins that can create public health and safety problems (CT DPH & CT DEEP 2023). Microcystin is one of the more predominant toxins, can cause liver damage at high enough concentrations, and is the cyanotoxin that is recommended for measuring to determine if toxic cyanobacteria blooms have dissipated enough so as not to present a public health risk.

The Environmental Protection Agency (EPA) recommends that microcystin levels in recreational waters be at or below 8 micrograms per liter (µg/L) to protect public health. Samples were collected weekly at the Hahlawah Beach on Ball Pond and analyzed for microcystin concentrations from late June through late August. All but on sample collected at Ball Pond in 2025 had concentrations of <1.0 µg/L (Table 3). The exception of 1.4 µg/L was from the mid-July sample.

Table 3. Microcystin concentrations of samples collected from the public beach on Ball Pond in 2025.

Date	µg/L	Date	µg/L
June 25, 2025	0.183	July 30, 2025	0.975
July 2, 2025	0.551	August 6, 2025	0.335
July 9, 2025	0.786	August 13, 2025	0.339
July 16, 2025	1.395	August 20, 2025	0.247
July 24, 2025	0.520	August 27, 2025	0.243

E. Saxitoxin Survey

Due to past observations of the filamentous cyanobacteria *Lyngbya sp*. observed growing attached to portions of the lakebed, a saxitoxin survey was conducted. *Lyngbya* is one of several genera of cyanobacteria that can produce saxitoxin, a potent neurotoxin (CT DPH & CT DEEP 2023). Samples of the algal mat on the bottom sediments or samples of the sediments themselves were collected with a grapple in 1 to 3 meters of depth along the shoreline at nine locations. Two surveys were performed: one on August 2nd and the other on August 23rd. Approximate locations where samples were collected are identified in Figure 12, along with the location of the microcystin testing location, and the water quality monitoring site.

We found a wide range of thresholds in the regulatory literature used to identify public health risks from saxitoxins. For example, Ohio uses a threshold of 0.8 µg/L for recreational public health advisories (ODH 2022), while Washington State uses a threshold of 75 µg/L (WSDOH 2025).

Surface sediment mats of *Lyngbya* were generally relegated to the southern regions of the lake which corresponded to the highest concentrations: 0.800 µg/L on August 2nd at Site 1; and 0.778 µg/L on August 23rd at Site 2. Most other concentrations were <0.5 µg/L (Table 4).

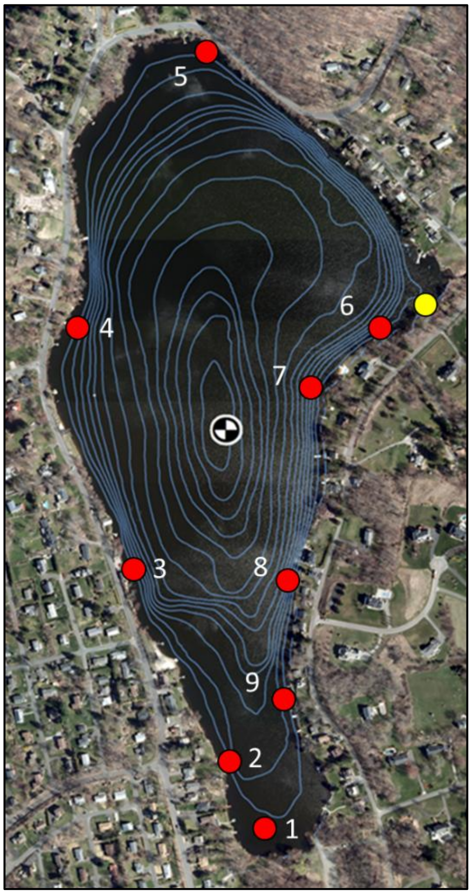

Figure 11. Approximate sampling site locations. Red = saxitoxin sites; yellow is the microcystin site; black & white is the water quality site.

Table 4. Saxitoxin levels measured in samples collected at nine locations in Ball Pond in 2025.

2-Aug-25		23-Aug-25	
Site	µg/L	Site	µg/L
1	0.800	1	0.282
2	0.018	2	0.778
3	0.172	3	0.108
4	0.018	4	0.056
5	0.014	5	0.136
6	0.678	6	0.214
7	0.018	7	0.154
8	0.326	8	0.190
9	0.022	9	0.248

VI. Water Chemistry

Much like Secchi transparency, chlorophyll-*a*, and phosphorus concentrations are used to assess current conditions and detect changes from past conditions, so also do several chemical characteristics of the lake water that are measured in the monitoring program. Below, specific conductance, pH and alkalinity, and base cations and anions concentrations measured in 2025 are described.

A. Specific Conductance

Conductivity is a surrogate measurement for the sum of the ionized minerals, metals, and salts in the water and a measure of water's ability to transmit an electrical current. Data collections included measures of both conductivity and specific conductance and were measured in microsiemens per cm (µS/cm). Specific conductance is conductivity but standardized to a set water temperature of 25°C. Specific conductance was reported below as temperature influences conductivity and – in the field – temperature varies with depth and date.

Specific conductance is an important metric in limnological studies due to its ability to detect pollutants and/or nutrient loadings. Specific conductance can also have an influence on organisms that inhabit a lake or pond; particularly, algae. The composition of plant and algal communities has been shown to be related, in part, to conductivity levels in lakes (e.g., June-Wells et.al. 2013, Siver 1993, McMaster & Schindler 2005). As was done with temperature and oxygen profile data, specific conductance data have been displayed as an isopleth chart (Fig. 13).

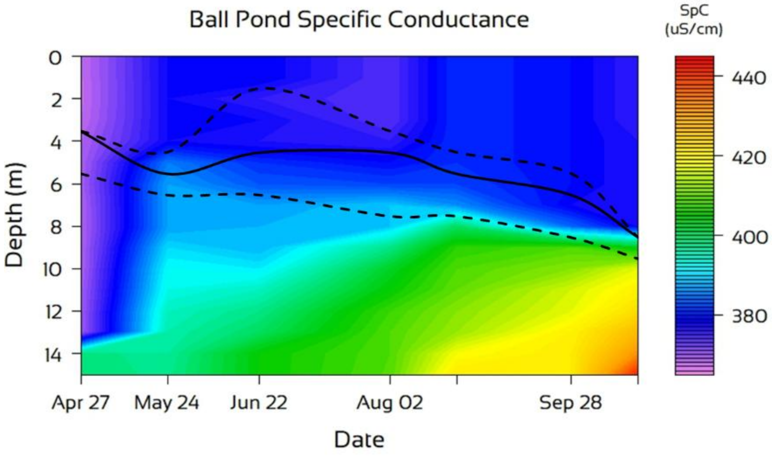

Figure 12. Specific conductance isopleth chart for the Ball Pond water column in 2025. The dashed lines represent the position of the upper and lower metalimnetic boundaries; the solid black lines represent the position of the thermocline.

Ball Pond specific conductance is high in comparison to most Connecticut lake. Lowest levels were always observed in the epilimnetic and metalimnetic layers. The seasonal average for the top 8 meters of the water column was 379 µS/cm. Lowest levels of 368 µS/cm were measured in late April and increased by only 1 µS/cm by 13 meters of depth before increasing to 399 µS/cm at the bottom on that date (Fig. 13).

The season average for 9 to 15 meters of depth was 404 µS/cm but levels of >420 µS/cm were measured within those depths near the bottom from late August through October. It was notable that highly elevated levels neared and abutted the lower metalimnetic boundary beginning early in the season and extending into the metalimnion up to the thermocline by October.

B. Oxidation Reduction Potential

The oxidation-reduction potential (aka redox potential or ORP) in lakes refers to the oxidative or reductive state in a particular stratum of the water column; it can provide insight as to whether compounds with phosphorus are changing from a particulate inactive state in lake sediments to a soluble, aqueous state that algae and cyanobacteria can use, that readily diffuses into overlying waters, and that can become available if mixed or diffused into layers where enough light can reach to support algae growth.

When ORP is ≥200 milli-volts (mV) phosphate remains bound to available iron; at ORP values of <200 mV, iron is biochemically reduced and the phosphate that is bound to the iron becomes soluble (Søndergaard 2009). In some cases, a sudden mixing of phosphate-laden bottom waters to the upper reaches of the water column during a storm or wind event can trigger an algae bloom. Diffusion of phosphate from water with high concentrations to water with low concentrations also occurs when resistance to mixing between depths is low. ORP data collected at the deep-water site is presented as an isopleth plot (Fig. 14).

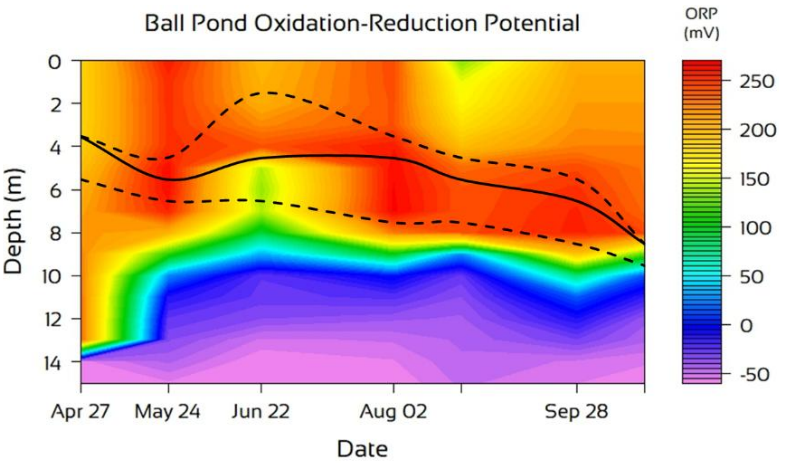

Figure 13. Oxidation-reduction potential isopleth chart for the Ball Pond water column in 2024. The dashed lines represent the position of the upper and lower metalimnetic boundaries; the solid black lines represent the position of the thermocline.

Levels of the water column near the bottom had very low ORP (<0.0 mV) throughout the season. Those very low ORP levels extended up from the bottom to 11 meters of depth by late May and were measured at 10 meters of depth in late June and late August. The very low ORP levels were observed after late August but not as high up in the water column. However, ORP of <200 mV were consistently measured from 9 meters to the bottom from late May through the end of the season.

On several occasions, ORP levels of <200 mV were measured in epilimnetic levels of the water column. In late April, ORP of 184 to 197 mV were measured in the top 5 meters of the water column. In late August, ORP of 133 mV at the surface increased to 198 mV at 4 meters of depth before exceeding 200 mV between 5 and 8 meters of depth. Low ORP in surface waters can result from a flux of organic matter, including algae blooms. Once the organic matter starts to decompose, ORP can decrease.

C. pH and Alkalinity

The normal pH of surface waters of lakes in the Northeast can be measured from approximately 6 to 9 SU (standard units). Very low or very high pH levels will not support diverse fauna and flora in freshwater ecosystems.

Algal community composition is influenced by pH. For example, the pH of the water will influence algae community characteristics by determining the type of dissolved carbon in the water column. At pH levels greater than 8.3, bicarbonate is the dominant form of carbon available to the pelagic algal community; the blue-green algae have adaptive advantages over other algae in those conditions in that they can efficiently utilize that form of carbon. Other algal groups are dependent upon carbon dioxide, which is more readily available in water below a pH of 8.3.

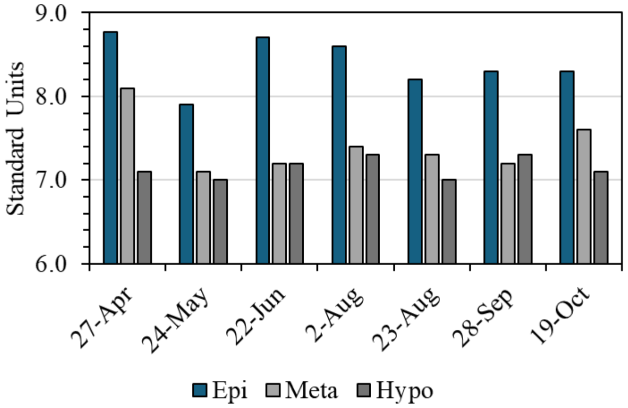

Figure 15. Epilimnetic (Epi), metalimnetic (Meta), and hypolimnetic (Hypo) pH measured in Ball Pond in 2025.

Higher epilimnetic and lower hypolimnetic pH levels in deep lakes are common and due to lower carbon dioxide levels in the epilimnion resulting from its use by algae in photosynthesis. Higher carbon levels at deeper depth, where algae are not harvesting it, will form weak carbonic acid which will lower the pH.

Epilimnetic pH ranged from 7.9 standard units (SU) measured in May to 8.8 SU measured in April and averaged 8.4 SU for the season. The season average hypolimnetic pH of 7.1 SU was significantly lower ($p<0.0001$) than the epilimnetic average. The hypolimnetic measurements were all between 7.0 and 7.3 SU.

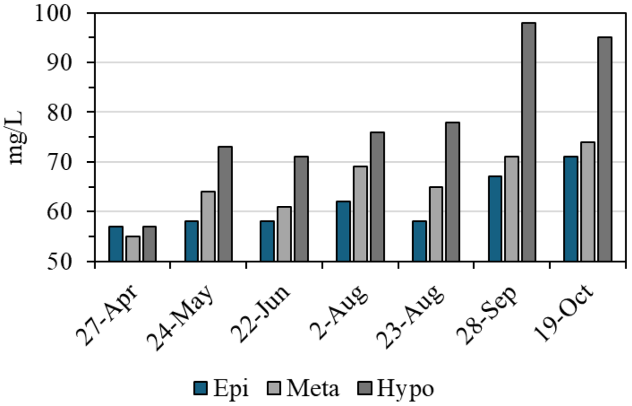

Figure 15. Epilimnetic (Epi), metalimnetic (Meta), and hypolimnetic (Hypo) alkalinity measured in Ball Pond in 2025.

The season average pH in the metalimnetic layer of 7.4 SU was significantly different from the average epilimnetic average ($p<0.00005$) but not the hypolimnion ($p>0.05$). In most months, the metalimnetic pH was very similar to the hypolimnetic pH. The exception occurred in April when metalimnetic pH was slightly closer to epilimnetic pH (Fig. 15).

Alkalinity is a measure of calcium carbonate and provides lake water its ability to neutralize acid (i.e., buffering capacity). Alkalinity of surface waters is largely influenced by local geology and other watershed characteristics. Alkalinity at the bottom of the water column can also be generated internally from the biologically mediated reduction of iron, manganese, and sulfate via cellular respiration in the anoxic lake sediments, and denitrification of nitrate to elemental nitrogen (Wetzel 2001). For purposes of assessing alkalinity and comparing it between strata and sites, the unit of measure reported by the laboratory, i.e., mg/L, was used.

Epilimnetic alkalinity was generally stable through late August when levels were between 57 and 62 mg/L., Levels increased to 67 mg/L by September and to 71 mg/L by October. The average for the season was 62 mg/L.

In contrast, hypolimnetic alkalinity increased from a season low of 57 mg/L in April to season highs of 98 and 95 mg/L in September and October, respectively. Levels from May to late August were all between 71 and 78 mg/L. The hypolimnetic average of 78 mg/L was significantly higher than the epilimnetic average ($p<0.05$).

Differences between the metalimnetic season average of 66 mg/L and averages from above and below (i.e. epilimnetic and hypolimnetic averages, respectively) were not statistically significant. Metalimnetic levels were initially 55 mg/L in April. From May through late August levels were between 60 and 70 mg/L. September and October levels were 71 and 74 mg/L, respectively.

D. Base Cations and Anions

Base cation and anion concentrations are important in understanding natural influences (e.g., dissolved salts from bedrock geology) as well as anthropogenic influences in the watershed (e.g., road salts). In most lakes, the dominant base cations in lake waters are calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}). Dominant anions include chloride (Cl^{-}), sulfate (SO_4^{2-}), and the alkalinity anions, i.e., carbonate (CO_3^{2-}), and bicarbonate (HCO_3^{-}). Those cations and anions are what collectively create much of the conductivity levels in lake water. The ratios and other characteristics of those ions can be diagnostic when compared to other lakes, and when compared to levels in the same lake over time.

Table 5. Base cations potassium (K^{+}), sodium (Na^{+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), and anions chloride (Cl^{-}) and alkalinity anions measured in Ball Pond in 2024. Levels are reported in mass (mg/L) and in milliequivalents (meq/L).

Date	Potassium (K^{+})		Sodium (Na^{+})		Calcium (Ca^{2+})	
	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L
27-Apr-25	2.1	0.05	36.4	1.6	21.7	1.1
22-Jun-25	2.2	0.06	36.3	1.6	22.3	1.1
2-Aug-25	2.1	0.05	34.0	1.5	21.2	1.1
28-Sep-25	2.2	0.06	37.2	1.6	22.1	1.1
19-Oct-25	2.3	0.06	37.3	1.6	21.7	1.1

Date	Magnesium (Mg^{2+})		Chloride (Cl^{-})		Alkalinity Anions	
	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L
27-Apr-25	7.8	0.7	65.9	1.9	57	1.14
22-Jun-25	7.7	0.6	66.9	1.9	58	1.16
2-Aug-25	7.3	0.6	---	---	62	1.24
28-Sep-25	7.7	0.6	64.7	1.8	67	1.34
19-Oct-25	7.7	0.6	67.4	1.9	71	1.42

The UCONN CESE lab who conducted the analyses reported results on a mass basis (mg/L). We converted those to their electrochemical equivalents or milliequivalents (meq/L).[1] Those were calculated by dividing the measured mass of an ion by its equivalent weight. This provided meaningful accounting for ionic or electrical charge (positive or negative). Accounting for electric charge can be preferable when comparing ion levels to other electrochemical characteristics of lake water, e.g., specific conductance. Ion levels were reported below in both mass and milliequivalents below (Table 5).

Concentrations for most of the ions over the season were generally stable except for the alkalinity anions. Alkalinity increased over the course of the season, suggesting that a likely source is internal alkalinity generation from biologically mediated reduction reactions in anoxic waters with low ORP. Season sodium and chloride concentrations were similar on a meq/L basis implicating influences of winter road runoff carrying deicing salts. Calcium and the alkalinity anions concentrations on a meq/L basis were also similar and high implicating some geological influences, e.g. glacial erratic deposits that are calcium carbonate in nature.

VII. Discussion

A. A Predictable System

The 2025 conditions in Ball Pond were generally consistent with those observed in past years. We have reported trophic dynamics at Ball Pond in the past as complex with standard trophic indicators representative of different trophic levels. Coprecipitation of phosphorus has also been described as contributing to some of those trophic inconsistencies.

This year, epilimnetic total phosphorus and total nitrogen levels were indicative of eutrophic conditions while summer Secchi transparency and summer chlorophyll levels were indicative of the lower mesotrophic conditions. Coprecipitation occurs when pH and calcium levels are high which result in the formation of calcite and the binding of phosphorus to those minerals rendering the phosphorus biologically inactive. The 2025 calcium levels were consistent with past levels (Table 7). Average pH was lower this year than in past years, but levels in three of the first four months of the season were ≥8.6 SU which is high. High productivity earlier in the season decreased as the season progressed while lower Secchi transparency increased concurrent with decreasing epilimnetic total phosphorus levels. Since Ball Pond algal productivity is phosphorus limited, the impact of high total nitrogen levels were likely minor.

As the calcite-phosphorus minerals sink, they can dissolve at lower depths once CO_2 levels increase causing pH to decrease. Except for April, monthly pH near the thermocline was like that of the hypolimnion. Both average hypolimnetic pH and that near the thermocline were significantly lower than epilimnetic pH. Combined with the internal loading of phosphorus due to the anoxic/highly reduced environment in the hypolimnion, the transportation

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[1] See https://en.wikipedia.org/wiki/Equivalent_weight

of phosphorus from the high pH epilimnion to lower pH conditions near the thermocline are contributing to the highest cyanobacteria concentrations located just below the thermocline.

Also consistent with past years, cyanobacteria blooms were observed in 2025 along the northeastern shoreline and along the southern shoreline near the boat launch (Fig. 17). Those bloom events were the result of vertical migration of cyanobacteria, followed by concentration of surfaced cells along downwind shoreline areas by light winds.

Table 6. Average water quality characteristics of Ball Pond in the 1930s (Deevey 1940), 1980 (Frink and Norvell 1984), 1993 (Canavan and Siver 1994), 2021 & 2022 (AER 2022, 2023), 2023, 2024, and 2025.

Parameter	Units	2025	2024	2023	2022	2021	1993	1980	1937-9
Total Nitrogen	µg/L	665	573	690	---	734	---	716	---
Total Phosphorus	µg/L	35	25	18	13	34	22	30	14
Chlorophyll-*a*	µg/L	8.4	7.2	6.6	6.8	6.5	5.0	3.0	5.5
Secchi Disk	meters	2.5	2.7	2.6	2.7	2.4	2.6	1.9	2.7
pH	SU	8.4	8.6	8.8	8.9	9.0	8.7	---	---
Sp. Conductance	µS/cm	376	369	427	413	417	283	---	---
Alkalinity	mg/L	62	63	73	84	82	64	52	28
Chloride (Cl^-)	mg/L	65.8	65.9	80.2	77.6	---	42.2	---	---
Calcium (Ca^{2+})	mg/L	21.8	20.7	22.5	24.4	24.1	19.7	19.6	---
Magnesium (Mg^{2+})	mg/L	7.6	7.5	7.8	8.1	---	6.6	5.6	---
Sodium (Na^+)	mg/L	36.2	42.4	39.9	44.6	---	24.6	9.2	---
Potassium (K^+)	mg/L	2.2	2.2	2.4	2.7	---	2.7	2.0	---

Last year we discussed a variety of techniques used to control blooms in smaller localized areas such as small ponds and shorelines. These include the use of barley straw, and applications of chemical algicide products including copper sulfate, and more recently peroxide-based algicides that do not leave permanent residues, and ultrasonics that utilizes ultrasound waves. These management techniques address the symptoms, i.e. the blooms, but not the cause which is the high level of internal phosphorus loading in the hypolimnion. For that, we have recommended sequestering sediment phosphorus with alum (see below).

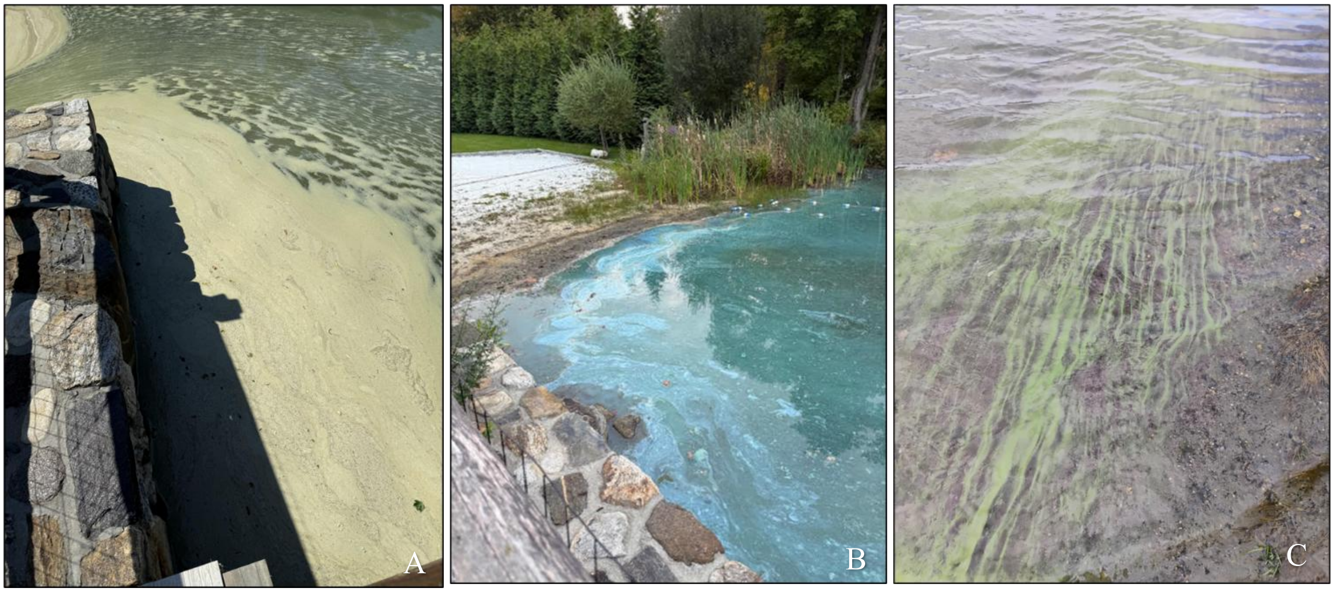

Figure 16. Photographs of a cyanobacteria bloom along the northeastern shoreline of Ball Pond on June 25, 2025 (A), and September 27, 2025 (B), and from the southern end of the lake near the boat launch on November 18, 2025 (C). Photo credit: Elissa Johnson.

B. Data Logger Project

Brawley Consulting Group worked in collaboration with BPAC, Friends of Ball Pond, and Western Connecticut State University on a data logger project to understand winter water column dynamics. Of particular interest were the thermal mixing patterns within the lake, and oxygen and specific conductance levels at the surface and near the bottom. Although there is still work to be done with regards to understanding winter oxygen concentrations in the water column, information gleaned from data collected so far have provided important insights into Ball Pond.

Data collected in the winter of 2024/2025 showed that the water column did thermally mix at least down to 13 meters where the temperature data logger at the deepest depth was located. In late October, surface waters were still warmer but decreased until they reached temperatures like those near the bottom by late November (Fig. 18). From late November through late December, temperatures at both depths, which were approximately the same, decreased to between 3-4 °C. In January of 2025, surface temperatures were slightly lower than bottom temperatures due to inverse stratification when the coldest water is near the surface under ice (approximately 0 °C) and temperature increases with depth to 3.98 °C when water is densest.

For much of February, the water column was mixed again until early March when surface waters began to slowly warm after the ice melted. By late April, there was an 8°C difference in temperature between the surface and 13 meters of depth. The lake was thermally stratified at that time based on our April water quality monitoring data.

Comparisons of specific conductance measured near the surface and at 13 meters of depth (near the bottom) were also revealing. For most of the project period, changes in epilimnetic specific conductance were subtle compared to the changes observed near the bottom. The one exception was the period between early January and early March when hypolimnetic specific conductance was far less variable (Fig. 18). This period likely corresponds with ice on conditions.

From late October through late November, when the lake was transitioning from stratified to mixed, specific conductance near the bottom was 50 to 100 µS/cm greater than that near the surface. While the water column was mixed, hypolimnetic specific conductance oscillated above and below surface levels. Once inverse stratification set up, surface specific conductance was as much as 50 µS/cm greater than levels at 13 meters. During that late December to early March period, both surface and bottom specific conductance gradually increased which may reflect the use of deicing salts on State Route 39 and town roads surrounding the lake.

Following ice off at the lake, surface specific conductance decreased while levels at the bottom become highly variable again and increased to levels that were greater than those near the surface. In summary, there does not appear to be a winter chemocline at Ball Pond, i.e., stratification due to chemically derived density gradients with depth at the lake. If there were, the bottom waters would have higher specific conductance due to higher dissolved salt levels yielding denser water at the bottom. Data on winter oxygen dynamic in the water column will be valuable in our efforts to understand the internal phosphorus loading processes at Ball Pond.

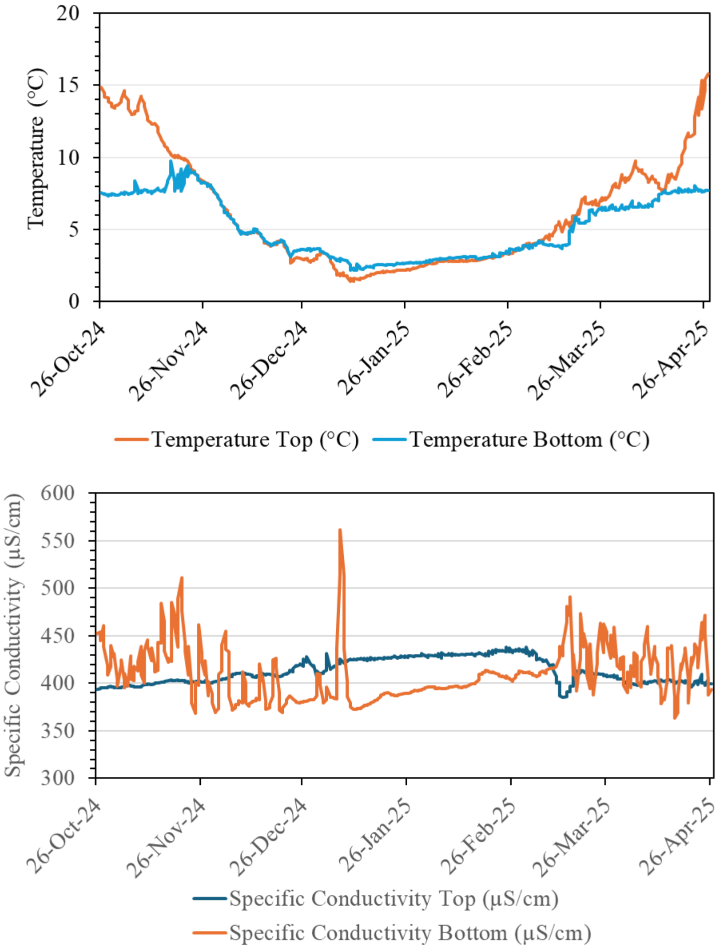

Figure 17. Data collected from October of 2024 through April of 2025 from the Ball Pond Data Logger Project. Top panel displays surface and bottom temperature over time; the bottom panel displays surface and bottom specific conductance over time.

The data loggers were deployed in the spring of 2025 after the winter data was retrieved. Data collected over the summer helped provide perspective into the stratification process discussed above. The isopleth charts that utilize one date each month to collect data give appearance that there are smooth, distinctive layers. The daily temperature data collected with the data loggers provided a much different perspective. Below, we have superimposed portions of isopleth charts created with the data logger data over the isopleths created with data collected from one day each month during the monitoring period (Fig. 19).

The logger data reflects the natural daily fluxes in temperature within the Ball Pond water column. The fluctuations are likely a result of mixing at a small scale. The mixing is undoubtedly not constrained to temperature. Other variables, e.g., dissolved oxygen, specific conductance and oxidation-reduction potential, if collected daily would exhibit similar kinds of fluxes. The same principle is likely to apply with variables like nutrients.

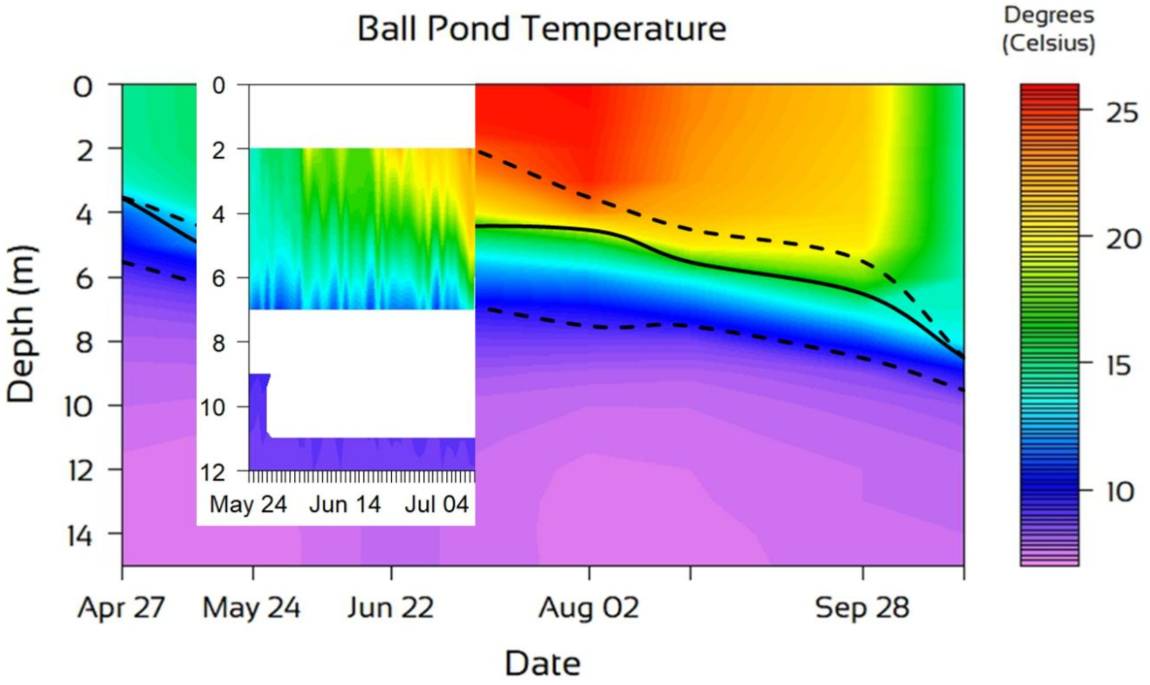

Figure 18. A portion of a temperature isopleth chart created with available data logger data collect over the 2025 season superimposed over the temperature isopleth created with data collected one day each month over the 2025 season.

C. Planning for Phosphorus Inactivation

In past annual reports and presentations at BPAC meetings, BCG has been described one of the key factors for the cyanobacteria blooms that occur at Ball Pond. A very high biological oxygen demand in the sediments of deeper portions of the lake changes the chemistry there such that phosphorus, that was once bound in a precipitated compound in the sediment, becomes free, i.e., in an aqueous state as phosphate (PO_4^{3-}). The phosphate diffuses upward from the bottom (from high concentrations to lower concentrations) and provides nutrients for cyanobacteria growth, particularly for those genera that can regulate their buoyancy and form very concentrated layers below the thermocline (see Fig. 11). When portions of that population become positively buoyant and float to the surface, light winds can skim even a light surface bloom across the lake and concentrate it in a downwind shoreline area.

The region of the lakebed where the “internal phosphorus loading” was likely to be occurring was delineated in the past as any lake bottom area deeper than 7 meters of depth and was calculated at 42.8 acres (Fig. 20). This past season, anoxic conditions were regularly observed at 6 meters and occasionally at 5 meters of depth. That suggests the phosphorus loading region may be >42.8 acres. A reexamination of historical oxygen concentrations at depth should be conducted.

One means of mitigating the blooms is to reduce the internal phosphorus loading with treatments such as alum. In summary, alum would be applied to that region of the lake where oxygen levels are at anoxic levels for protracted periods of time. The alum would strip phosphate from the water as it sank to the bottom, and more importantly, form a flocculant on the bottom which would prevent phosphates from being released from the sediments. Sediment phosphorus content and dosing rates would be determined by sampling the sediments for measurements of several phosphorus compound (e.g., phosphorus bound to iron) and by titrating sediments with alum to determine a more exact dosing rate. Alum treatments are expensive. We provided a very rough estimate of $19,350 dollars to treat the ~43 acres of Ball Pond that is >7 meters deep. The investment in the pretreatment analysis of measuring sediment phosphorus and titrating with alum can help keep costs down.

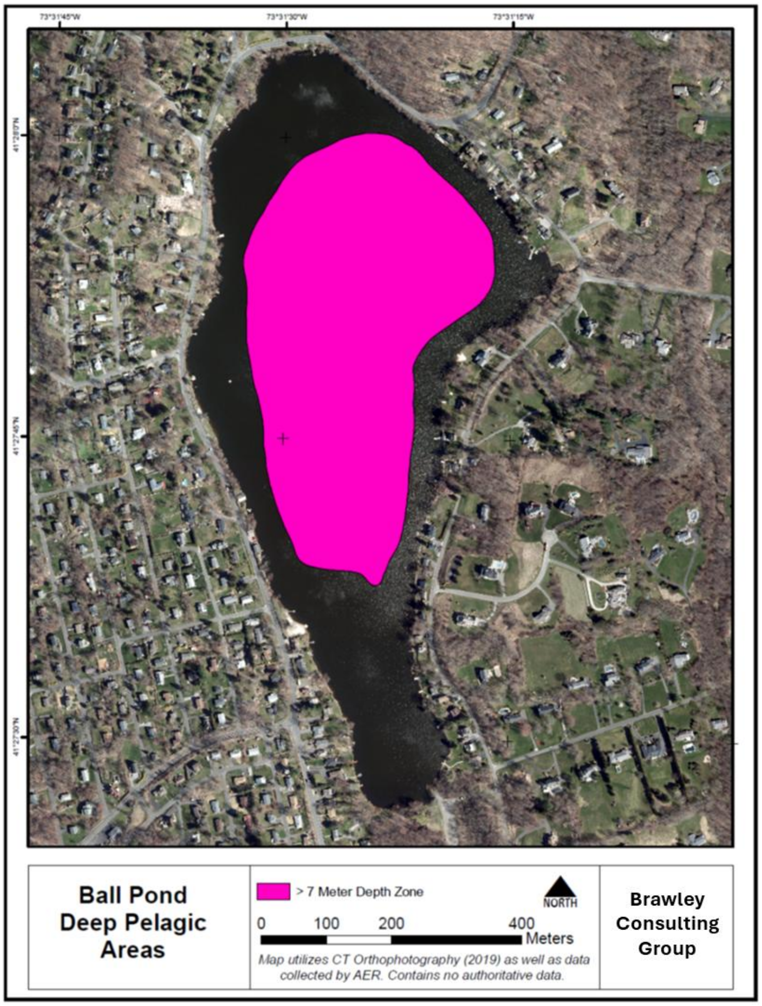

Figure 19. Map of Ball Pond displaying areas >7 meters of depth.

At the 2025 Annual Meeting, BCG was asked to consider developing an exploratory alum treatment plan using several different funding scenarios. There were several challenges. In-lake testing with alum cannot be performed without a permit from CT DEEP. Furthermore, at approximately $450 or more per acre, even $5,000 dollars for just the material put into a test treatment would only allow for treating approximately 11 acres of the area needed to be treated. It is unclear if notable improvements could be measured without knowing phosphorus concentrations in the sediments and how much alum would be needed to sequester that phosphorus.

In lieu of an exploratory treatment, we recommend considering the pretreatment analyses discussed above: estimated sediment phosphorus content and titrating sediment samples with alum for an exact dosing rate. Below with have provided approximate cost estimates associated with those initiatives.

Step 1: Sediment Phosphorus Analysis

Includes: Mapping 8 10-acre plots; collecting a sample of sediment from each plot; sediment shipping; laboratory analyses; interpreting results in a summary report. Estimated cost: $4,000.00

Step 2: Sediment Titration with Alum

Includes: Collecting 4 sediment samples withing the target internal phosphorus loading zone; sediment shipping; laboratory analyses; interpreting results in a summary report. Estimated cost: $6,050.00

Step 3: Quotes

Results of analyses would be used to request quotes from several selected contractors. Cost: Included with Step 2.

D. Cyanotoxin Testing

The threshold for cyanobacteria cell concentration when there is a high public health risk is 100,000 cells/ml. Cell concentrations at the surface during blooms along the Ball Pond shoreline are very likely in the 100s of 1000s of cell/L and should be treated accordingly, i.e. avoiding contact due to high public health risk. It is fortuitous that the microcystin sampling site, Hahlawah Beach, is in the general vicinity of some of the cyanobacteria blooms that occur along the Ball Pond shoreline. Results from microcystin analyses were all well-below the threshold of 8 µg/L above which indicates a public health threat.

The results from saxitoxin testing done in August of 2025 are more ambiguous due to the range of thresholds used to delineate high risk conditions. Based on State of Ohio standards, saxitoxin concentrations measured in samples collected from Ball Pond equaled or nearly the threshold of 0.8 µg/L twice in the 18 samples analyzed during August. Based on the State of Washington guidelines, Ball Pond levels pose no risk.

VIII. Recommendations

The water quality monitoring and cyanotoxin monitoring programs have proven to be useful elements of the lake management program at Ball Pond and should be continued.

- The assay test kit for measuring saxitoxins contained enough wells to conduct the analysis of nine samples in duplicate three times. As described above, samples were collected twice. BCG will work with WCSU to have a third set of samples collected in 2026 analyzed.

One of the primary water quality concerns at Ball Pond is the seasonal cyanobacteria blooms that occur along the northeastern shoreline, in the cove west of the State boat launch, and perhaps elsewhere.

- We continue to recommend exploring the use of ultrasound for managing shoreline blooms. Include an examination of the feasibility and costs (upfront and operating costs). Reach out to some of the manufacturers and companies marketing these products. Some companies are LG Sonic, American Pond Aeration, and Pond Algae Solutions.

To sequester phosphorus in the sediment to inhibit internal phosphorus loading, an understanding of the type and concentration of phosphorus compounds in the sediment is needed. Once compound types and concentrations are determined, laboratory titrations with alum and sediments should be performed to pinpoint amounts of alum needed to sequester the phosphorus in the Ball Pond sediments.

- Develop a three-to-five-year plan for an alum treatment. The plan should include developing funding for appropriate testing and titration of sediment phosphorus.
- Alum treatments require state permits. The State tends to look more favorably on applications where there have been notable watershed-based initiatives to reduce phosphorus pollution. Initiatives could include dissemination of educational materials, tracking storm drain clean outs on the State and Municipal roads, and tracking other watershed-based initiatives undertaken by the Town of New Fairfield (e.g., septic management / sewer avoidance ordinance) or in the Town (e.g., Soil Testing Day).
- State permit applications for in-lake treatments, e.g., alum, are looked upon more favorably when there is a watershed-based plan and educational initiatives at the lake to address watershed-based sources of nutrients. Begin to create a list of educational initiatives you have already undertaken (e.g., websites, posters, etc.) and begin development of a watershed-based plan.

Aquatic invasive species management and prevention continue to be important components of lake management initiatives across the State of Connecticut and elsewhere. Ball Pond is susceptible to invasions of new invasive plants and animals.

- View, discuss, and perhaps act in response to the Western Connecticut State University's 2024 Connecticut Lakes Symposia. The three events in 2024 focused on aquatic invasive species and grant programs culminating in the November event with a discussion on rapid response planning.
- Develop, obtain, and disseminate materials to educate the Ball Pond community on the identification and prevention of aquatic invasive species, including zebra mussels and hydrilla.

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Appendix A. Watershed Land Use Cover Data from 2016 NOAA CCAP Map

Ball Pond Land Cover - 2016 NOAA CCAP Data

Land Cover	Area (acres)	Percent (%)
Impervious	33.5	13.6
Developed, Open Space	53.0	21.6
Grassland/Herbaceous	1.0	0.4
Mixed Forest	69.8	28.4
Scrub/Shrub	3.4	1.4
Palustrine Forested Wetland	1.9	0.8
Palustrine Scrub/Shrub Wetland	0.0	0.0
Palustrine Emergent Wetland	0.1	0.1
Barren Land	0.2	0.1
Open Water	82.7	33.6
Palustrine Aquatic Bed	0.2	0.1
Total	245.8	100.0

Appendix B. Field and Laboratory Water Quality Data

April 27, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	14.6	12.4	121.3	4.6	367.8	183.7	8.8
1	14.6	12.5	122.1	5.9	367.8	184.0	8.8
2	14.6	12.5	122.4	5.9	367.7	184.1	8.7
3	14.1	12.8	124.0	7.1	368.0	185.1	8.7
4	11.4	13.9	126.6	9.6	368.9	186.7	8.7
5	10.2	12.2	108.5	16.7	369.1	196.7	8.1
6	9.0	9.9	85.0	13.6	369.4	206.4	7.7
7	8.3	8.6	72.7	11.0	368.9	212.9	7.5
8	7.9	7.2	60.7	10.9	368.8	218.6	7.4
9	7.7	6.0	50.2	10.8	368.8	224.1	7.3
10	7.6	4.8	39.8	10.6	369.0	227.6	7.2
11	7.4	3.7	30.9	10.5	369.4	230.7	7.1
12	7.4	3.1	25.3	9.9	369.7	232.7	7.1
13	7.4	2.9	23.8	9.5	369.8	233.6	7.1
14	7.3	0.4	3.5	0.4	398.8	-56.7	6.8

May 24, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	15.6	9.5	95.7	3.3	378.2	259.8	7.9
1	15.6	8.4	84.3	3.6	378.3	252.9	7.9
2	15.6	8.3	83.7	3.6	378.3	252.5	7.9
3	15.5	8.1	81.6	3.0	378.2	251.5	7.9
4	15.5	8.1	81.2	2.8	378.4	252.0	7.8
5	13.2	2.9	28.1	13.0	384.7	264.0	7.1
6	10.2	0.3	2.7	11.0	387.4	263.7	7.0
7	8.7	0.2	1.6	7.3	387.1	255.7	7.0
8	8.0	0.1	1.2	6.6	387.4	204.2	7.0
9	7.8	0.1	0.9	7.8	389.8	114.3	7.0
10	7.5	0.1	0.6	8.1	391.6	26.6	7.0
11	7.4	0.1	0.5	9.5	393.0	-10.5	7.0
12	7.3	0.1	0.4	10.9	394.8	-25.4	7.0
13	7.3	0.1	0.4	11.1	396.0	-34.3	7.0
14	7.2	0.1	0.4	10.5	397.4	-43.9	7.0
14.5	7.2	0.0	0.4	10.8	397.6	-55.8	7.0

June 22, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	25.4	10.2	124.4	5.9	379	200.0	8.7
1	25.3	10.4	125.9	6.5	379	204.3	8.7
2	23.4	11.2	131.6	12.0	376	207.5	8.8
3	20.9	6.7	75.2	3.5	378	222.8	8.1
4	17.5	0.3	3.2	5.2	377	241.1	7.2
5	13.6	0.1	1.3	5.6	381	143.9	7.2
6	11.5	0.1	0.6	5.5	383	136.7	7.2
7	9.5	0.0	0.4	7.1	387	143.5	7.2
8	8.7	0.0	0.3	4.7	388	92.5	7.2
9	8.2	0.0	0.2	4.2	388	34.4	7.3
10	7.8	0.0	0.2	3.9	391	-24.5	7.2
11	7.8	0.0	0.2	3.5	395	-27.0	7.2
12	7.7	0.0	0.2	3.5	398	-35.0	7.2
13	7.7	0.0	0.2	3.1	400	-51.0	7.2
14	7.7	0.0	0.2	2.8	405	-60.0	7.2
14.5							

August 2, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	25.4	10.2	124.4	5.9	379	200.0	8.7
1	25.3	10.4	125.9	6.5	379	204.3	8.7
2	23.4	11.2	131.6	12.0	376	207.5	8.8
3	20.9	6.7	75.2	3.5	378	222.8	8.1
4	17.5	0.3	3.2	5.2	377	241.1	7.2
5	13.6	0.1	1.3	5.6	381	143.9	7.2
6	11.5	0.1	0.6	5.5	383	136.7	7.2
7	9.5	0.0	0.4	7.1	387	143.5	7.2
8	8.7	0.0	0.3	4.7	388	92.5	7.2
9	8.2	0.0	0.2	4.2	388	34.4	7.3
10	7.8	0.0	0.2	3.9	391	-24.5	7.2
11	7.8	0.0	0.2	3.5	395	-27.0	7.2
12	7.7	0.0	0.2	3.5	398	-35.0	7.2
13	7.7	0.0	0.2	3.1	400	-51.0	7.2
14	7.7	0.0	0.2	2.8	405	-60.0	7.2
15							

August 23, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	23.5	8.6	100.8	2.5	381.2	133.3	8.2
1	23.3	8.4	98.4	2.5	380.6	156.1	8.2
2	23.1	8.4	97.5	2.8	380.7	163.4	8.2
3	22.9	8.2	94.9	2.5	380.8	178.2	8.2
4	22.3	7.6	86.8	2.8	380.5	197.9	8.0
5	20.4	3.9	42.9	2.3	380.8	232.7	7.3
6	13.8	1.5	14.8	4.8	381.9	240.5	7.2
7	11.0	0.6	5.6	5.5	385.5	241.1	7.2
8	8.7	0.4	3.6	19.8	399.7	242.6	7.2
9	7.9	0.3	2.1	6.8	406.7	28.4	7.2
10	7.6	0.2	1.2	5.2	408.6	-27.3	7.2
11	7.5	0.1	1.1	4.9	409.8	-35.4	7.2
12	7.4	0.1	0.9	4.9	412.1	-40.8	7.1
13	7.4	0.1	0.7	4.8	413.1	-44.4	7.1
14	7.3	0.1	0.6	5.2	418.0	-46.0	7.1
14.5	7.3	0.1	0.5	10.3	421.0	-49.0	7.0

September 28, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	21.7	8.9	100.9	1.8	379	208	8.2
1	21.6	9.0	101.1	2.3	379	211	8.3
2	21.4	9.0	101.3	2.1	379	215	8.3
3	21.2	9.0	100.9	1.9	379	219	8.3
4	21.0	8.8	97.9	2.3	379	225	8.2
5	20.3	6.1	67.4	2.3	379	244	7.7
6	17.8	1.1	11.1	2.5	379	252	7.2
7	14.1	0.3	2.9	8.5	378	256	7.2
8	10.9	0.1	1.2	23.8	384	257	7.3
9	8.4	0.1	0.9	8.1	409	196	7.2
10	7.9	0.1	0.6	4.2	412	79	7.3
11	7.7	0.1	0.6	3.7	416	16	7.3
12	7.6	0.1	0.5	4.4	417	-10	7.3
13	7.6	0.1	0.4	4.0	420	-30	7.3
14	7.5	0.0	0.4	4.2	421	-51	7.2
14.5	7.5	0.0	0.3	3.8	420.9	-55	7.2

October 19, 2025

Depth (m)	Temp (°C)	Oxygen (mg/L)	O_2 Saturation (%)	Rel. Phyco. (µg/L)	Specific Cond. (µS/cm)	ORP (mV)	pH (SU)
0.5	14.4	9.0	87.7	3.5	376	208	8.4
1	14.4	9.0	87.3	1.1	376	211	8.3
2	14.3	8.5	82.7	3.7	376	215	8.1
3	14.3	8.5	82.2	3.4	376	217	8.1
4	14.3	8.0	77.2	3.0	377	225	8.0
5	14.2	7.8	75.4	2.8	377	229	7.9
6	14.2	7.8	75.2	2.2	377	230	7.9
7	14.0	7.5	72.2	2.1	377	234	7.8
8	13.5	5.1	48.5	2.3	378	245	7.6
9	10.0	0.2	2.1	4.3	404	125	7.2
10	8.2	0.1	1	4.6	417	14	7.2
11	7.9	0.1	0.8	3.9	420	-15	7.2
12	7.7	0.1	0.5	3.6	423	-38	7.2
13	7.6	0.1	0.5	4.1	428	-44	7.2
14	7.6	0.1	0.4	4.8	433	-54	7.1
15	7.6	0.1	0.4	34.3	442	-60	7.1

Date	TPhos Epi	TPhos Meta	TPhos Hypo	TNitro Epi	TNitro Meta	TNitro Hypo
			µg/L			
27-Apr-25	36	55	110	701	958	829
24-May-25	58	82	192	827	1048	1338
22-Jun-25	48	45	262	805	629	1848
2-Aug-25	31	61	293	665	774	2145
23-Aug-25	23	29	455	579	557	3126
28-Sep-25	22	52	661	537	663	4030
19-Oct-25	29	54	945	629	1191	4045

Date	Ammon Epi	Ammon Meta	Ammon Hypo	Secchi	Chloro
		µg/L		meters	µg/L
27-Apr-25	4	7	25	1.60	
24-May-25	95	173	601	2.58	12.7
22-Jun-25	13	22	1204	1.64	11.6
2-Aug-25	6	28	1447	1.97	9.7
23-Aug-25	4	10	2323	2.90	3.5
28-Sep-25	7	11	3319	4.22	4.8
19-Oct-25	28	532	2708	2.64	8.1

Appendix C. Algae Data

Algal genera identified from the plankton net samples and whole water samples collected Ball Pond in 2025.

CHLOROPHYTA

Anikistrodesmus sp.
Arthrodesmus sp.
Chlamydomonas sp.
Closterium sp.
Coelastrum sp.
Cosmarium sp.
Crucigenia sp.
Dictyosphaerium sp.
Elakatothrix sp.
Eudorina sp.
Gloeocystis sp.
Kirchneriella sp.
Lagerheimia sp.
Mougeotia sp.
Nephrocytium sp.
Oocystis sp.
Padorina sp.
Pediastrum sp.
Quadrigula sp.
Scenedesmus sp.
Selenastrum sp.
Spondylosium sp.
Staurastrum sp.
Tetraedron sp.
Treibaria sp.

CYANOPHYTA

Aphanizomenon sp.
Aphanocapsa sp.
Chroococcus sp.
Dolichospermum sp.
Gomphosphaeria
Lyngbya sp.
Merismopedia sp.
Microcystis sp.
Planktothrix sp.
Pseudoanabaena sp.
Snowella sp.
Woronichinia sp.

CHRYSOPHYTA

Dinobryon sp.
Mallomonas sp.
Synura sp.
Uroglenopsis sp.

BACILLARIOPHYTA

Asterionella sp.
Cyclotella sp.
Fragilaria sp.
Rhizosolenia sp.
Synedra sp.

PYRRHOPHYTA

Ceratium sp.
Gymnodinium sp
Peridinium sp.

EUGLENOPHYTA

Trachelomonas sp.

CRYPTOPHYTA

Cryptomonas ovata

Algae and cyanobacteria cell count data from Ball Pond in 2024.

April 27, 2025

Taxa	Genus / species	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	1931	5.0	35197	90.6
	Planktothrix sp.	30037	77.3		
	Pseudoanabaena sp.	3228	8.3		
	Woronichinia sp.	0	0.0		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	443	1.1
	Closterium sp.	63	0.2		
	Scenedesmus sp.	317	0.8		
	Staurastrum sp.	32	0.1		
	Tetraedron sp.	32	0.1		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	2311	5.9
	Dinobryon sp.	1519	3.9		
	Uroglenopsis sp.	791	2.0		
Bacillariophyta	*Asterionella sp.*	0	0.0	285	0.7
	Cyclotella sp.	190	0.5		
	Synedra sp.	95	0.2		
Dinophyceae	*Ceratium sp.*	0	0.0	0	0.0
	Peridinium sp.	0	0.0		
Cryptophyceae	*Cryptomonas sp.*	380	1.0	380	1.0
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	127	0.3
	Trachelomonas sp.	127	0.3		
	Unknown	95	0.2	95	0.2
Taxa identified 13	Totals	38837	100	38837	100

May 24, 2025

Taxa	*Genus / species*	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp..*	0	0.0	1912	45.0
	Dolichospermum sp.	9	0.2		
	Planktothrix sp.	1895	44.6		
	Woronichinia sp.	9	0.2		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	1098	25.8
	Closterium sp.	51	1.2		
	Elakatothrix sp.	9	0.2		
	Eudorina elegans	137	3.2		
	Gloeocystis sp.	103	2.4		
	Oocystis sp.	103	2.4		
	Padorina sp.	103	2.4		
	Scenedesmus sp.	180	4.2		
	Selenastrum sp.	26	0.6		
	Staurastrum sp.	34	0.8		
	Tetraedron sp.	352	8.3		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	600	14.1
	Mallomonas sp.	9	0.2		
	Synura sp.	51	1.2		
	Uroglenopsis sp.	540	12.7		
Bacillariophyta	*Asterionella sp.*	0	0.0	172	4.0
	Cyclotella sp.	172	4.0		
Dinophyceae	*Ceratium sp.*	0	0.0	9	0.2
	Peridinium sp.	9	0.2		
Cryptophyceae	*Cryptomonas sp.*	292	6.9	292	6.9
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	146	3.4
	Trachelomonas sp.	146	3.4		
	Unknown	26	0.6	26	0.6
Taxa identified 20	*Totals*	4253	100	4253	100

June 22, 2025

Taxa	*Genus / species*	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	0	0.0	15038	88.5
	Dolichospermum sp.	15038	88.5		
	Woronichinia sp.	0	0.0		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	1809	10.6
	Closterium sp.	57	0.3		
	Gloeocystis sp.	1640	9.7		
	Scenedesmus sp.	28	0.2		
	Tetraedron sp.	85	0.5		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	0	0.0
	Dinobryon sp.	0	0.0		
	Uroglenopsis sp.	0	0.0		
Bacillariophyta	*Asterionella sp.*	0	0.0	28	0.2
	Cyclotella sp.	28	0.2		
Dinophyceae	*Ceratium sp.*	0	0.0	28	0.2
	Peridinium sp.	28	0.2		
Cryptophyceae	*Cryptomonas sp.*	57	0.3	57	0.3
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	28	0.2
	Trachelomonas sp.	28	0.2		
	Unknown	0	0.0	0	0.0
Taxa identified 9	*Totals*	16989	100	16989	100

August 2, 2025

Taxa	*Genus / species*	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	0	0.0	10430	55.5
	Chroococcus sp.	209	1.1		
	Dolichospermum sp.	2174	11.6		
	Lyngbya sp.	21	0.1		
	Snowella sp.	8005	42.6		
	Woronichinia sp.	21	0.1		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	4118	21.9
	Closterium sp.	21	0.1		
	Elakatothrix sp.	42	0.2		
	Eudorina elegans	0	0.0		
	Gloeocystis sp.	3909	20.8		
	Oocystis sp.	21	0.1		
	Scenedesmus sp.	84	0.4		
	Spondylosium sp.	42	0.2		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	0	0.0
	Dinobryon sp.	0	0.0		
Bacillariophyta	*Asterionella sp.*	0	0.0	3950	21.0
	Rhizosolenia sp.	63	0.3		
	Stephanodiscus sp.	0	0.0		
	Synedra sp.	3888	20.7		
Dinophyceae	*Ceratium sp.*	21	0.1	63	0.3
	Peridinium sp.	42	0.2		
Cryptophyceae	*Cryptomonas sp.*	63	0.3	63	0.3
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	42	0.2
	Trachelomonas sp.	42	0.2		
	Unknown	125	0.7	125	0.7
Taxa identified 17	*Totals*	18791	100	18791	100

August 23, 2025

Taxa	Genus / species	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	0	0.0	4493	78.6
	Chroococcus sp.	123	2.1		
	Dolichospermum sp.	148	2.6		
	Pseudoanabaena sp.	222	3.9		
	Snowella sp.	3999	69.5		
	Woronichinia sp.	0	0.0		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	1185	20.7
	Closterium sp.	222	3.9		
	Coelastrum sp	99	1.7		
	Gloeocystis sp.	321	5.6		
	Oocystis sp.	272	4.7		
	Pediastrum sp.	99	1.7		
	Staurastrum sp.	148	2.6		
	Tetraedron sp.	25	0.4		
	Treubaria sp.	37	0.6		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	0	0.0
	Dinobryon sp.	0	0.0		
	Uroglenopsis sp.	0	0.0		
Bacillariophyta	*Asterionella sp.*	0	0.0	12	0.2
	Synedra sp.	12	0.2		
	Tabellaria sp.	0	0.0		
Dinophyceae	*Ceratium sp.*	12	0.2	25	0.4
	Peridinium sp.	12	0.2		
Cryptophyceae	*Cryptomonas sp.*	0	0.0	0	0.0
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	0	0.0
	Trachelomonas sp.	0	0.0		
	Unknown	0	0.0	0	0.0
Taxa identified 15	*Totals*	5751	100	5714	100

September 28, 2025

Taxa	*Genus / species*	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	0	0.0	2181	55.2
	Dolichospermum sp.	1833	46.4		
	Merismopedia sp.	348	8.8		
	Woronichinia sp.	0	0.0		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	841	21.3
	Closterium sp.	7	0.2		
	Gloeocystis sp.	333	8.4		
	Kirchneriella sp.	43	1.1		
	Oocystis sp.	14	0.4		
	Scenedesmus sp.	72	1.8		
	Spondylosium sp.	159	4.0		
	Staurastrum sp.	7	0.2		
	Tetraedron sp.	203	5.1		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	717	18.2
	Dinobryon sp.	471	11.9		
	Mallomonas sp.	51	1.3		
	Uroglenopsis sp.	196	5.0		
Bacillariophyta	*Asterionella sp.*	101	2.6	123	3.1
	Synedra sp.	22	0.6		
	Tabellaria sp.	0	0.0		
Dinophyceae	*Ceratium sp.*	0	0.0	7	0.2
	Peridinium sp.	7	0.2		
Cryptophyceae	*Cryptomonas sp.*	36	0.9	36	0.9
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	0	0.0
	Trachelomonas sp.	0	0.0		
	Unknown	43	1.1	43	1.1
Taxa identified 17	*Totals*	3949	100	3949	100

October 19, 2025

Taxa	*Genus / species*	Cells / mL	%	Taxa cells / mL	Taxa %
Cyanophyta	*Aphanizomenon sp. sp.*	0	0.0	116	1.6
	Dolichospermum sp.	116	1.6		
	Woronichinia sp.	0	0.0		
Chlorophyta	*Anikistrodesmus sp.*	0	0.0	347	4.7
	Closterium sp.	13	0.2		
	Cruceginia sp.	51	0.7		
	Oocystis sp.	51	0.7		
	Scenedesmus sp.	180	2.4		
	Tetraedron sp.	51	0.7		
Chrysophyta	*Chrysosphaerella sp.*	0	0.0	5457	73.9
	Dinobryon sp.	5393	73.0		
	Mallomonas sp.	39	0.5		
	Synura sp.	0	0.0		
	Uroglenopsis sp.	26	0.3		
Bacillariophyta	*Asterionella sp.*	912	12.3	1258	17.0
	Synedra sp.	347	4.7		
	Tabellaria sp.	0	0.0		
Dinophyceae	*Ceratium sp.*	0	0.0	0	0.0
	Peridinium sp.	0	0.0		
Cryptophyceae	*Cryptomonas sp.*	90	1.2	90	1.2
	Rhodomonas sp.	0	0.0		
Euglenophyceae	*Euglena sp.*	0	0.0	39	0.5
	Trachelomonas sp.	39	0.5		
	Unknown	77	1.0	77	1.0
Taxa identified					
13	*Totals*	7383	100	7383	100

Appendix D. Preparers' Qualifications

Laurence J. Marsicano

25 Nutmeg Drive, New Milford, CT 06776, (860) 354-5969, larry.marsicano@gmail.com

RELEVANT EXPERIENCE

- Thirty years as a lake ecologist, manager, advocate, educator, and leader in Connecticut. Successful in the academic, public, and private sectors.
- Advanced the mission of the Candlewood Lake Authority from 1998 through 2017 with the last 14 of those as Executive Director. The board and staff of that agency served the five municipalities surrounding Candlewood Lake, the largest lake in the State and one of Connecticut's most important inland water resources.
- Developed meaningful relationships and worked with the general CT lake community, local and state environmental agency staff, academic researchers, elected leaders at all levels of government, and educators from middle school through college/university levels.
- Co-directed an interdistrict grant program that utilized Candlewood Lake as a living, learning laboratory. The program ran for 10+ years and engaged ~150 high school students and teachers each year.
- Have trained and supervised employees and/or students in Limnological and Paleolimnological field and laboratory methods.
- Founding member of the Connecticut Federation of Lakes, have, and served as a volunteer and an officer of Connecticut's lake advocacy, nonprofit organization until 2022.

PROFESSIONAL EXPERIENCE

- **Principal Limnologist – Brawley Consulting Group, LLC.** 2023 to present
- **Principal Partner – Aquatic Ecosystem Research, LLC.** July 2017 to 2022
- **Adjunct Faculty** – Western Connecticut State University, Biol. and Enviro. Science Dept. August 2011 to present.
- **Executive Director –** Candlewood Lake Authority, Sherman, CT 06784. April 2003 to July 2017
- **Lake Preservation Director –** Candlewood Lake Authority, Sherman, CT 06784. April 1998 to Oct. 2002
- **Academic Research Associate –** Connecticut College, New London, CT 06320. Sept. 1989 to Jan. 1998
- **Visiting Lecturer –** Connecticut College, New London, CT 06320. August 1997 to January 1998
- **Research Assistant** – Western Connecticut State University, Danbury, CT 06810. 1987 to 1989

CERTIFICATION, EDUCATION, AND TRAINING

- **Certified Lake Manager**, North American Lake Management Society, 2017
- **Professional Certification** in GIS, Pace University, 2014
- **Graduate Certification** in GIS Technology, University of New Haven 2001
- **M.A. in Botany**, Connecticut College 1993
- **B.A. in Biology**, Western Connecticut State University 1988

AWARDS

- **Excellence in Environmental Stewardship** from the **Connecticut Outdoor and Environmental Education Association** in 2018
- **Recognition of Service** in the **Congressional Record** by **US Rep. Elizabeth Esty** on June 14, 2017
- **Watershed Conservationist Award** from the **Housatonic Valley Association** in 2011
- **Conservation Professional of the Year** from the **Litchfield County Conservation District** in 2002
- **Honor Award**, **Southern New England Chapter of the Soil and Water Conservation Society** in 2000.
- **Green Circle Award** from the **Connecticut Department of Environmental Protection** in 1999.
- **Conservation Award** from **Housatonic Valley Association** for publication entitled *Candlewood Lake: Watershed Awareness and Lake Preservation* in 1998.

ORGANIZATIONS

- **Connecticut Federation of Lakes** – Founding member 1995; Treasurer from 1995 – 2001; Vice President from 2009 – 2011, 2018 - present; President from 2011 - 2015
- **Connecticut Forest and Park Association** – Board member from 1994 – 2002
- **North American Lakes Management Society** – Member since 1990

SELECTED PUBLICATIONS

PEER-REVIEWED SCIENTIFIC PAPERS

Siver, P.A., Sibley, J., Lott, AM., **Marsicano**, L.J. Temporal changes in diatom valve diameter indicate shifts in lake trophic status. J Paleolimnology 66, 127–140 (2021). https://doi.org/10.1007/s10933-021-00192-y

Siver, P., L. **Marsicano**, A. Lott, S. Wagener, N. Morris. 2018. Wind Induced Impacts on Hypolimnetic Temperature and Thermal Structure of Candlewood Lake (Connecticut, U.S.A.) from 1985-2015. Geo: Geography and the Environment. 5(2). https://doi.org/10.1002/geo2.56

Kohli, P., Siver, P.A., **Marsicano**, L.J., Hamer, J.S., and Coffin, A.M. 2017. Statistical Assessment of Long-term Trends for Management of Candlewood Lake, Connecticut, USA. Journal of Lake and Reservoir Management. 33:280-300

Lonergan, T., L. **Marsicano**, and M. Wagener. 2014. A laboratory examination of the effectiveness of winter seasonal drawdown to control invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Journal of Lake and Reservoir Management. 30:381-392

Moore H.H., Niering W.A., **Marsicano** L.J, and Dowdell M. 1999. Vegetation change in created emergent wetlands (1988–1996) in Connecticut (USA). Wetland Ecology and Management. 7:177-191.

Siver, P.A. A. M. Lott, E. Cash, J. Moss, and L.J. **Marsicano**. 1999. Century changes in Connecticut, USA, lakes as inferred from siliceous algal remains and their relationship to land use changes. Limnology and Oceanography 44:1928-1935.

Siver, P.A. and L.J. **Marsicano**. 1996. Inferring trophic conditions using scaled chrysophytes. Beiheft zur Nova Hedwigia 114:233-246.

Siver, P.A., Canavan, R.W. IV, Field, C., **Marsicano**, L.J. and A.M. Lott. 1996. Historical changes in Connecticut lakes over a 55-year period. Journal of Environmental Quality 25: 334-345

Marsicano, L.J., J.L. Hartranft, P.A. Siver, and J.S. Hamer. 1995. An historical account of water quality changes in Candlewood Lake, Connecticut, over a sixty-year period using paleolimnology and ten years of water quality data. Journal of Lake and Reservoir Management 11:15-28.

Lott, A.M., Siver, P.A., **Marsicano**, L.J., Kodama, K.P. and R.E. Moeller. 1994. The paleolimnology of a small waterbody in the Pocono Mountains of Pennsylvania, USA: reconstructing 19th-20th century specific conductivity trends in relation to changing land use. Journal of Paleolimnology 12: 75-86.

Marsicano, L.J. and P.A. Siver. 1993. A paleolimnological assessment of lake acidification in five Connecticut lakes. Journal of Paleolimnology 9:202-221.

Siver, P.A. and L.J. **Marsicano**. 1993. *Mallomonas connensis* sp. nov., a new species of Synurophyceae from a small New England lake. Nordic Journal Botany. 13: 337-342

Siver, P.A. and L.J. **Marsicano**. 1991. Assessing acidification trends in Connecticut lakes using a paleolimnological approach. CT. Department of Environmental Protection Bulletin, 44 pp. + appendices

POLICY PAPERS AND SUBMITTALS

Marsicano, LJ. 2009. An Examination of Recreational Pressures on Candlewood Lake, CT. Candlewood Lake Authority. Sherman, CT. 68 pp.

Marsicano, L.J., et al. 2000 – 2017. Submittals of the Candlewood Lake Authority to the Federal Energy Regulatory Commission during license renewal and management plan processes for Housatonic Hydro, FERC Docket No. P-2576.

A. Hunter Brawley
95 Pilgrim Drive, Windsor CT 06095
Mobile: 203-525-5991
hbrawley@gmail.com

PROFESSIONAL EXPERIENCE

Owner/Manager, Brawley Consulting Group LLC, Windsor, CT

(January 2008 to present).

Provides land conservation and management services to local land trusts and conservation organizations, including designing and implementing habitat restoration projects, grant writing, trail design and construction, crafting and monitoring conservation easement, boundary posting, Baseline Documentation Reports and developing property management plans. www.brawleycg.com

Land Manager, Naromi Land Trust, Sherman, CT

(March 2004 to present).

Manage all land trust properties and help acquire, monitor and enforce conservation easements. Responsibilities also include designing and building trails, securing funding for habitat restoration projects, and assisting with organizational and administrative tasks. Work cooperatively with the town and other conservation organizations to identify and prioritize lands for future acquisition. www.naromi.org

Land Manager, Kent Land Trust, Kent, CT

(September 2008 to August 2014).

Manage all land trust properties and help acquire, monitor and enforce conservation easements. Responsibilities also include securing funding for habitat restoration projects and preparing Baseline Documentation Reports (BDRs) and property management plans. Addressed backlog of stewardship items required for Kent Land Trust to become the second land trust in Connecticut accredited by the Land Trust Alliance.

Project Manager, Northeast Instream Habitat Program, Amherst MA.

(January 2004 to March 2005).

Coordinated all facets of two fisheries habitat assessment projects working with researcher at the University of Massachusetts, including project planning, data collection, hiring and overseeing seasonal staff, data analysis and report preparation. http://www.neihp.org/index.htm

Executive Director, Pomperaug River Watershed Coalition, Southbury, CT

(July 2001 to May 2003).

Managed all activities of non-profit watershed management organization dedicated to conserving regional water resources, including research, outreach, budgets, grant writing, website development, fundraising, and volunteer relations. www.pomperaug.org

Senior Project Manager, LabLite, LLC, New Milford, CT

(January 2000 to June 2001).

Product development, testing, sales, and customer service for a software company that provides Laboratory Information Management Software (LIMS) to environmental and other laboratories. www.lablite.com

Research Coordinator, The National Audubon Society, Southbury, CT

(March 1998 to January 2000).

Designed and implemented all research on birds and other wildlife at the 625-acre wildlife sanctuary. Conducted natural resources inventory, created checklists of wildlife and plants, established environmental education programs, and coordinated cooperative research projects with state agencies and regional conservation organizations. http://ct.audubon.org/IBA_BOR.html

Environmental Analyst, Land-Tech Consultants, Inc., Southbury, CT

(November 1996 to February1998).

As Project Manager conducted environmental impact statements, wetland assessments, and wildlife surveys; prepared federal, state and local permit applications; designed pond and tidal wetland restoration projects; and conducted lake diagnostic studies. Worked with state agencies and local land use agencies to mitigate impacts of residential and commercial development projects. www.landtechconsult.com

Wetland Ecologist, The Deep River Land Trust, Deep River, CT.

(July to October 1995).

Worked in association with The Nature Conservancy Connecticut Chapter on a conservation project at two freshwater tidal marshes in the lower Connecticut River. Position entailed mapping dominant vegetation communities, identifying potential environmental impacts, researching information on appropriate buffer zones and recommending methods for long-term monitoring of the system.

Research Assistant, The Nature Conservancy CT Chapter, Weston, CT.

(May to July 1995).

Assisted with research on the productivity and survivorship of Worm-eating Warblers at the 1700-acre Devil's Den Preserve in Weston, CT. Responsibilities included mist-netting, bird banding, and locating and monitoring approximately 25 nest sites throughout the breeding season. http://www.nature.org/wherewework/northamerica/states/connecticut/

Master's Thesis Research, Connecticut College, New London, CT.

(September 1993 to May 1995).

Conducted two-year study investigating relationships between bird populations and environmental conditions in tidal wetlands of Connecticut. Quantified bird use, vegetation, and selected environmental parameters in eight tidal marsh systems on the Long Island Sound to assess the use of birds as indicators of environmental quality.
http://www.conncoll.edu/departments/botany/index.htm

Research Associate, Connecticut College Arboretum, New London, CT.

(Sept. 1992 to January 1994).

Conducted a natural resources inventory of The Harriet C. Moore Foundation property in Westerly, RI, including producing lists of all plants and animals (flora and fauna), conducting a breeding bird census, and identifying and tagging over 100 ornamental trees. Developed a five-year plan for the management and use of this 35-acre public land preserve.
http://arboretum.conncoll.edu/

Principal Investigator, The Nature Conservancy CT Chapter, Middletown, CT

(Summer 1994).

Studied five marshes in the tidelands of the lower Connecticut River to assess the impacts of the spread of common reed (*Phragmites australis*) on bird populations. Designed project that included the systematic collection of data on bird use, vegetation sampling and an analysis of physical site characteristics.
http://www.nature.org/wherewework/northamerica/states/connecticut/

EDUCATION

Connecticut College, New London, CT. Master of Arts in Botany, 1995.

Connecticut College, New London, CT. Bachelor of Arts in American History, 1982.

The Loomis Chaffee School, Windsor, CT. Graduated 1978.

PUBLICATIONS

Brawley, A. H., Zitter, R. and L. Marsicano, Editors. 2005. Candlewood Lake Buffer Guidelines. Candlewood Lake News *Special Edition*, Vol 1:21.

Warren, R.S., P. E. Fell, R. Rozsa, A. H. Brawley, A. C. Orsted, E. T. Olson, V. Swamy and W. A. Niering. 2002. Salt Marsh Restoration in Connecticut: 20 years of Science and Management. *Restoration Ecology* 10 (3) 497-513.

Markow, J. and H. Brawley. 2001. Herpetofaunal and Avifaunal Surveys of Vaughn's Neck Peninsula, Candlewood Lake, Connecticut. Report to the Town of New Fairfield, CT. 32 p.

Brawley, A. H. 1998. A Vegetation Survey and Conservation Analysis of Vaughn's Neck Peninsula. Report to The Candlewood Lake Authority. The National Audubon Society. 11 p.

Brawley, A. H., R. S. Warren and R. A. Askins. 1998. Bird Use of Restoration and Reference Marshes Within the Barn Island Wildlife Management Area, Stonington, Connecticut, USA. *Environmental Management* 22(4): 625-633.

Marsicano, L. J. and A. H. Brawley. 1997. Land Use, Watersheds, and Aquatic Resources. *Connecticut Woodlands* 62(3): p. 21.

Niering, W. A., and A. H. Brawley. 1996. Functions and Values Assessment of Area A Downstream Wetlands and Watercourses. Naval Submarine Base New London, Groton, CT. Report to Brown & Root Environmental, The Environmental Protection Agency, and The United States Navy. 36 p.

Brawley, A.H. 1995. Pratt and Post Coves: A Vegetation Survey and Conservation Analysis. Report to the Deep River Land Trust, Deep River, CT. 62 p.

Brawley, A.H. 1995. Birds of Connecticut's Tidal Wetlands: Relating Patterns of Use to Environmental Conditions. Master's Thesis, Connecticut College, New London, CT. 87 p.

Brawley, A.H. 1994. Birds of the Connecticut River Estuary: Relating Patterns of Use to Environmental Conditions. Report to the Nature Conservancy Connecticut Chapter Conservation Biology Research Program, Middletown, CT. 23 p.

Brawley, A.H., G.D. Dreyer. 1994. Master Plan for the Future Management and Use of Moore Woods. Connecticut College Arboretum Publication. New London, CT. 65 p.

Brawley, A.H., G.D. Dreyer and W.A. Niering. 1993. Connecticut College Arboretum Phase One Report to the Harriet Chappell Moore Foundation. Connecticut College Arboretum Publication. New London, CT. 100 p.

ACTIVITIES

Forest and Trails Conservation Committee, Connecticut Forest & Park Association (CFPA)

Coverts Project Cooperator, UConn Cooperative Extension System

WILLIAM HENLEY
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EXPERIENCE

Sr. Aquatic Resource Scientist **May 2018 – Present**
South Central Connecticut Regional Water Authority, New Haven, CT

- **Supervise source water quality monitoring at a regional water company serving 400,000+ customers in 15 towns**
- **Coordinate field work on 11 active reservoirs totaling over 2,000 acres as well as watershed lands (26,000 acres)**
- **Manage environmental programs and initiatives as they relate to source waters (streams, reservoirs, aquifers)**
- **Administer program budgets as well as plan and manage special projects**
- **Collect in situ profile data and water samples at reservoirs to monitor reservoir ecosystem health**
- **Process samples at the Authority's laboratory; analyze, interpret, and report the results**
- **Conduct aquatic macrophyte surveys and manage downstream release compliance**
- **Attend public events and participate in environmental outreach and education**
- **Contribute to ecological restoration by collaborating with various departments and external stakeholders**
- **Operate/maintain water quality sampling equipment as well as company boat and vehicle**

Core accomplishments:

- **Played a focal role in the realization of a new stream water quality monitoring initiative**
- **Worked on the discovery and management of an invasive species in one of the Authorities waterbodies**
- **Provided management and oversight of downstream release from reservoirs, and determined needs to meet new regulations.**

Fisheries Durational Resource Technician **Apr – Nov 2016, July 2017 – Mar 2018**
DEEP Inland Fisheries Division, Marlborough, CT

- **Provided support to fisheries biologists by collecting biological data as it relates to fish and aquatic ecosystems at over 65 stream sites and 25 lakes and ponds**
- **Conducted monitoring of stream and lake fish species utilizing electrofishing boats, backpacks, and trap nets**
- **Performed surveys of freshwater anglers on statewide lakes 2-3 days weekly in open water and ice conditions**
- **Collected and cataloged freshwater mussels for identification in conjunction with the CT DEEP Wildlife Division**
- **As a lead observer, facilitated stream crossing and culvert assessments for the North Atlantic Aquatic Connectivity Collaborative (NAACC)**
- **Collected dissolved oxygen profiles on lakes intended for stocking as part of a long-term dataset**
- **Provided direction to new technicians and oversaw volunteers**

Core accomplishments:

- **Served as a leader for sampling crews as well as managed several critical projects**
- **Participated in the discovery/confirmation of an invasive plant now found in the Connecticut River**
- **Contributed to a study of winter road sand impact presented at the Connecticut Natural Resource Conference**
- **Certified as North Atlantic Aquatic Connectivity Collaborative (NAACC) Lead Observer**
- **Participated in wild Brook Trout PIT tagging initiative**

Adjunct Limnologist **July 2015 – January 2023**
Aquatic Ecosystem Research, Branford, CT

- **Worked as a technician under the companies' principal limnologist executing field work on over a dozen freshwater bodies of water totaling over 2,500 acres**
- **Performed water quality monitoring and algal sampling using YSI Water Quality Sondes and Van Dorn samplers**
- **Conducted aquatic plant community surveys, including invasive species monitoring**
- **Collected various geospatial data, aquatic plant data, bathymetric data, and infrastructure data to conduct research, analyze trends, and create geospatial products and maps**
- **Compiled and managed large data sets and generated accurate reports on a regular basis**
- **Closely collaborated with freshwater and coastal stakeholders on the creation and planning of conservation and management projects**

Core accomplishments:

- **Developed various geospatial methodologies for assessment of ecological systems**
- **Implemented new techniques for monitoring aquatic plant communities**
- **Created standardized templates for company map products**
- **Integrated new technologies for bathymetric and plant mapping**
- **Participated in research initiatives for various projects, including authorship on a research paper**

Wildlife, Geospatial & Field Technician **May 2016 – May 2018**
Davison Environmental, Chester, CT

- **Worked independently on a variety of projects performing various assorted environmental work as a subcontracted environmental technician**
- **Accountable for geospatial data collection and analysis**
- **Participated in wetland and plant surveys as well as mapping initiatives**
- **Conducted wildlife surveys for amphibians, herps, birds, and bats**
- **Solely developed geospatial techniques and maps**

Environmental & Aquatic Field Technician **Summer 2013 – 2015**
All Habitat Services, Branford, CT

- **Identified and removed invasive wetland, upland, and aquatic vegetation by applying pesticides**
- **Conducted aquatic vegetation surveys and water quality sampling as well as produced** professional map products
- **Implemented new geospatial methodologies to survey sediments and bathymetry**

EDUCATION

B.A. in Geography with minor in Wildlife Conservation • *University of Delaware* **Spring 2015**
Graduate Certificate Geographic Information Science • *University of Delaware* **Spring 2015**

VOLUNTEER & COMMUNITY SERVICE

White-tailed Deer Capture & Tracking • University of Delaware, Milton, Delaware **Jan – Apr 2015**
Marsh Bird Surveys • St. Jones Reserve, Dover, Delaware **June – July 2014**
President of National Meteorological Society Student Chapter, University of Delaware
Boy Scouts of America • Rank of Life Scout

PUBLICATIONS

June-Wells M, Simpkins T, Coleman AM, **Henley W**, Jacobs R, Aarrestad P, Buck G, Stevens C, Benson G. (2017) Seventeen years of grass carp: an examination of vegetation management and collateral impacts in Ball Pond, New Fairfield, Connecticut. Lake and Reservoir Management 33:84–100

SKILLS & QUALIFICATIONS

Proficient with Microsoft Word, Excel, and PowerPoint
Proficient with ArcMap, ENVI, and GIS Data Procurement
Basic knowledge of NCL, Python, R, and Unix
Proficient in use of GPS hand and backpack units (Garmin, Trimble)
Proficient in a variety of water quality sampling techniques/equipment
North Atlantic Aquatic Connectivity Collaborative (NAACC) Lead Observer
National Weather Service Skywarn storm spotter training
North American Lake Management Society Certifield Lake Manager