2024

ECOSYSTEM MONITORING REPORT

CHILMARK POND

GREAT POND FOUNDATION

Prepared on behalf of

CHILMARK POND FOUNDATION

CHILMARK POND FOUNDATION

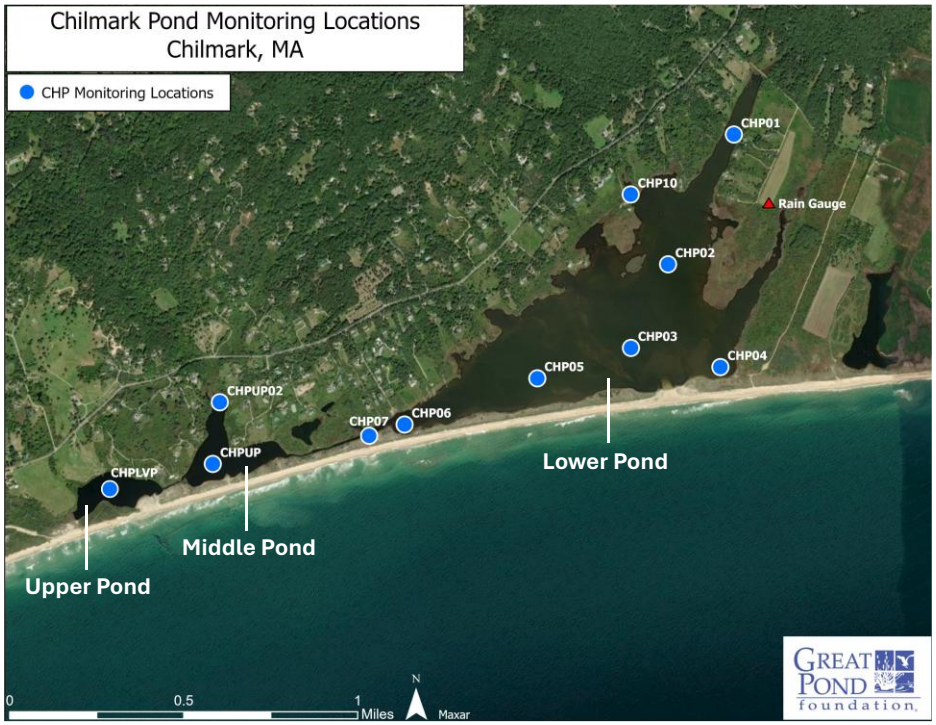
GREAT POND foundation®

CHILMARK POND
Executive Summary

2024

Study Area

Chilmark Pond (CHP) is a coastal estuary approximately 210 acres in size located on Martha's Vineyard's southern shoreline. CHP is a complex system comprised of 3 interconnected basins known as the "Upper", "Middle", and "Lower" Ponds. These 3 basins encompass a roughly 3,400-acre watershed. The barrier beach separating the Lower Pond from the ocean is manually breached 3-5 times per year as a nutrient and elevation management tool.

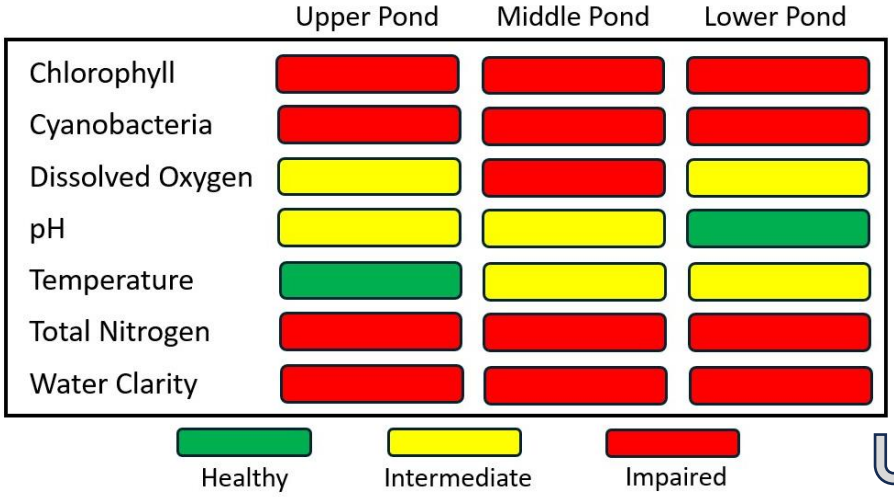


Sampling Regime 2024

In 2024, on behalf of the Chilmark Pond Foundation (CPF), Great Pond Foundation (GPF) resumed an ecosystem monitoring program on CHP for the 4th consecutive year. A total of 23 weekly monitoring trips were conducted between May and October. During each trip, water quality data was obtained for 11 monitoring sites (see map to left). Nutrient samples were collected at 8 of the regular 11 monitoring sites once a month.

GPF expanded its existing program in 2024 with the addition of a new monitoring station in the Upper Pond, as well as the deployment of stationary logging sensors in both the Upper and Middle Ponds.

Summary of Metrics, 2024



Cut Dates 2024

Date of Opening	Date of Closure	Cut Duration
*Jan 10th	Jan 16th	6 days
Mar 4th	Mar 6th	2 days
Apr 5th	Apr 12th	7 days
May 21st	Jun 8th	18 days
Oct 16th	Oct 24th	8 days

*Cut on January 10th occurred naturally rather than through a man-made breach.

The "Summary of Metrics" tool assigns health rankings to individual water quality metrics. Refer to the *Appendix* for information on how rankings are assigned.

Pond Summary 2024

CHP exhibited poor water quality in 2024, continuing trends observed since 2021. Elevated nutrient levels, specifically that of nitrogen, drove increased phytoplankton growth across the Pond. Impairment was most pronounced in the system's western region, where a concentrated cyanobacteria bloom belonging to the genus *Dolichospermum* formed during the late summer for the 3rd straight year. Current data suggest that the recurrence of *Dolichospermum* bloom formation on the Middle Pond during the late summer may owe to high nitrogen availability coupled with cooling water temperatures.

Introduction

Chilmark Pond (CHP) exhibited poor water quality and signs of ecosystem impairment in 2024, continuing trends observed in the Pond since regular monitoring first began in 2021. Elevated nutrient levels, specifically that of nitrogen, once again drove increased phytoplankton growth across CHP in 2024, reducing water clarity and depleting dissolved oxygen levels at the pond bottom. Despite all regions of the Pond suffering from the same core issue of nutrient impairment, impacts were felt most heavily in the system's western region (i.e. Upper Pond, Middle Pond, and Abel's Hill Crossing). This region of the Pond saw the development of 3 unique algal and cyanobacteria bloom types in 2024, including the formation of a concentrated cyanobacteria bloom of the genus *Dolichospermum* during the late summer, representing the third straight year in which this has occurred.

In response to community feedback expressing concern over the degraded state of CHP's western region, Great Pond Foundation (GPF) expanded the scope of its existing monitoring program in 2024 to better understand the factors contributing to the western region's persisting issues. This included the establishment of a new monitoring station in the Upper Pond, as well as the deployment of stationary sensors that passively record data in both western basins. This expansion of the monitoring program combined with 4 years of high-resolution data enabled the most in-depth analysis of bloom timing and contributing factors put forth by GPF to date, the results of which are presented in this report.

Tracking Bloom Dynamics in 2024

In 2024, 3 distinct algal and cyanobacteria bloom types were observed in the western region of the CHP system. The geographic extent of each of these blooms is shown in **Figure 1**.

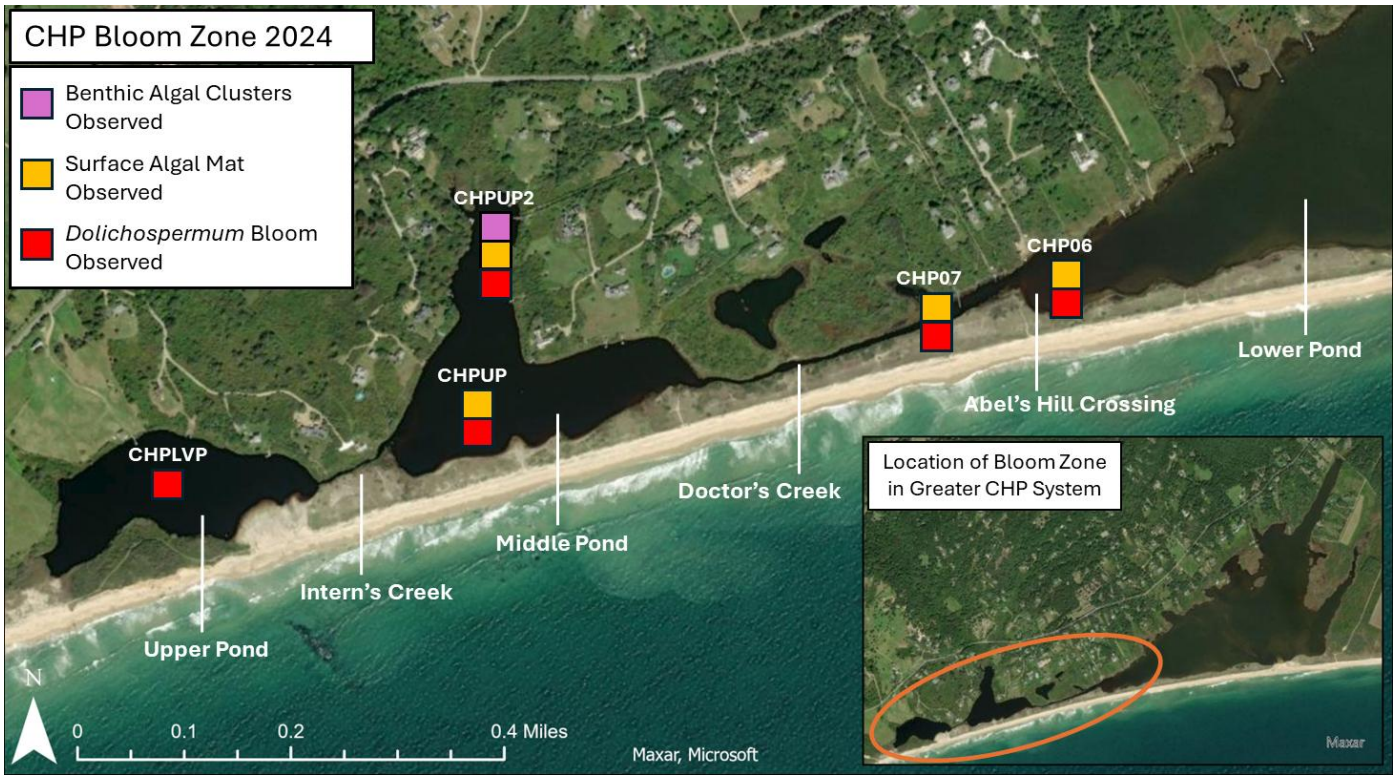


Figure 1. *The region of the CHP system that experienced algal and cyanobacterial blooms in 2024 is shown. Colored boxes indicate that a specific bloom type was observed at a given monitoring station.*

A brief overview of each of these bloom types is provided below. Photos are shown in **Figure 2**. For context, cyanobacteria blooms typically come in 1 of 2 forms: benthic or planktonic. Benthic cyanobacteria grow in macroalgal clusters or mats on the pond floor. These mats may remain on the pond floor (see Bloom A below), or float to the surface if air bubbles become entrapped within (see Bloom B below). Alternatively, planktonic cyanobacteria float freely within the water column and may form a bloom when high concentrations become diffuse throughout the water (see Bloom C below).

Figure 2. *Photos of each bloom type observed in CHP in 2024.*

A) Benthic Algal Clusters: Macro-clusters of benthic (i.e. bottom-dwelling) algal material were regularly observed at the northern tip of the Middle Pond between 6/4/24 and 10/23/24. These clusters were initially discovered following the opening of the cut on 5/21/24 as a result of the Pond's lowered water elevation. Analysis of this material revealed cyanobacteria as the dominant phytoplankton class (50-70% of composition), although elevated concentrations of diatoms (a separate type of phytoplankton) were also present. These clusters were entirely contained to the northern tip of the Middle Pond. The summer of 2024 represents the first time that this specific benthic material has been documented in the CHP system since monitoring began in 2021.

B) Surface Algal Mat: A surface macroalgal mat was first discovered at Abel's Hill Crossing on 6/19/24. While the bulk of the mat had dissipated by late July, clumps of material continued to be observed along the edges of the Pond through 9/24/24. A surface algal mat was also observed in the Middle Pond between 7/24/24-8/14/24, representing the second straight year that a surface algal bloom has formed here in July. Material was typically most concentrated at the Middle Pond's northern tip (where wind tends to drive accumulation) but was often seen extending down to the basin's southwest corner as well. These mats were composed of a variety of different phytoplankton classes, including cyanobacteria, green algae, and diatoms.

C) *Dolichospermum* Bloom: For the third consecutive year, the western CHP system experienced a planktonic cyanobacteria bloom during the late summer and early fall. These recurring late season blooms have been confirmed as belonging to the cyanobacteria genus *Dolichospermum*, a genus capable of producing toxins harmful to humans and pets, including microcystins and anatoxins. These blooms take the form of "surface scum", which is most commonly associated with cyanobacteria blooms.

This scum appears as green, paint-like streaks or specks present at the surface of the pond and often becomes concentrated along downwind shorelines.

A timeline of the *Dolichospermum* bloom that formed in 2024 is depicted in **Figure 3**. Visible *Dolichospermum* scum was first observed on 8/5/24 in Intern's Creek, before expanding to the Upper Pond and Doctor's Creek the following week. By the end of August, the *Dolichospermum* bloom had spread across the entire western system (Upper Pond -> Middle Pond -> Abel's Hill Crossing), ultimately reaching its peak extent for the year. While the bloom remained present in the system's traditional bloom zone (Middle Pond, Doctor's Creek, and Abel's Hill Crossing) through mid-October, it had disappeared from the system's westernmost region (Upper Pond and Intern's Creek) by early September. Given that an Upper Pond monitoring site was only added in 2024, it's unclear how far upstream CHP's recurring *Dolichospermum* blooms originate before moving downstream.

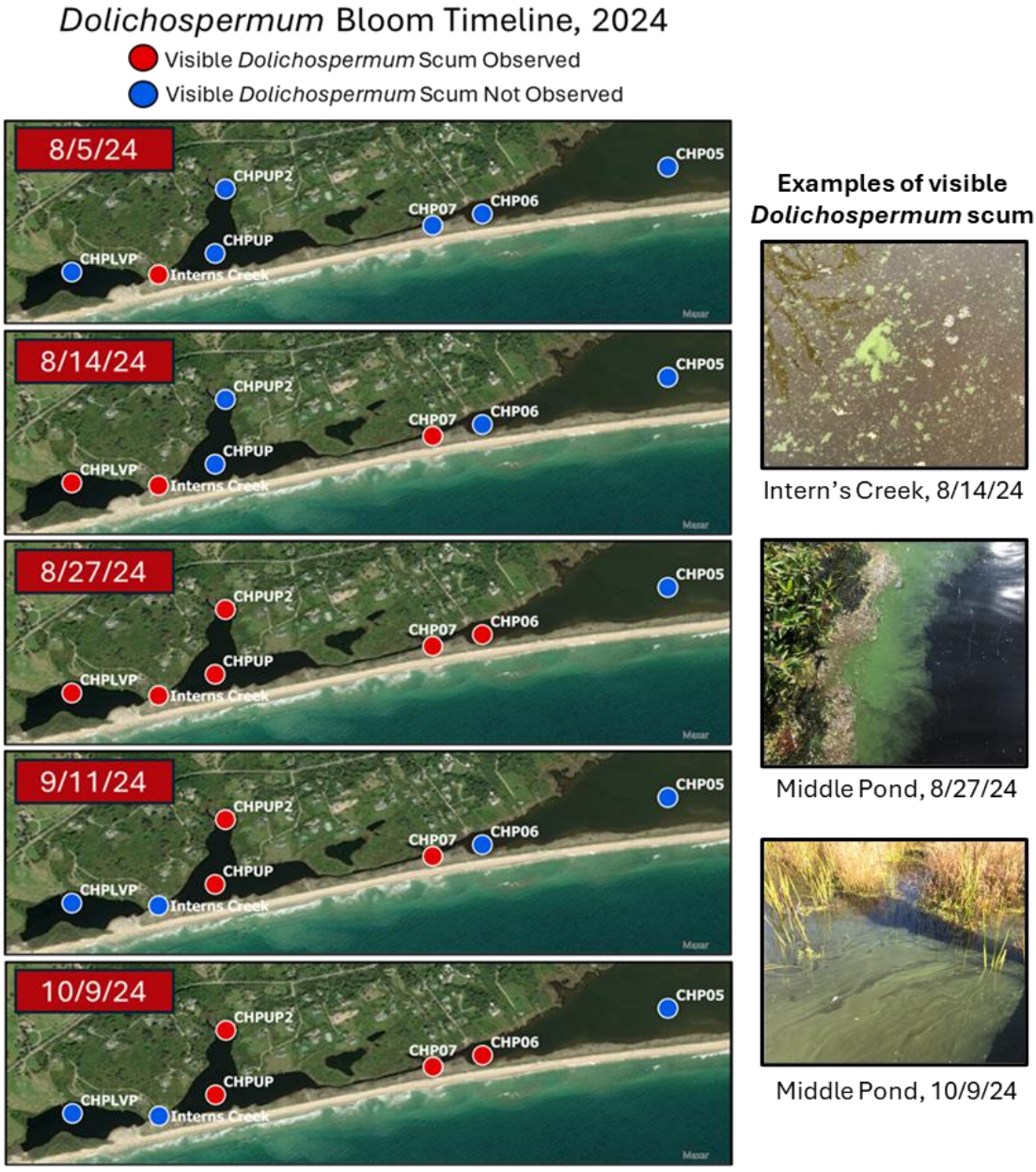


Figure 3. *A timeline of the Dolichospermum bloom seen in the western region of CHP in 2024.*

Exploring Community Shifts and Bloom Drivers

Each respective subregion of the greater CHP system exhibited its own unique phytoplankton community in 2024 (**Figure 4**). Consistent with trends observed in the Pond in 2022 and 2023, the Middle Pond and Abel's Hill Crossing continued to host primarily cyanobacteria-dominated communities, while the same was true of green algae in the Lower Pond. Unlike these other regions, the Upper Pond was not dominated by 1 singular phytoplankton class in 2024 but rather exhibited a more balanced community composition. In looking at changes in composition during the 2024 monitoring season, the month of August appears to be the year's primary period of community transition. During this timeframe, the Upper Pond saw a decline in overall phytoplankton growth, while the Middle and Lower Ponds saw the beginnings of planktonic cyanobacteria and green algae blooms, respectively.

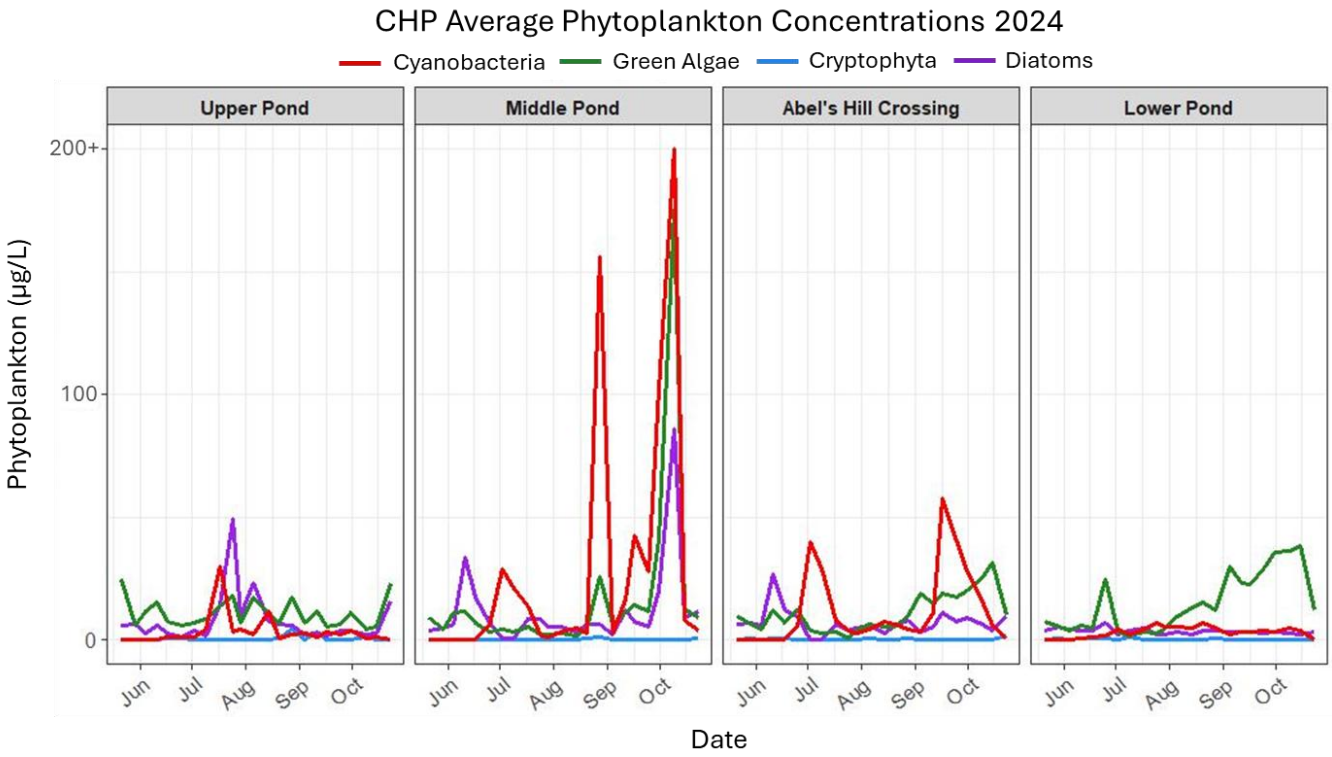


Figure 4. *Phytoplankton concentrations within 4 subregions of CHP during the 2024 season. Plotted values pertain to the average concentration among all monitoring stations within a given subregion (see Appendix).*

The potential influence of 2 environmental factors (nitrogen and water temperature) in promoting the widespread community shift seen in August is examined in **Figure 5**. All 3 basins saw a notable rise in total nitrogen (TN) concentrations during this August transition period, suggesting that the community shifts seen across the system were largely brought on by heightened nutrient availability. This is evident in both the Middle and Lower Ponds exhibiting a rise in chlorophyll levels (a measure of overall phytoplankton growth) in conjunction with increased TN availability.

Alternatively, despite the Upper Pond seeing a pronounced TN spike in August, chlorophyll levels in this basin gradually declined over the same period. It's unclear exactly why this was the case, although it's possible that the short-lived nature of the nitrogen spike prevented excess phytoplankton buildup, as the basin had seen a return to healthy TN levels by September. This is in contrast to the Middle and Lower Ponds, where TN levels remained elevated into the fall.

Beyond nutrients, water temperature is also known to influence the respective life cycles of different phytoplankton species. After reaching a peak in early August, water temperatures across each of CHP's 3 basins began a steady decline that lasted the remainder of the season (**Figure 5**), suggesting that cooling water temperatures may have also contributed to the Pond's late summer community shift.

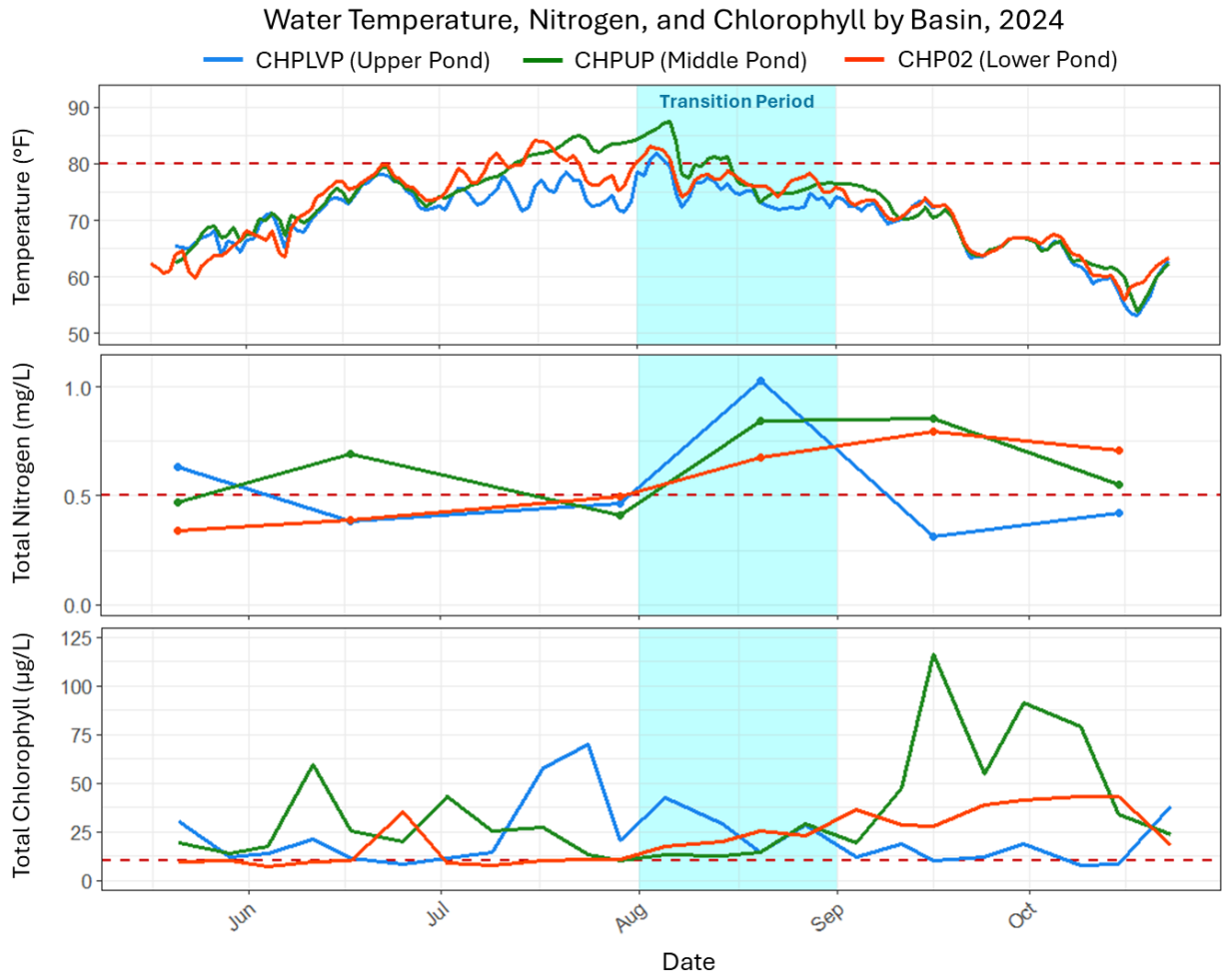


Figure 5. *Mean daily water temperature (in °F), total nitrogen (in mg/L), and total chlorophyll (in ug/L) at stations CHPLVP (Upper Pond), CHPUP (Middle Pond), and CHP02 (Lower Pond) in 2024. Dashed red lines represent the State's mean daily water temperature (80 °F), total nitrogen (0.5 ug/L), and total chlorophyll (10 ug/L) management thresholds. The shaded blue area highlights the month of August 2024, a transitionary period in the state of the Pond.*

This August transition period marked the start of the planktonic *Dolichospermum* bloom seen across most of the western system in 2024, a bloom that has consistently plagued this region (particularly the Middle Pond) since 2022. The influence of nitrogen levels and water temperature in driving the development of late summer *Dolichospermum* blooms in the Middle Pond is examined across multiple years in **Figure 6**. Timeframes shaded in blue represent a given year's *Dolichospermum* bloom period. In looking at 2022, it should be noted that while planktonic cyanobacteria concentrations reached bloom status as early as late July, the year's initial bloom was not *Dolichospermum* but rather the cyanobacteria genus *Sphaerospermopsis*. As such, this period is not shaded in blue.

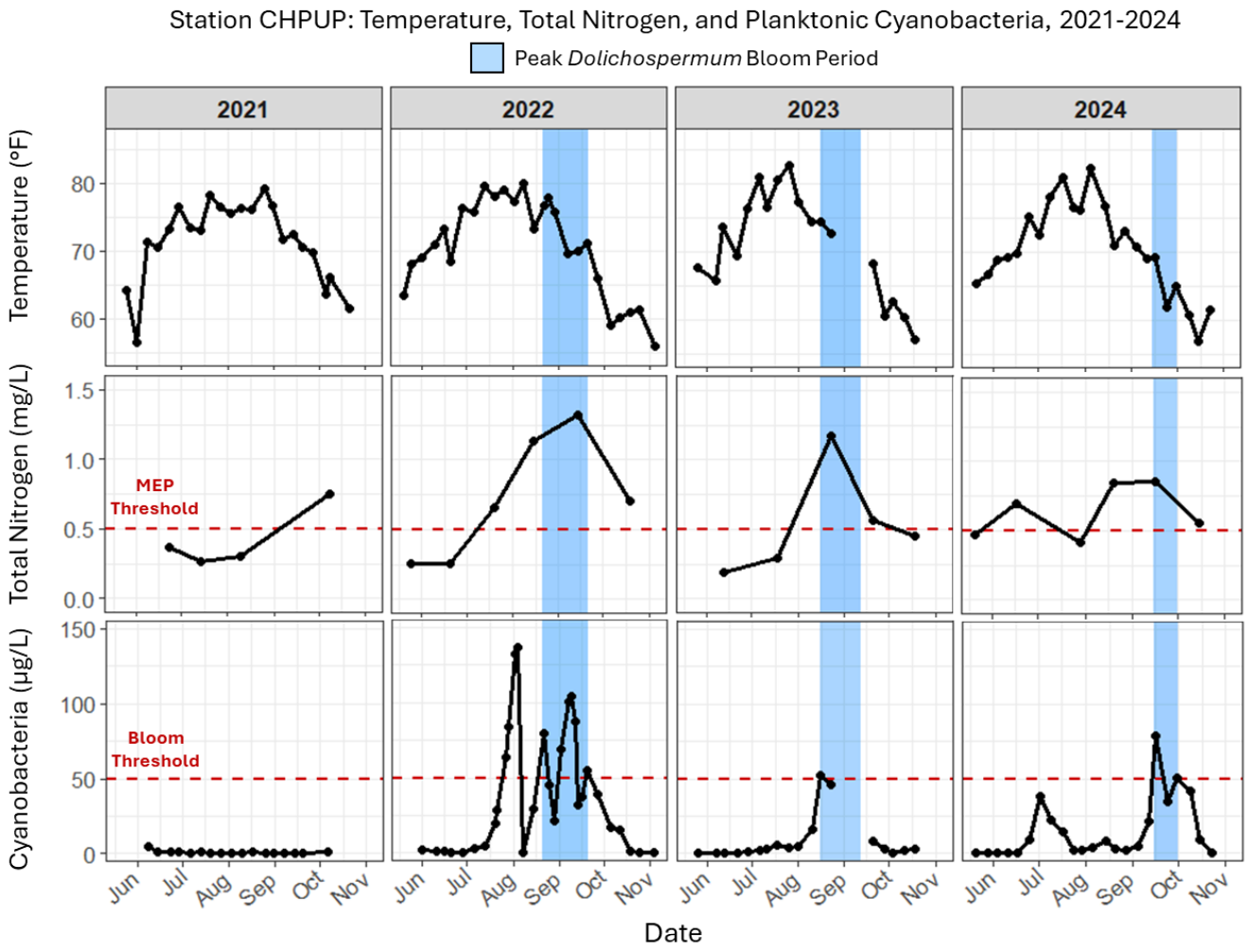


Figure 6. *Water temperature averaged across all depths (in °F), total nitrogen (in mg/L), and planktonic cyanobacteria (in ug/L) at station CHPUP each year from 2021 to 2024. Blue shading represents a given year's Dolichospermum bloom period. Dashed red lines represent State-established management thresholds. Data is missing for 2023's bloom period due to conditions preventing access to the CHPUP monitoring station.*

TN levels and planktonic cyanobacteria concentrations in the Middle Pond appear to be closely linked, with the timing of peak nitrogen levels seemingly dictating the timing of planktonic bloom formation (**Figure 6)**. In 2022, planktonic cyanobacteria concentrations first reached bloom status in July at the same time as TN levels rose above the State's nitrogen threshold. Similarly, cyanobacteria concentrations in 2023 first reached bloom status in August in conjunction with a spike in TN above this threshold. While planktonic cyanobacteria concentrations in 2024 didn't reach bloom status until September, roughly a month after TN first rose above the State's threshold, the timing of this bloom still coincided with the year's highest recorded TN level. By comparison, in 2021, a year in which no blooms were observed, TN levels remained relatively low throughout most of the season.

While trends in TN levels seem to largely determine when planktonic cyanobacteria levels in the Middle Pond are prone to rise, they are unable to explain the recurring timing of *Dolichospermum* blooms during the late monitoring season on their own, as implied by 2022's July nitrogen spike inducing a different planktonic cyanobacteria bloom rather than a *Dolichospermum* bloom.

Each year from 2022 to 2024, *Dolichospermum* blooms formed after water temperatures dropped below ~75 °F as they began to cool through the late summer and early fall (**Figure 6**). Studies have shown that *Dolichospermum* is effective in outcompeting other species of cyanobacteria at lower water temperatures, specifically at temperatures of 68 °F and below (Zhang et al., 2020; Deng et al., 2024; Liu et al., 2024). While the Middle Pond's observed *Dolichospermum* temperature threshold (~75 °F) does not directly match that of the literature (68 °F), it's close enough to suggest that the perennial timing of *Dolichospermum* blooms during the late summer season is likely the result of a shift to the genus' preferred temperature range. This may explain why the planktonic bloom in July of 2022 comprised the genus *Sphaerospermopsis*, a group of cyanobacteria with its own unique temperature niche, rather than *Dolichospermum*, which prefers the cooler waters of the late summer.

Unaccounted for in the planktonic cyanobacteria measurements plotted in **Figure 6** are the surface macroalgal mats that formed on the Middle Pond in late July of 2023 and 2024. In both years, these mats formed when water temperatures were at their peak (>75 °F), before disappearing in August as temperatures cooled and *Dolichospermum* concentrations began to rise (**Figure 7**). Both macroalgal blooms formed during summers in which July TN levels were not particularly high, suggesting that hot water and lower nitrogen may be the winning combination in triggering macroalgal mat formation. By comparison, 2022's planktonic *Sphaerospermopsis* bloom in July coincided with high TN and high temperatures. These trends suggest that during hot Julys in the Middle Pond, nitrogen availability may ultimately determine the type of mid-summer bloom that forms prior to *Dolichospermum* taking over in the late summer.

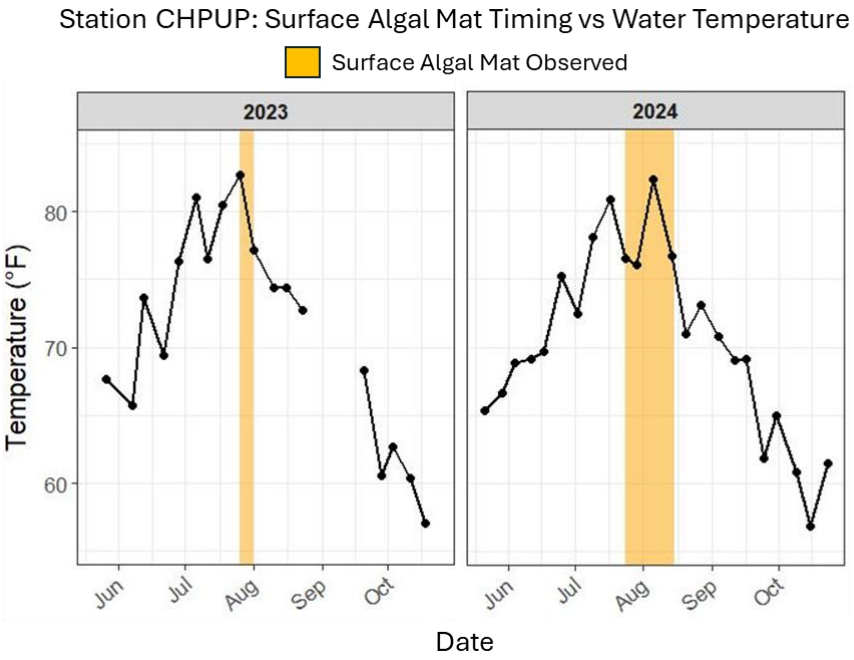


Figure 7. *Water temperature (averaged across all depths) at station CHPUP (Middle Pond) in 2023 and 2024. Timeframes shaded in orange saw the presence of a surface algal mat.*

Conclusion

CHP exhibited overall poor water quality and ecosystem health in 2024. Various algal and cyanobacteria bloom types formed in the fresh to low-brackish waters of CHP's western region, with the most bloom activity seen in the Middle Pond. An analysis of Middle Pond bloom dynamics from 2021-2024 yields the following:

1) Surface algal mats may form in July when temperatures exceed 75 °F.

    a. If July TN levels exceed the State's 0.5 mg/L threshold, a planktonic cyanobacteria bloom distinct from that of *Dolichospermum* may form instead.
2) Planktonic *Dolichospermum* blooms are likely to form during the late summer or early fall when TN levels exceed the State's 0.5 mg/L threshold and water temperatures drop below 75 °F.

It should be noted that the trends presented above are based on only a few years of data and fail to account for other factors that influence bloom development. As such, these trends should be considered a starting point for anticipating blooms rather than a definitive prediction model. Additional years of data collection will be necessary to better resolve these complicated dynamics. Regardless, trends observed in the Pond indicate that excess nutrient loading, specifically that of nitrogen, is the primary driver of impairment not only in CHP's western region, but across the overall system. This is consistent with the findings of the Massachusetts Estuaries Project's (MEP) 2015 report on CHP (Howes et al., 2015). As such, future management must be planned with nutrient mitigation in mind if the CHP ecosystem is to return to a healthier state.

Adequately addressing the nutrient problem in CHP will likely be a multi-decade process given the logistical and financial challenges of updating infrastructure and implementing localized solutions within the Pond's watershed. In the meantime, cut optimization and innovative solutions can be used to temper the impacts of nutrient impairment in the short-term. In the winter of 2025-2026, the delta of sand north of the Pond's cut site will be dredged by the Chilmark Pond Foundation to improve flushing during breaches of the barrier beach. Additionally, the Chilmark Pond Foundation deployed an ultrasonic buoy in the Middle Pond in July of 2025 to prevent cyanobacteria growth through the emittance of sonic waves. This is the first of its kind employed in Massachusetts. Scientific monitoring is vital in measuring the success of remediation efforts. As such, the Chilmark Pond and Great Pond Foundations will continue a regular monitoring program during the summer/fall of 2025, providing real-time data on the efficacy of the buoy with hopes that it will improve water quality.

Works Cited

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Appendix

Refer to GPF's **Summary of Metrics Methodology** page for information on how the Summary of Metrics rankings included in this report's executive summary were assigned.

In Figure 4, average total chlorophyll concentrations are plotted for 4 CHP subregions (Upper Pond, Middle Pond, Abel's Hill Crossing, and Lower Pond). Plotted chlorophyll values pertain to the average concentration of the following monitoring stations:

- Upper Pond: CHPLVP
- Middle Pond: CHPUP, CHPUP2
- Abel's Hill Crossing: CHP06, CHP07
- Lower Pond: CHP01, CHP02, CHP03, CHP04, CHP05, CHP10

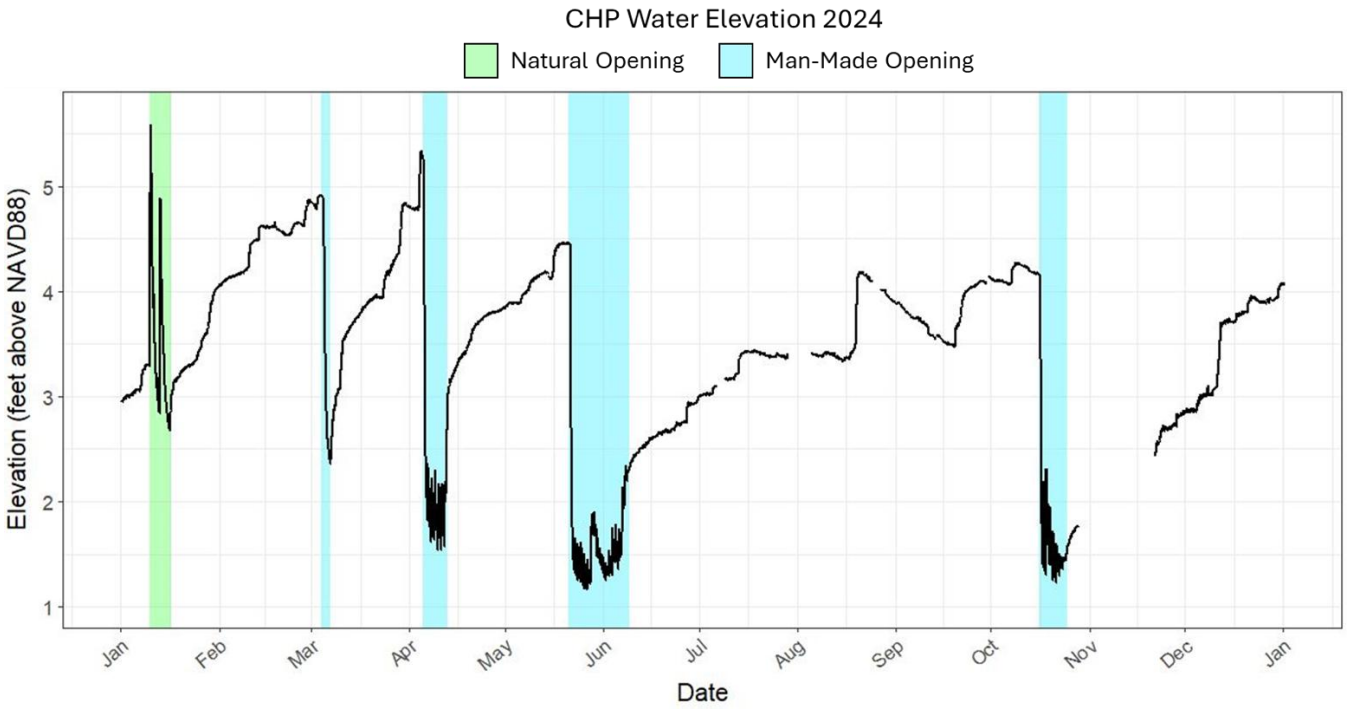

Figure A1. *Water elevation (in feet above the NAVD88 datum) in CHP for the year 2024. Green and blue shading indicate that the Pond was open to the ocean via a natural or man-made breach, respectively.*

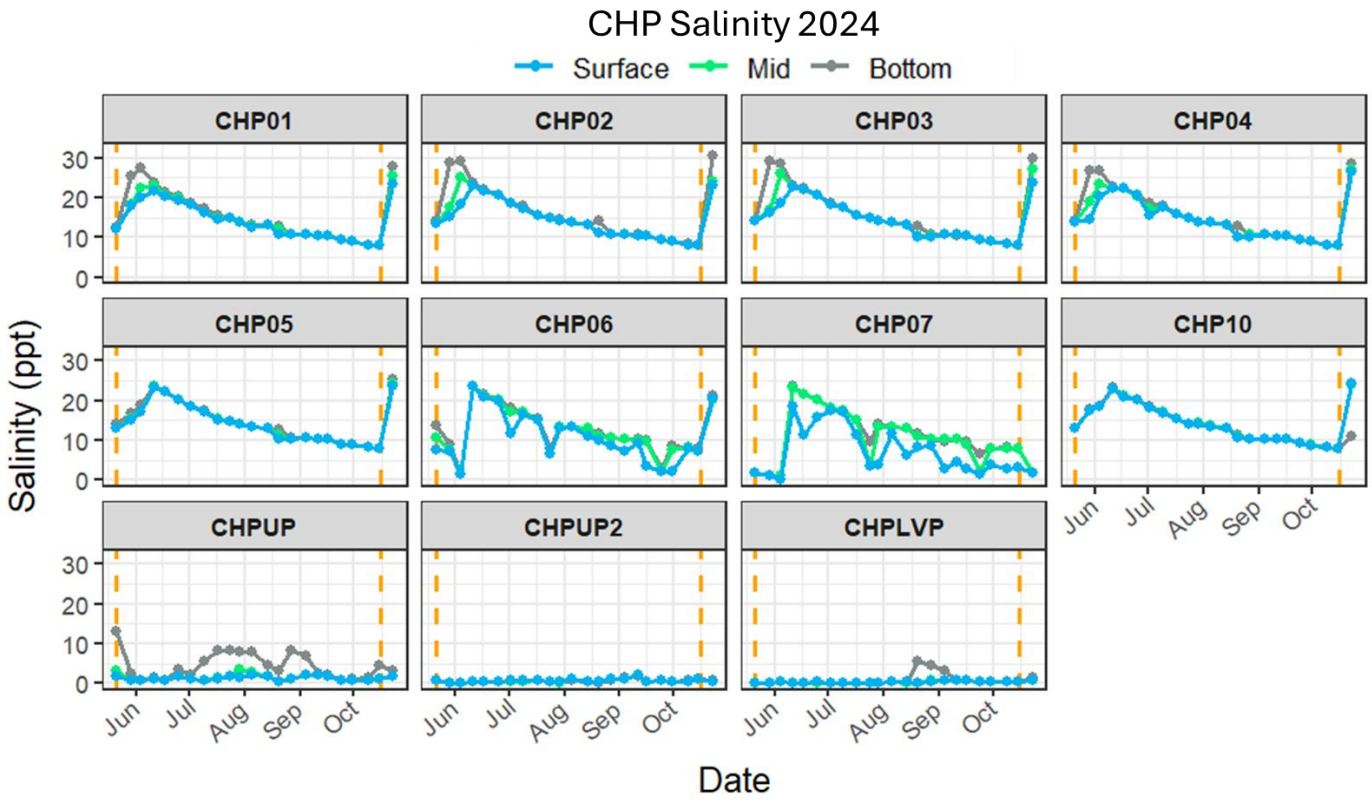

Figure A2. *Salinity in parts per thousand (ppt) for CHP's 11 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). Dashed yellow lines indicate an opening on the Pond.*

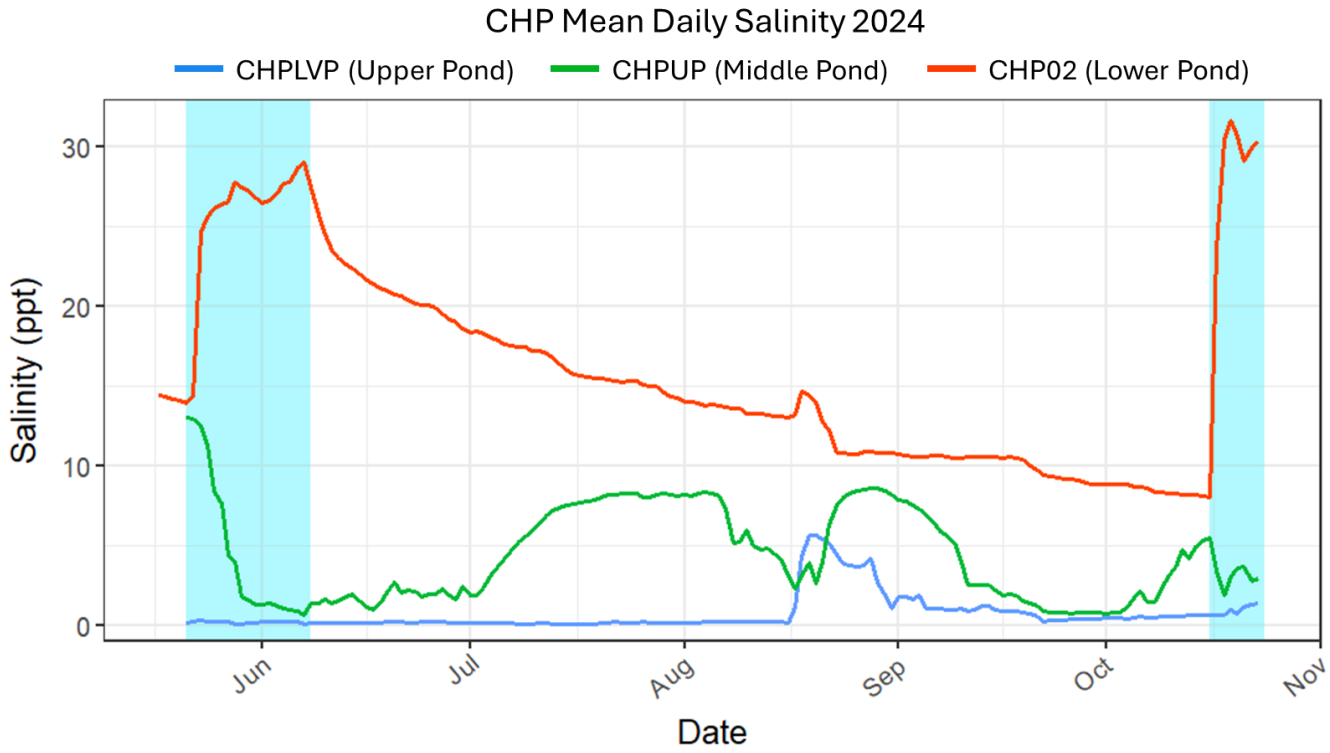

Figure A3. *Mean daily salinity (in ppt) at monitoring stations CHPLVP (Upper Pond), CHPUP (Middle Pond), and CHP02 (Lower Pond) during the 2024 field season. Blue shading represents an opening on the Pond.*

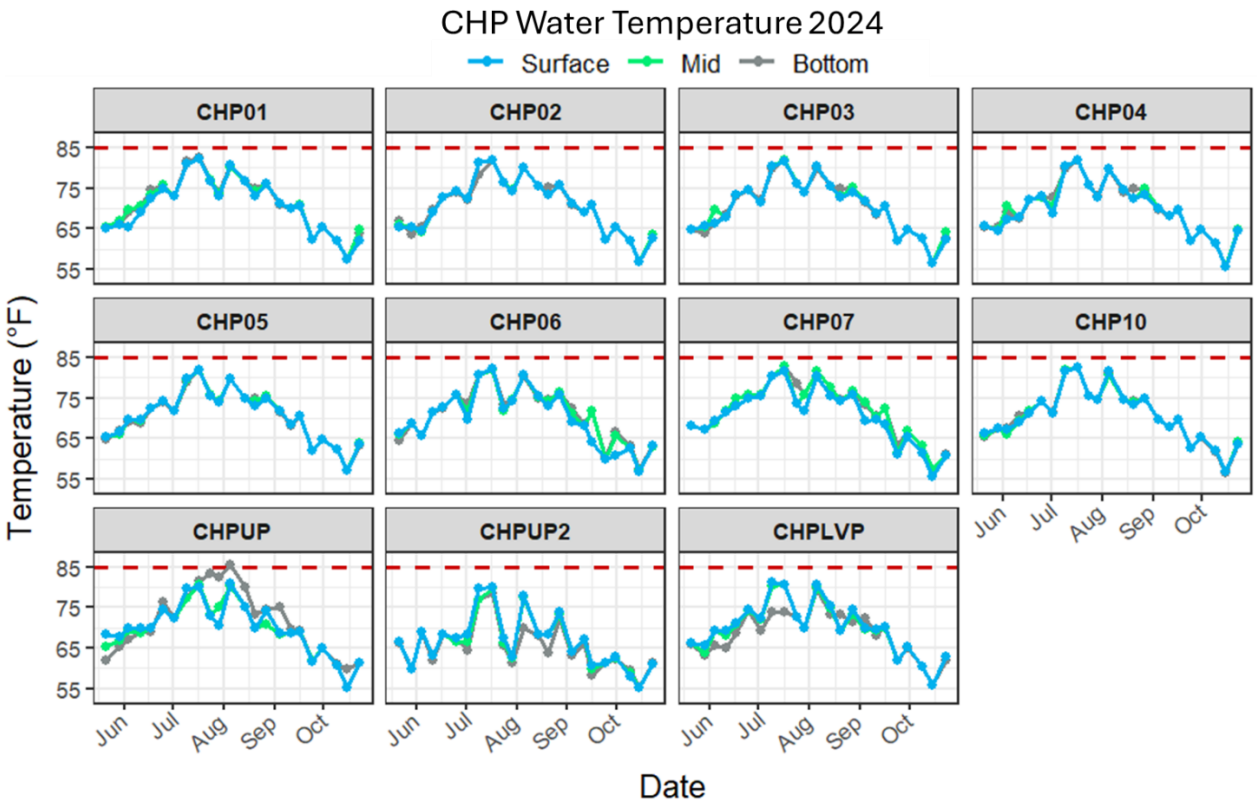

Figure A4. *Water temperature (in °F) for CHP's 11 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed red line represents the State's 85 °F management threshold.*

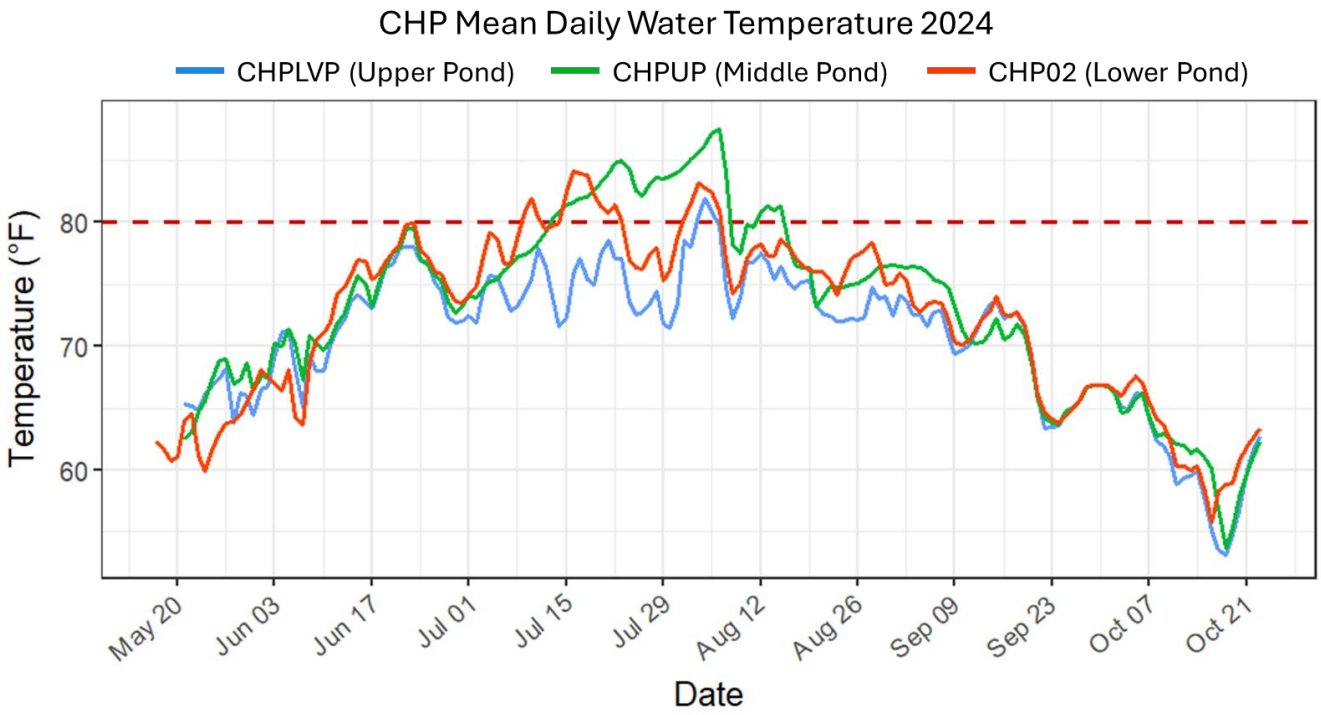

Figure A5. *Mean daily water temperature (in °F) at monitoring stations CHPLVP (Upper Pond), CHPUP (Middle Pond), and CHP02 (Lower Pond) during the 2024 field season. The dashed red line represents the State's 80 °F mean daily temperature threshold.*

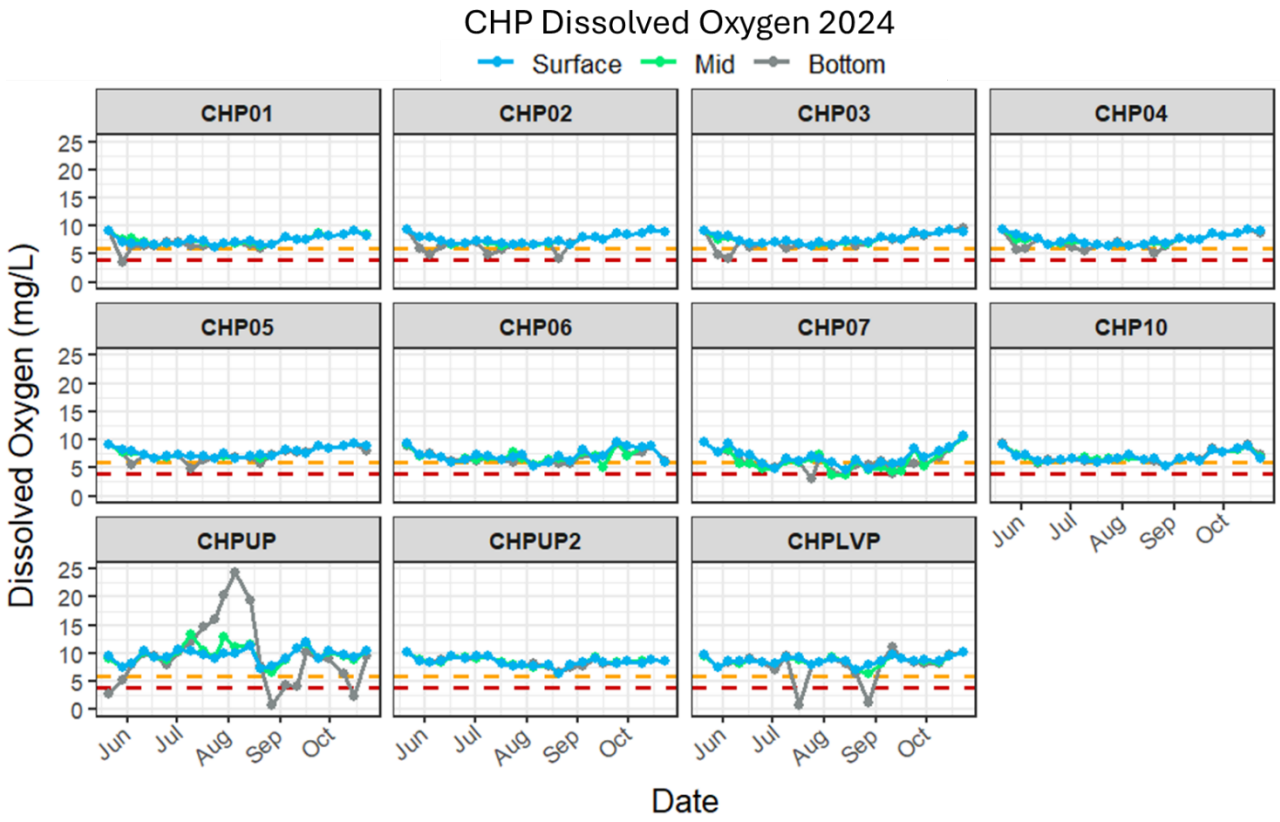

Figure A6. *Dissolved oxygen (DO) in mg/L for CHP's 11 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed yellow line represents the State's 6 mg/L management threshold and the dashed red line indicates when DO levels dropped critically low (<4 mg/L).*

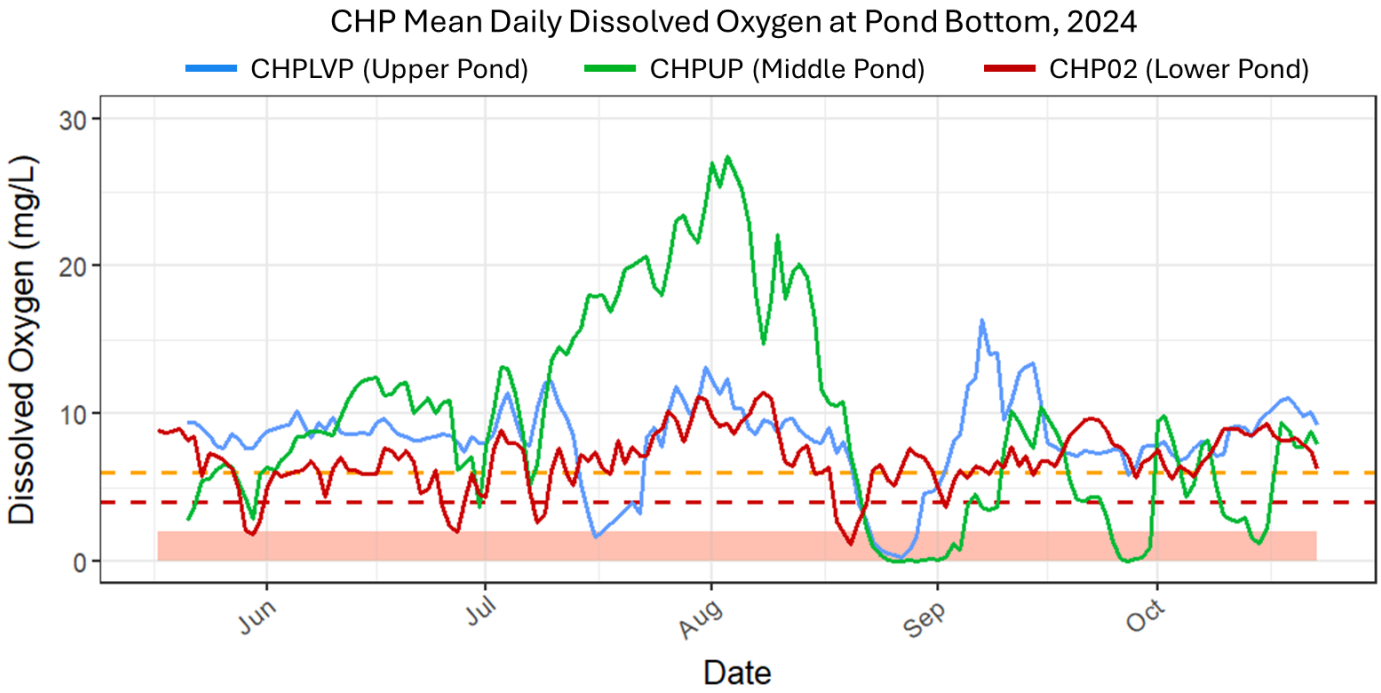

Figure A7. *Mean daily dissolved oxygen (DO) in mg/L at monitoring stations CHPLVP (Upper Pond), CHPUP (Middle Pond), and CHP02 (Lower Pond) during the 2024 field season. Data was recorded at the pond bottom. The dashed yellow line represents the 6 mg/L management threshold, the dashed red line indicates when DO levels dropped critically low (<4 mg/L), and the light red box indicates when hypoxia occurred (<2 mg/L). In a healthy ecosystem, daily fluctuations of DO should remain above the 6 mg/L threshold.*

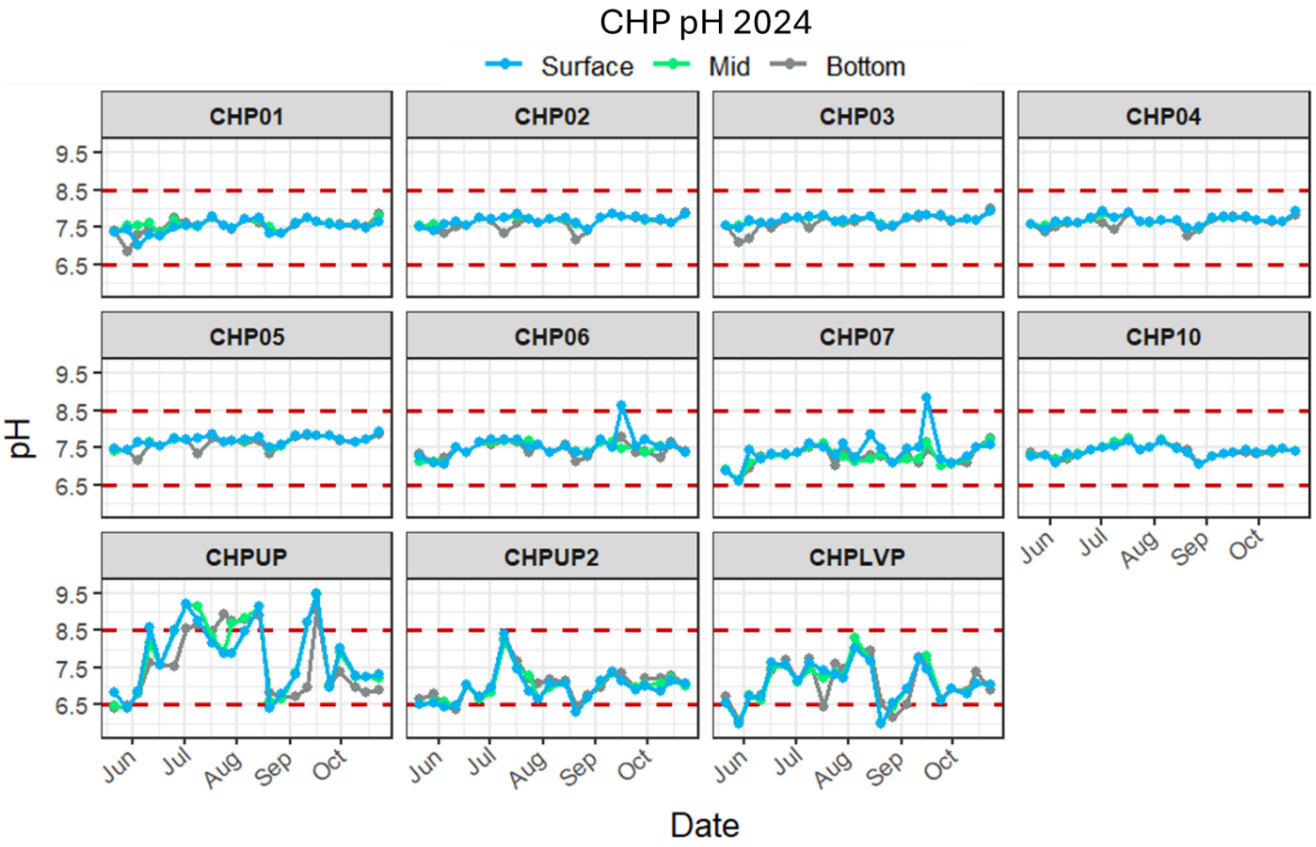

Figure A8. *pH for CHP's 11 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed red lines indicate the boundaries of the pH management target (6.5-8.5).*

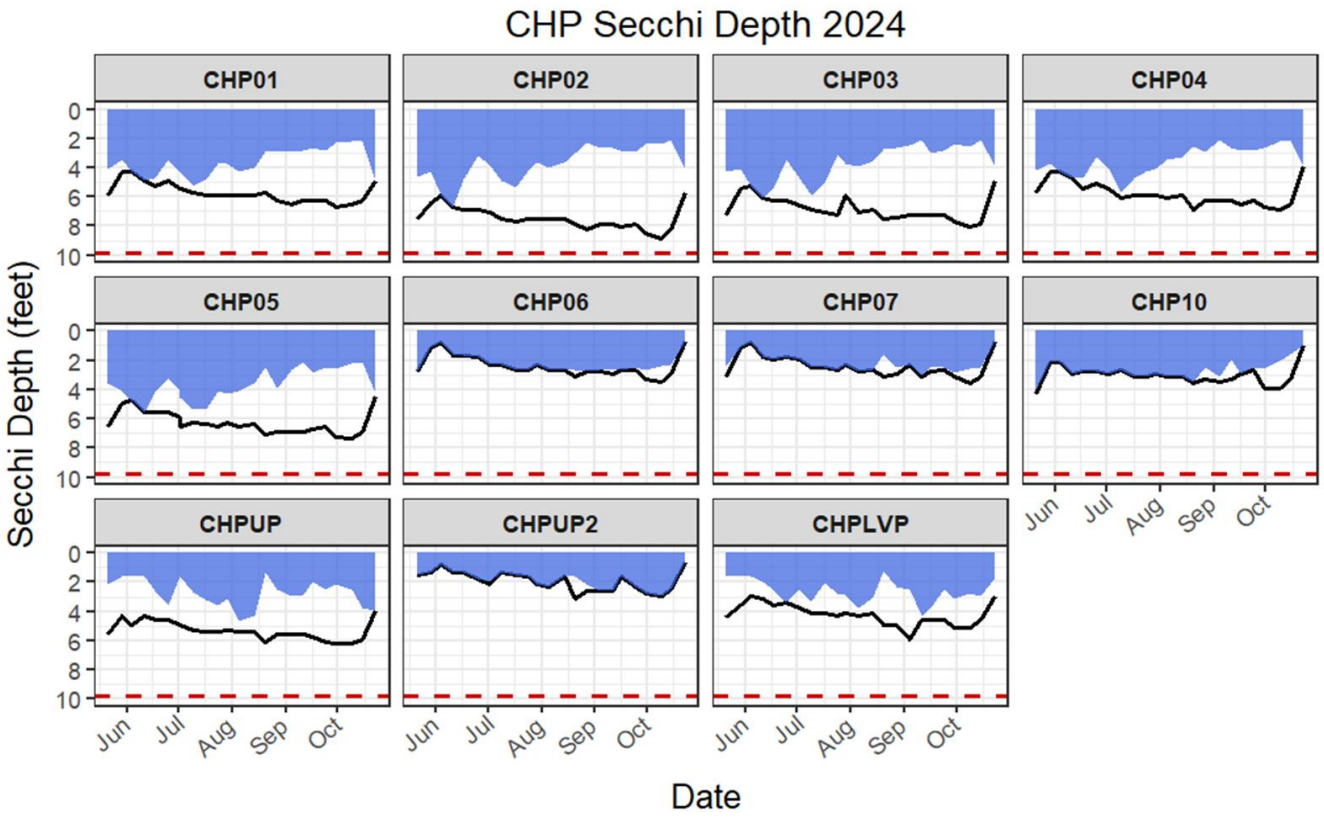

Figure A9. *Secchi depth and total depth (in feet) for CHP's 11 monitoring stations during the 2024 field season. Secchi depth is the depth at which a standardized disk disappears, thereby representing visibility into the water column. Total depth at each station is represented by a black line in these figures, while visible Secchi depth is represented by the blue shaded area. Any point where Secchi depth is equal to bottom depth indicates that visibility was to the bottom. A monitoring area is considered to have good water clarity when Secchi depth equals the total depth at sites shallower than 9.8 feet, or when Secchi depth is greater than or equal to 9.8 feet at deeper locations (9.8 feet represented by the dashed red line).*

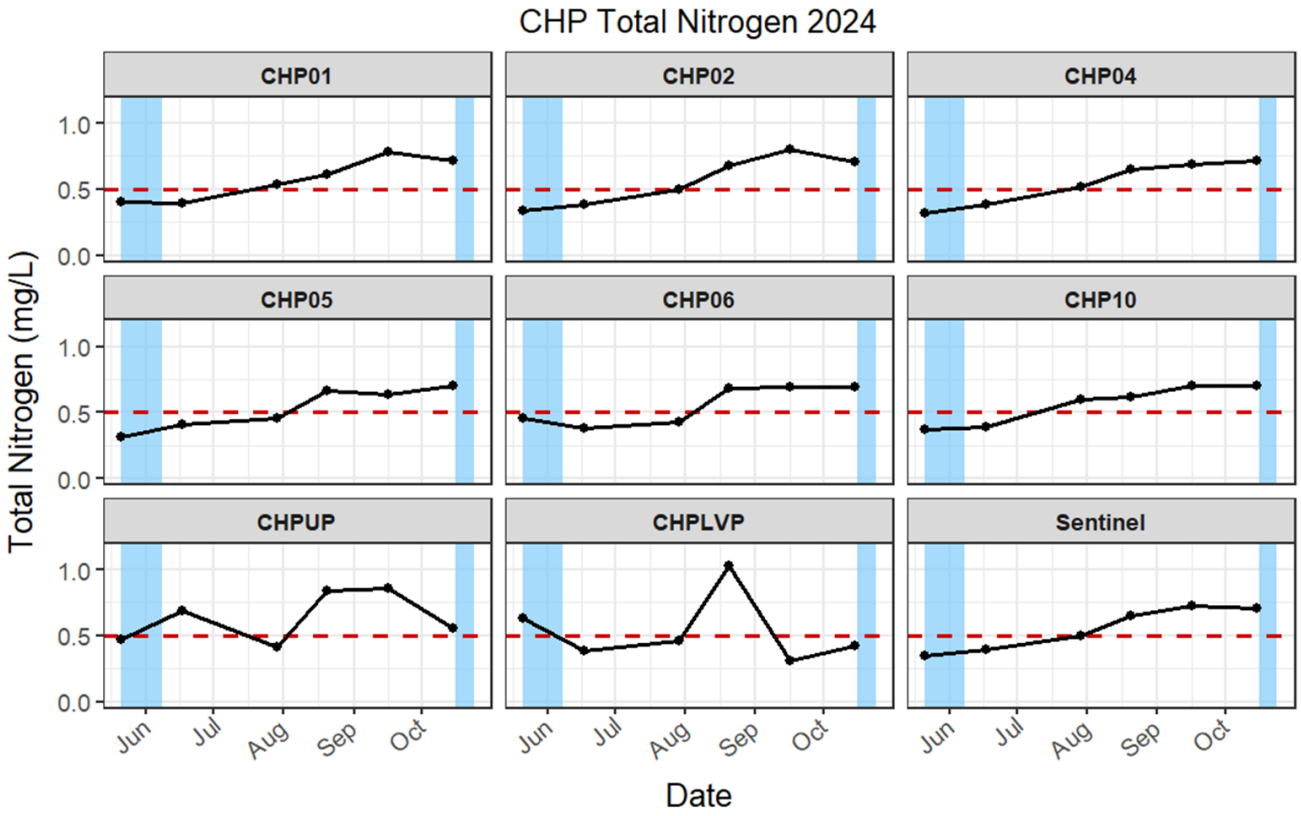

Figure A10. *Total nitrogen (in mg/L) for CHP's 8 nutrient monitoring stations and the "sentinel station" (average of stations CHP01, CHP02, CHP04, & CHP05) in 2024. The dashed red line represents the State's management threshold (0.5 mg/L). Blue shading indicates an opening on the Pond.*

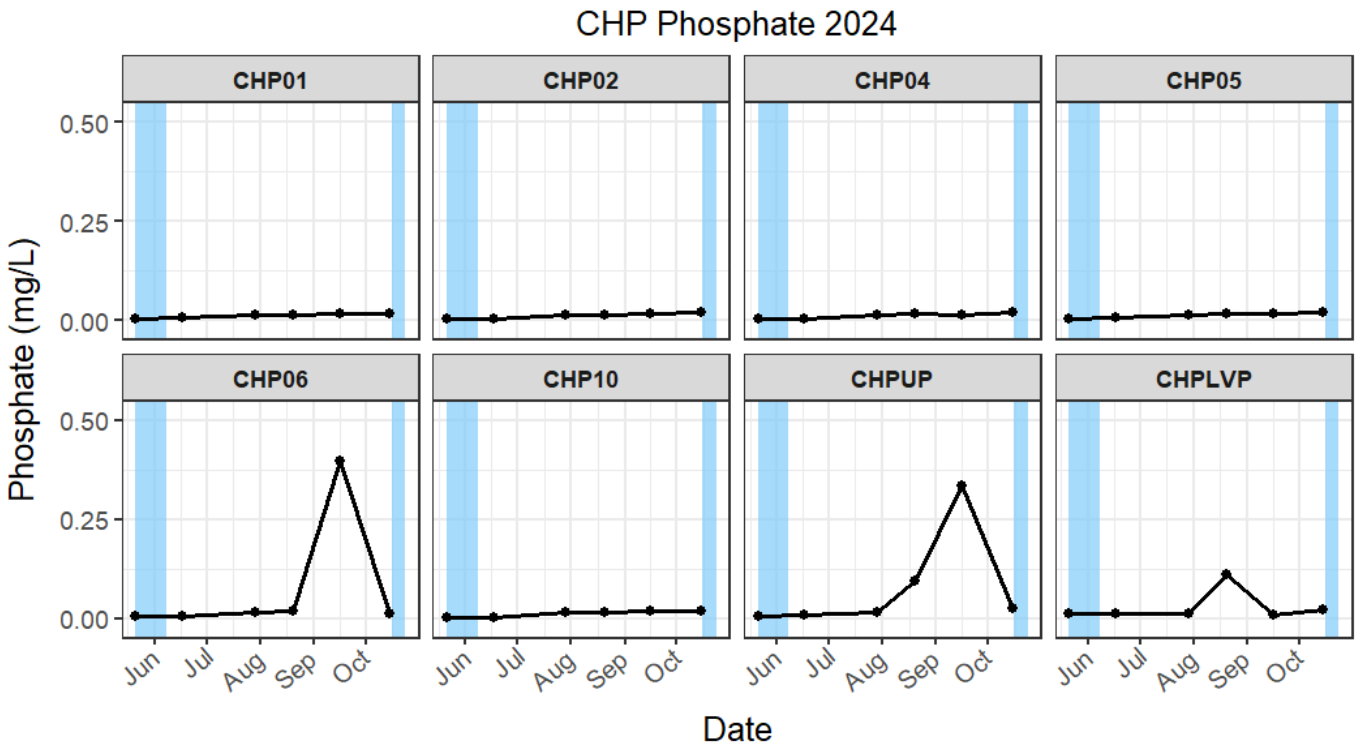

Figure A11. *Phosphate (in mg/L) for CHP's 8 nutrient monitoring stations in 2024. Blue shading indicates an opening on the Pond.*

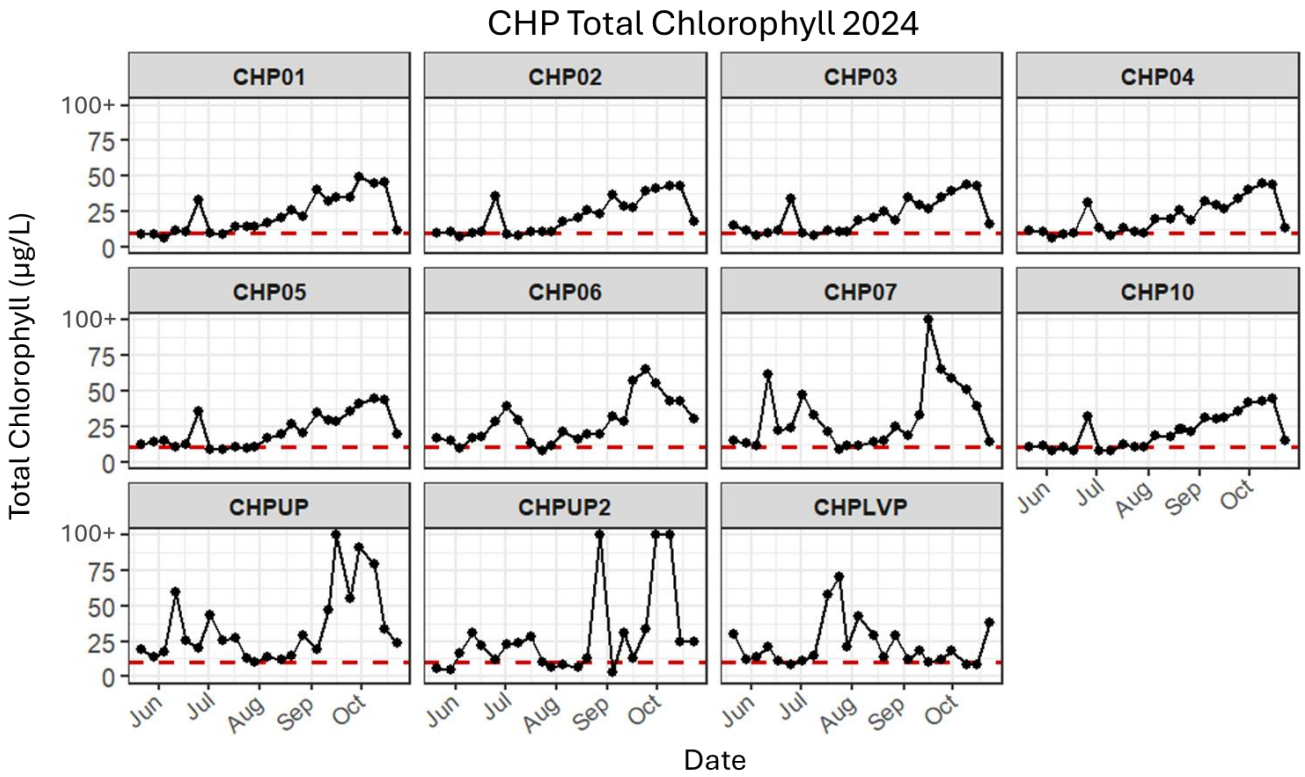

Figure A12. *Total chlorophyll (in ug/L) for CHP's 11 monitoring stations during the 2024 field season. The dashed red line represents the State's management threshold (10 ug/L). Note that the y-axis is capped at 100 ug/L.*

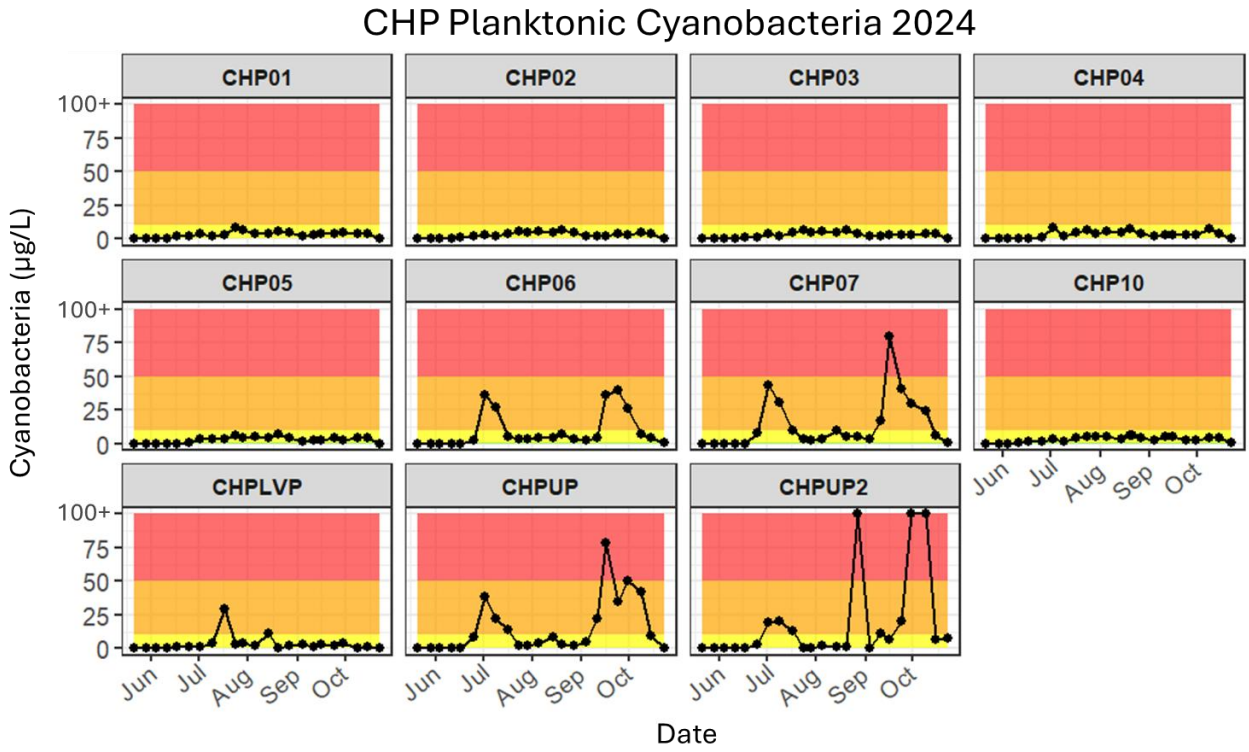

Figure A13. *Planktonic cyanobacteria (in µg/L) at CHP's 11 monitoring stations during the 2024 field season. Background colors pertain to the color-coded risk matrix used by the MV CYANO$_{TM}$ monitoring program (see* ***Figure A14****). Note that the y-axis is capped at 100 ug/L.*

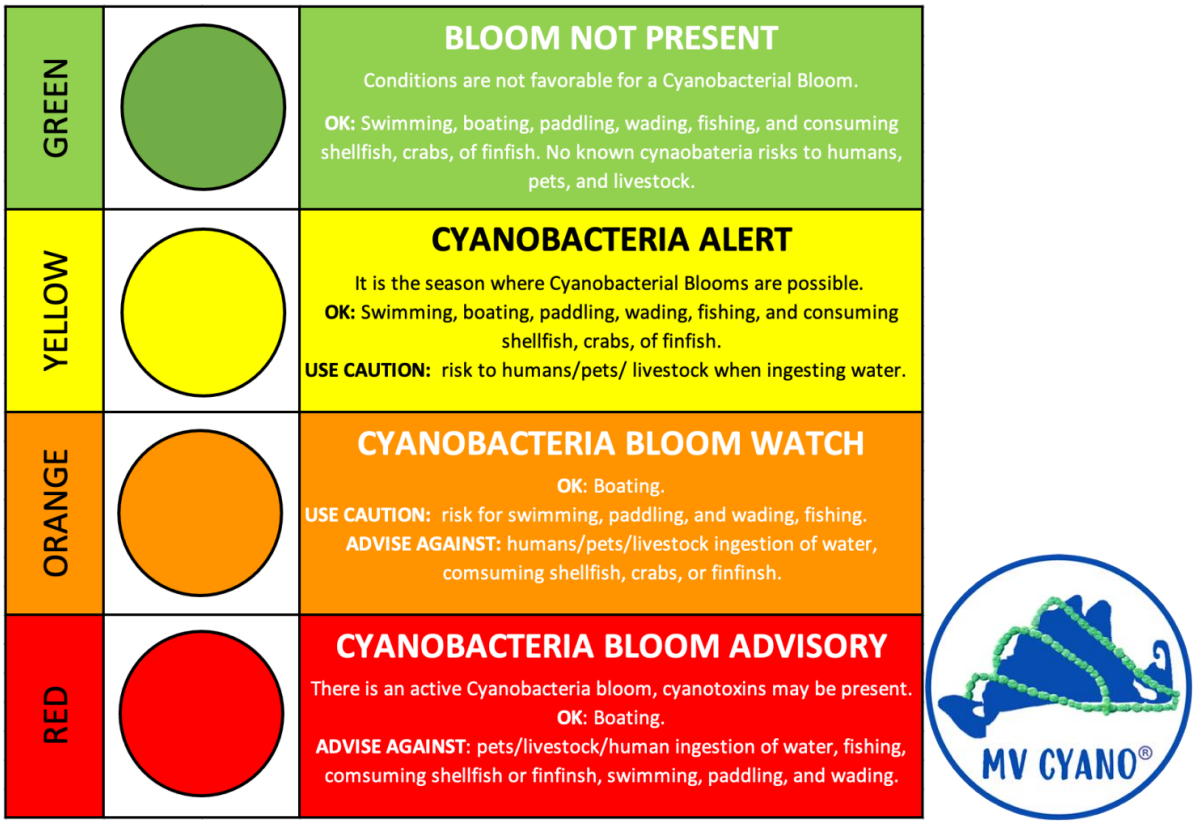

Figure A14. *The color-coded messaging & logo used by the MV CYANO$_{TM}$ monitoring program.*