2024

ECOSYSTEM MONITORING REPORT

EDGARTOWN GREAT POND

GREAT POND FOUNDATION

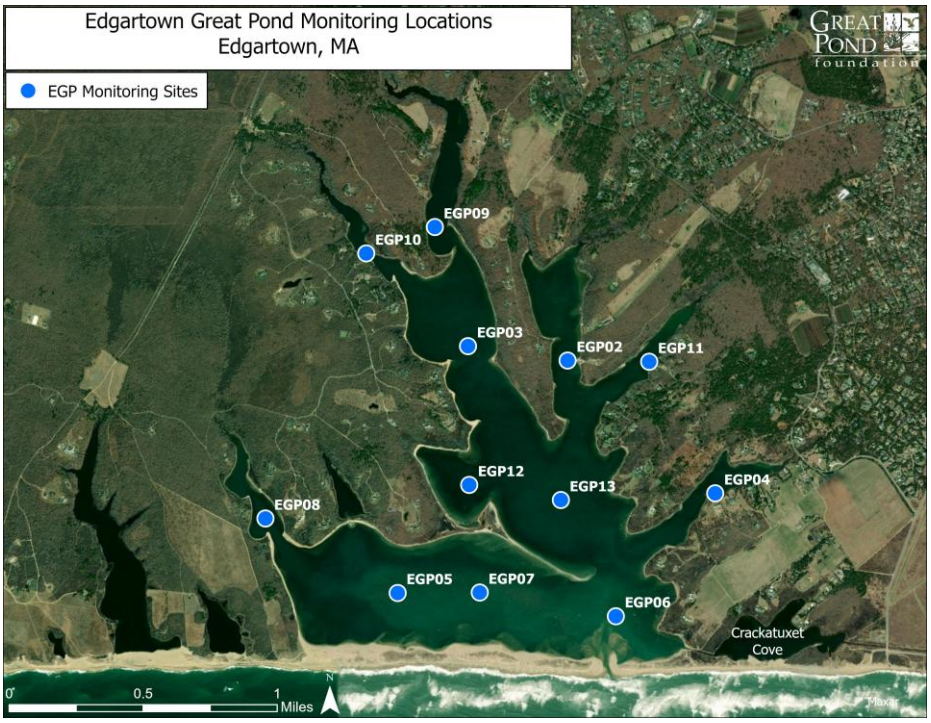
GREAT POND foundation®

EDGARTOWN GREAT POND
Executive Summary

2024

Study Area

Edgartown Great Pond (EGP) is a coastal estuary approximately 890 acres in size located on the southern shoreline of Martha's Vineyard in the Town of Edgartown, MA. The Pond encompasses a roughly 4,850-acre watershed. The barrier beach separating EGP from the ocean is manually breached 3-5 times/year as a nutrient and elevation management tool.

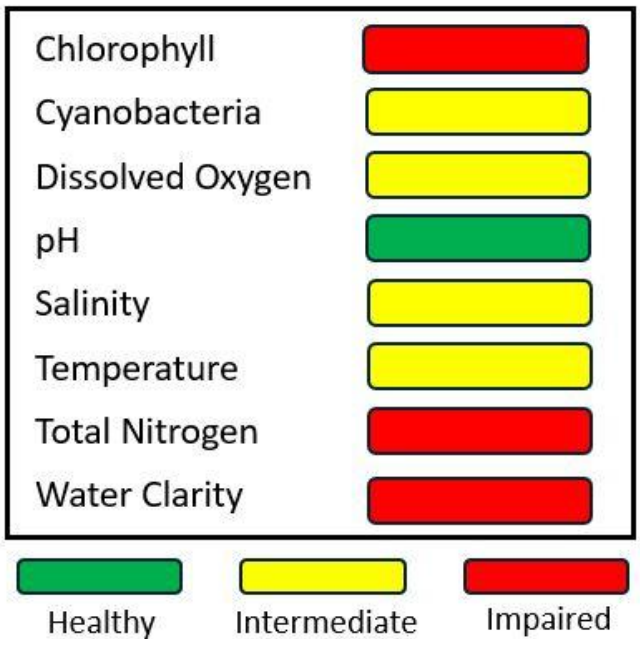


Sampling Regime 2024

In 2024, Great Pond Foundation (GPF) continued its ecosystem monitoring program on EGP for the 9th consecutive year. A total of 26 weekly monitoring trips were conducted between May and October. During each trip, water quality data was obtained for 12 monitoring sites (see map to left). Nutrient samples were collected at 8 of the regular 12 monitoring sites once a month.

GPF conducted 5 extra monitoring trips during the offseason (Feb-Apr, Nov-Dec) as part of a pilot study examining winter nutrient levels. These trips were made possible by the Edgartown Shellfish Department and the Edey Foundation.

Summary of Metrics, 2024



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

Cut Dates 2024

Date of Opening	Date of Closure	Cut Duration
*Jan 10th	Jan 23rd	13 days
Apr 16th	Apr 25th	9 days
Jul 20th	Jul 31st	11 days

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

Pond Summary 2024

The summer of 2024 represented a period of resilience and rebound for the EGP ecosystem. This improvement comes after the Pond experienced a substantial decline in water quality and the loss of hundreds of acres of eelgrass back in 2022, brought on by a sharp rise in nitrogen levels. The Pond's improved state in 2024 largely owes to the occurrence of an 11-day opening in July that flushed out nutrient-rich, algal-dense pondwater with low-nutrient saltwater. Despite this, EGP's eelgrass beds were once again absent in 2024, indicating that the Pond remains in a degraded state. Past data trends clearly reveal excess nutrient loading (namely that of nitrogen) as the Pond's primary driver of impairment.

Introduction

The summer of 2024 represented a period of resilience and rebound for Edgartown Great Pond (EGP). This improvement comes after the Pond suffered a notable decline in health that began in 2022 and persisted through 2023, largely brought on by a sharp spike in summer nitrogen levels. In 2022, this increased nitrogen supply fueled a steep rise in chlorophyll concentrations, signaling excess phytoplankton growth within the Pond. As various types of phytoplankton (including cyanobacteria) rapidly filled the water column, water clarity dropped dramatically, blocking sunlight from reaching eelgrass on the pond floor.

Leading up to 2022, eelgrass meadows, the gold standard for ecosystem health, had returned to the Pond following a decade of community-lead restoration. Eelgrass can only grow when the ecosystem is stable for an extended period of time. Once present, eelgrass gives back to the ecosystem by absorbing nutrients like nitrogen and phosphorus, sequestering carbon, stabilizing sediment, supplying oxygen, and providing nursery habitat.

From 2019-2021, the Pond's eelgrass meadows endured years of intermittent high turbidity and low salinity stress. While these meadows remained present through the spring of 2022, the exceptionally turbid waters of the summer reduced light availability at the bottom substantially, which, combined with the year's low salinity levels as a result of sub-optimal cuts, caused eelgrass to have almost completely disappeared by the end of the season. This sudden loss of hundreds of acres of eelgrass represented a tipping point beyond which the seagrass could not rebound. In the fall of 2022, GPF and EPA scientists searched for seagrass and found only a single plant. In 2023 and 2024, GPF used a drop camera to search for eelgrass meadows and observed a dark murky bottom void of any vegetation (**Figure 1**).

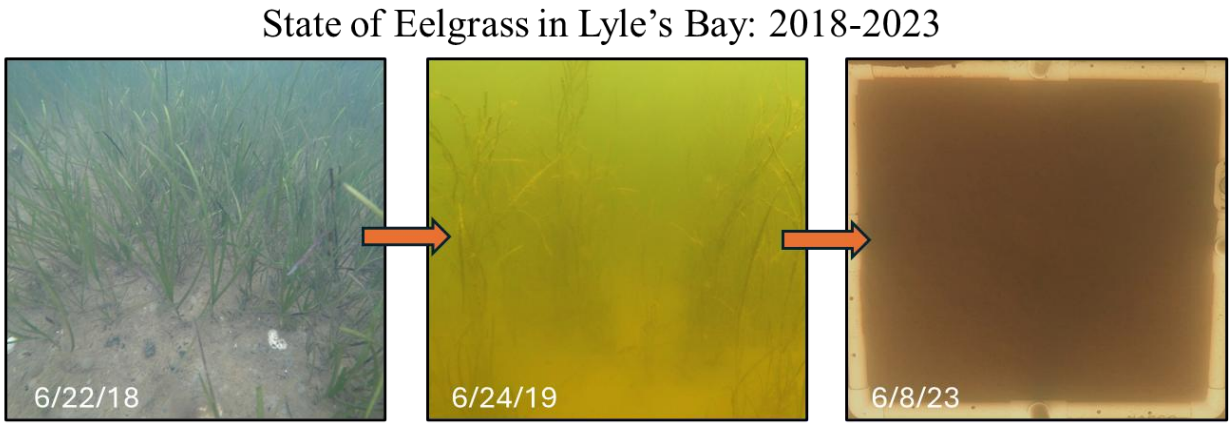


Figure 1. *Photo log depicting changes in eelgrass habitat within EGP's Lyle's Bay from 2018 to 2023.*

EGP's improved state in 2024 largely owes to the occurrence of an 11-day opening in July that replaced nutrient-rich pondwater with nutrient-deficient seawater, preventing the late summer phytoplankton bloom that was seen during each of the prior 2 years. By the fall of 2024, water clarity had improved, while the Pond's phytoplankton community more closely resembled its healthier pre-2022 composition.

Despite noted improvements in 2024, the Pond continued to show signs of ecosystem impairment, including a sustained absence of eelgrass and sub-optimal water clarity. These persisting issues primarily owe to nitrogen levels continuing to exceed regulatory standards. As such, if EGP is to see a return to health and the re-establishment of its eelgrass meadows, future action must be taken to mitigate nutrient loading into the Pond.

Discussion

While EGP demonstrated resilience in 2024, the Pond still exhibited signs of ecosystem impairment, continuing trends observed in 2022 and 2023. Indications of impairment included heat stress, critically low dissolved oxygen (DO) levels at the pond bottom, excess nutrient concentrations, elevated chlorophyll levels, sub-optimal water clarity, and a general absence of eelgrass.

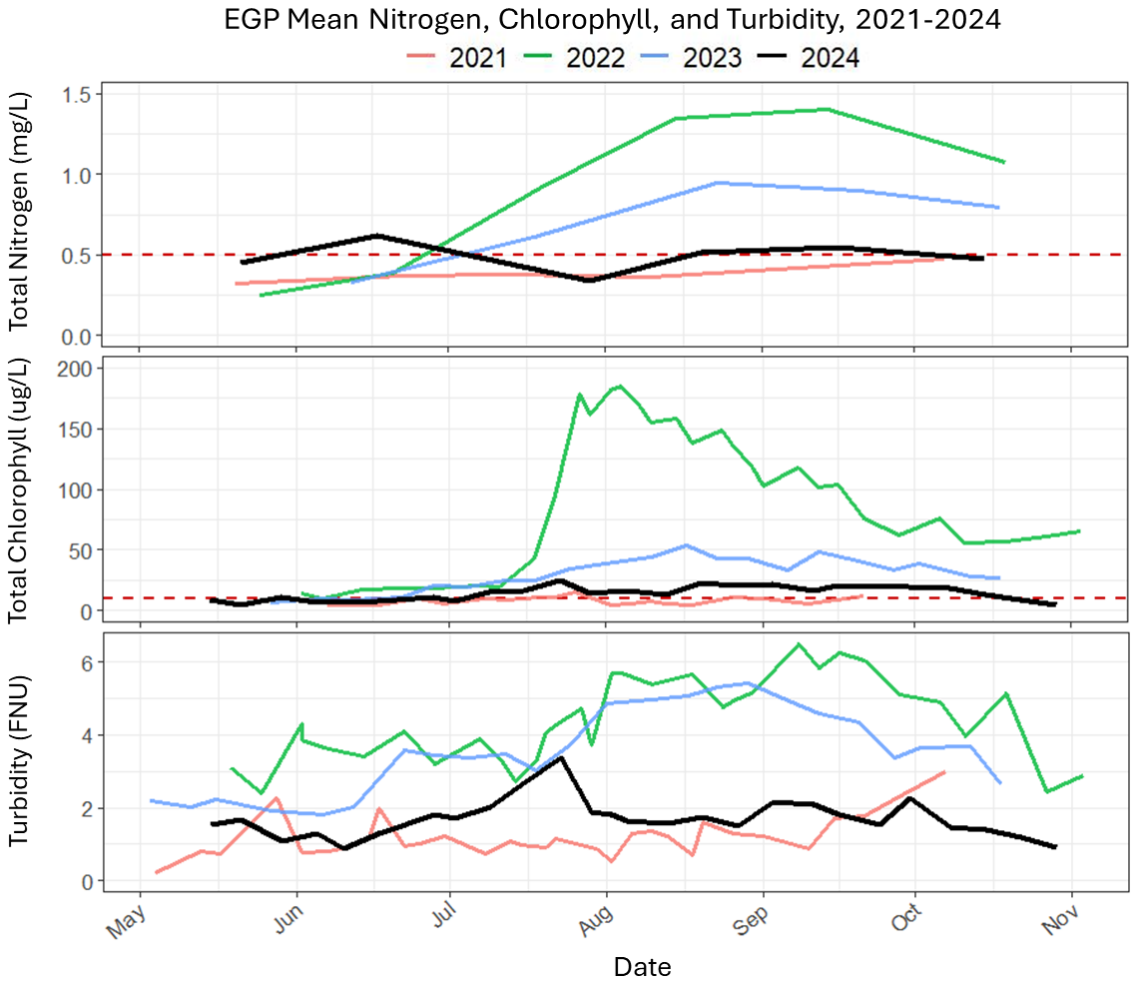


Figure 2. *Average total nitrogen, total chlorophyll, and turbidity for the years 2021-2024. Dashed red lines refer to the State's 0.5 mg/L TN and 10 ug/L chlorophyll management thresholds, respectively. Nitrogen values pertain to the EGP "sentinel station" (average of stations EGP02, EGP03, EGP05, EGP06, & EGP09).*

Despite seeing continued impairment among several key water quality metrics, the summer of 2024 still represented a period of overall improvement for the health of the EGP ecosystem. Through the early summer of 2024, the state of the Pond initially appeared to be following a path similar to that seen in 2022 and 2023, with rising total nitrogen (TN) concentrations driving increased chlorophyll (a measure of phytoplankton growth) and turbidity levels (**Figure 2**). However, TN concentrations dropped off

come late July, ultimately remaining lower than both 2022 and 2023 during the latter half of the monitoring season. In conjunction with this mid-summer decline in nitrogen, 2024 saw a reduction in chlorophyll and turbidity through the late summer and early fall.

Much of the improvement seen in the health of the EGP ecosystem during the summer of 2024 can be attributed to the occurrence of a July cut (open from 7/20-7/31), representing the first summer opening on the Pond since 2021. For context, the barrier beach separating EGP from the ocean is intentionally breached or "cut" 3-5 times per year to drain the Pond and allow for a period of tidal exchange with the sea. The impact of the summer opening in 2024 is evident in nitrogen, chlorophyll, and turbidity levels all dropping noticeably during the lifespan of the cut, halting the initial decline in pond health seen through the early summer (**Figure 3**).

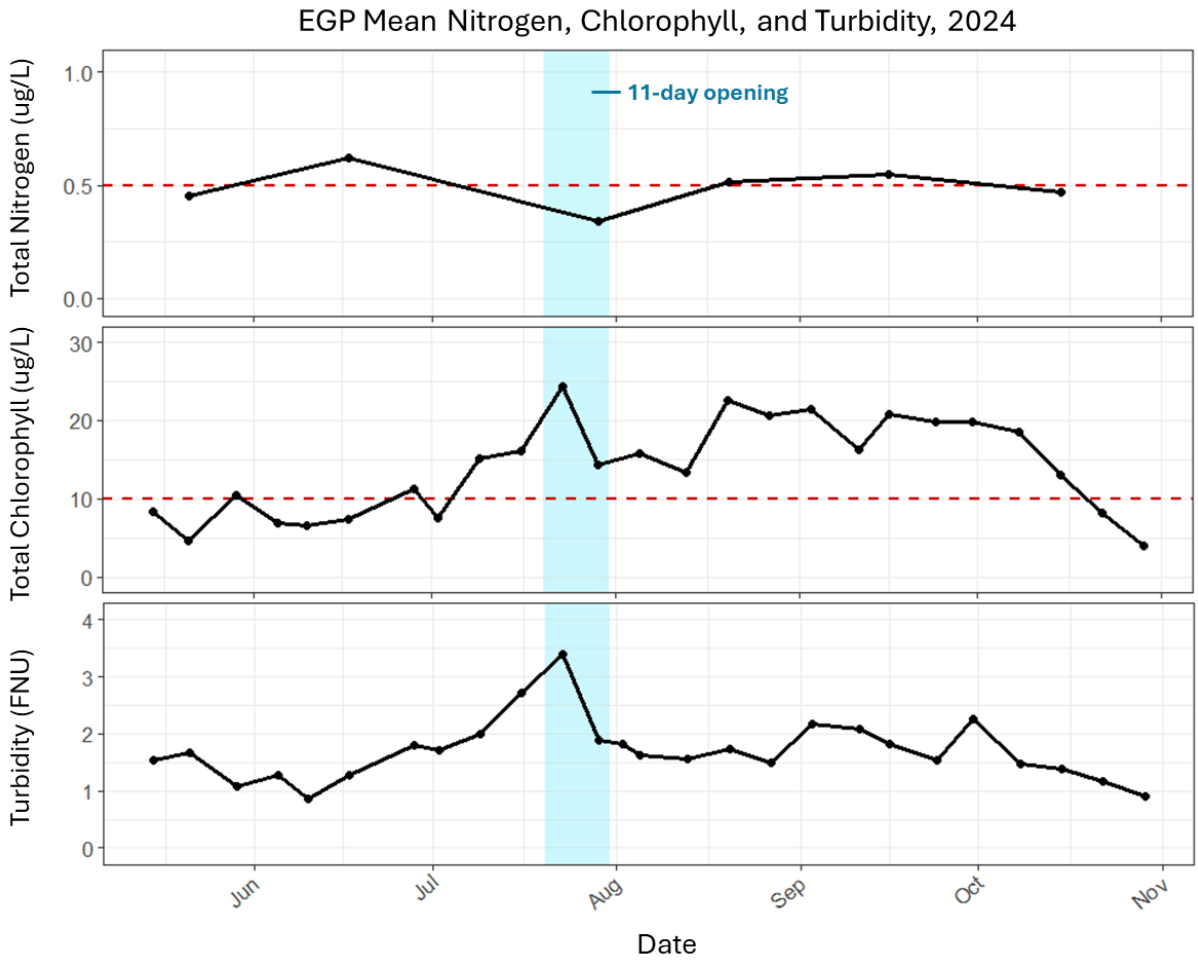


Figure 3. *Average total nitrogen, total chlorophyll, and turbidity during the 2024 monitoring season. The shaded blue area represents the duration of EGP's July opening. Dashed red lines refer to the State's 0.5 mg/L TN and 10 ug/L chlorophyll management thresholds, respectively. Nitrogen values pertain to the EGP "sentinel station" (average of stations EGP02, EGP03, EGP05, EGP06, & EGP09).*

The pronounced improvement in the state of the Pond can be largely attributed to the cut's extended 11-day lifespan, allowing for more than a week of tidal flushing that effectively replaced nutrient-rich, algal-dense pondwater with nutrient-poor seawater. The successful removal of nitrogen during the July opening enabled EGP to maintain lower TN concentrations through the later summer and early fall

relative to 2022 and 2023. This in turn limited phytoplankton growth (including cyanobacteria) over the same period, preventing chlorophyll and turbidity levels from rising in the cut's aftermath.

Past data collected in EGP has shown that at least 9-11 days of tidal exchange are required for a successful flush of the system. This dynamic is clearly illustrated by 2024's July opening, as neither chlorophyll nor turbidity levels had shown any improvement by day 3 of the cut but had both declined noticeably by the time of GPF's next sampling trip on day 9 (**Figure 3**). This suggests that the health of the Pond may have fared considerably worse had the year's summer opening closed before 11 days of tidal exchange could occur.

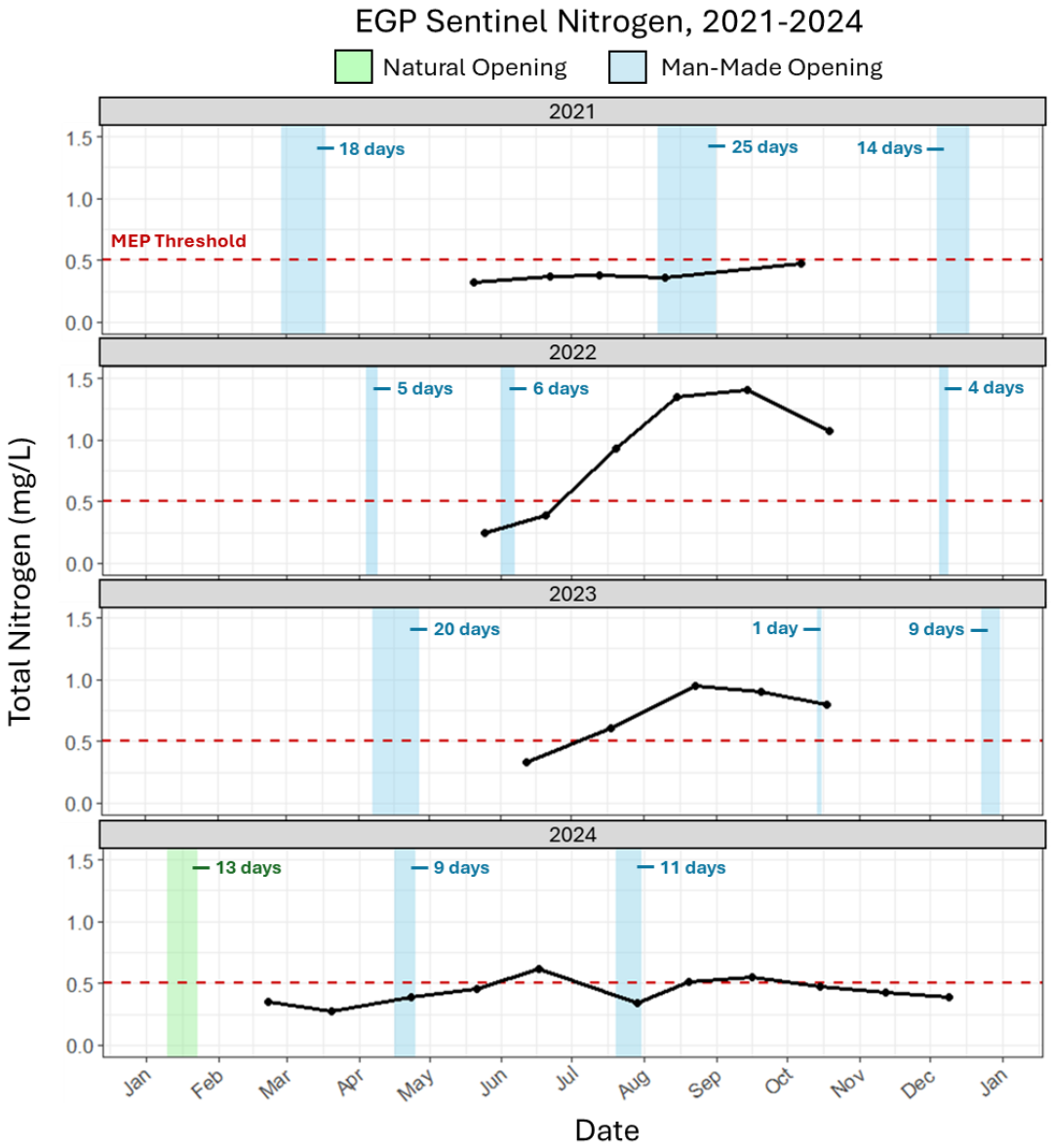


Figure 4. *Total nitrogen for the EGP "sentinel station" (average of stations EGP02, EGP03, EGP05, EGP06, and EGP09) for the years 2021-2024. Dashed red lines represent the States' 0.5 mg/L management threshold.*

Data going back to 2021 suggests that the timing and duration of openings prior to and during the summer season may play an important role in regulating summer pond health in EGP (**Figure 4**). Summer nitrogen levels in 2024 were the lowest observed in the Pond since 2021. In comparing cut

trends between these 2 years, both 2021 and 2024 experienced long-lived openings (≥ 9 days) during both the spring and summer, respectively. These trends can be contrasted to 2022, EGP's worst year of nitrogen impairment, in which EGP experienced 2 short-lived openings (≤ 6 days) in the spring. In looking at 2023, an intermediate year of nitrogen impairment, EGP experienced a long-lived 20-day opening in the spring but never saw a summer opening. These trends ultimately suggest that frequent, effective flushes of the Pond can serve to lower nitrogen inventories in EGP, with summer nitrogen mitigation being maximized when long-lived openings occur during both the spring and summer.

GPF conducted a pilot nutrient study during the offseason of 2024 to better establish how nitrogen levels in EGP vary across the entire calendar year. These data can be seen in the bottom graph of **Figure 4**, where monthly nitrogen data is available for each month from February to December, expanding beyond the typical May to October sampling regime. Mean TN in EGP never exceeded the State's 0.5 mg/L management threshold during any offseason sampling run (Feb-Apr, Nov-Dec). Given that offseason data only exists for 2024, it's unclear whether these same trends (low TN during winter/spring, high TN during summer, declining TN during fall) are typical. Regardless, the data collected through this offseason pilot study have established a baseline that will allow for future comparison with additional offseason nutrient data.

While the beneficial impact that 2024's summer opening had on the health of the Pond is clear, summer cuts should not be viewed as the end-all solution in combating ecosystem impairment in EGP. Summer cuts are not always guaranteed, as the ability of the Pond to be opened during the summer is entirely dependent on it reaching a sufficiently high elevation. This is determined by a number of uncontrollable variables, including the timing and duration of the previous opening, as well as rainfall, evaporation, and groundwater use by plants. The random nature of pond rise is well illustrated in comparing elevation trends in 2023 and 2024. Both of these years experienced spring openings that closed in late April; however, only 2024 saw a summer opening. This can be attributed to 2024 receiving a particularly large amount of rainfall during the late spring prior to evaporative and vegetative water losses rising during the early summer (**Table 1**).

Table 1. *May rainfall totals on Martha's Vineyard. Data was obtained from the National Weather Service for the Martha's Vineyard Airport.*

Time Period	Rainfall (inches)
May 2023	1.35
May 2024	5.53
May Average (2000-2024)	3.39

While sufficient elevation may provide the opportunity for a summer cut, opening the Pond during the summer can be risky. Short-lived openings may only serve to drop the Pond's elevation without providing an adequate flush, leaving behind a shallow, nutrient-rich pond highly susceptible to heat stress, increased phytoplankton growth, and dissolved oxygen depletion. Under these circumstances, short-lived summer openings may cause conditions in the Pond to deteriorate, especially if followed by hot temperatures and/or a lack of rainfall. The success of 2024's July cut in improving ecosystem health ultimately owes to the extended 11-day duration of the breach, likely enabled in part by the performance of dredging around the cut site in March of 2024.

Table 2. *Average length of man-made openings on EGP by year. Years during which dredging was performed are shaded in blue.*

Year	Dredge Year?	Average Length of Openings (days)
2018	Yes	30.67
2019	Yes	26
2020	No	7.25
2021	Yes	19
2022	No	5
2023	Yes	6
2024	Yes	10

Years in which dredging is performed on EGP during the annual "dredging window" (Dec-Mar) have traditionally seen longer average opening durations relative to non-dredge years (**Table 2**). This can be attributed to the removal of sand shoals around the cut site, improving flow and flushing dynamics during a breach. However, dredging isn't always a guarantee of improvement, as cut duration is ultimately influenced by a number of uncontrollable environmental factors (tide, sea state, wind, etc.). This dynamic is well illustrated by 2023 encompassing an average opening length of just 6 days despite the performance of winter dredging. Beyond the possibility of poor cut performance even with dredging, annual dredging isn't always possible due to logistical, financial, and permitting restraints. As such, dredging and pond cuts cannot be relied upon as the Pond's sole nitrogen management tools. Rather, remediation must also focus on the source of the problem with the reduction of nitrogen inputs within the watershed.

Conclusion

In 2024, EGP experienced overall improvement in its ecosystem health following 2 years of particularly poor water quality. This improvement can be largely attributed to the occurrence of an 11-day opening in July that flushed excess nutrients from the Pond, mitigating phytoplankton growth, turbidity build-up, and dissolved oxygen depletion through the remainder of the monitoring season. However, EGP still displayed many of the same signs of impairment that were seen in 2022 and 2023, including a continued absence of eelgrass from the Pond. Given that eelgrass has long been considered the key indicator of a healthy EGP ecosystem, the seagrass' persisting hiatus shows that the Pond remains in a degraded state.

Pond cuts are important in supporting eelgrass growth due to their ability to raise salinity levels and remove excess nutrients. To stabilize the environment enough for eelgrass to return, cuts of EGP must be made as soon as conditions allow. Missing a window for a cut can have detrimental consequences that can allow for salinity to drop too low or for nitrogen to rise too high. Between 2009 and 2019 when eelgrass was returning to the Pond, cuts were often made as soon as the cold season passed (Feb/March), again in the spring, then in the summer or early fall, and finally between mid-November and mid-December. Going into the new year with a low, salty EGP reduced the likelihood of spring flooding and optimized conditions before the eelgrass growing season (May/June).

While cut performance and timing should be optimized to support eelgrass growth in EGP, cut closure and pond rise are ultimately decided by uncontrollable natural forces (shoaling, precipitation, weather, etc.). As such, EGP may go for an extended period without a cut or see a breach close prematurely even with highly meticulous planning. In the event of poor cut performance or extended periods in between cuts, EGP's eelgrass beds have shown the capacity to handle intermittent low salinity stress, as can be seen in 2019 and 2021 (**Figure 5**). Eelgrass has also been shown to handle some level of nitrogen-induced turbidity stress (2019-2021); however, nitrogen levels have remained so elevated over the last

few years that the resulting turbidity levels have barred the seagrass from returning since its initial disappearance in 2022.

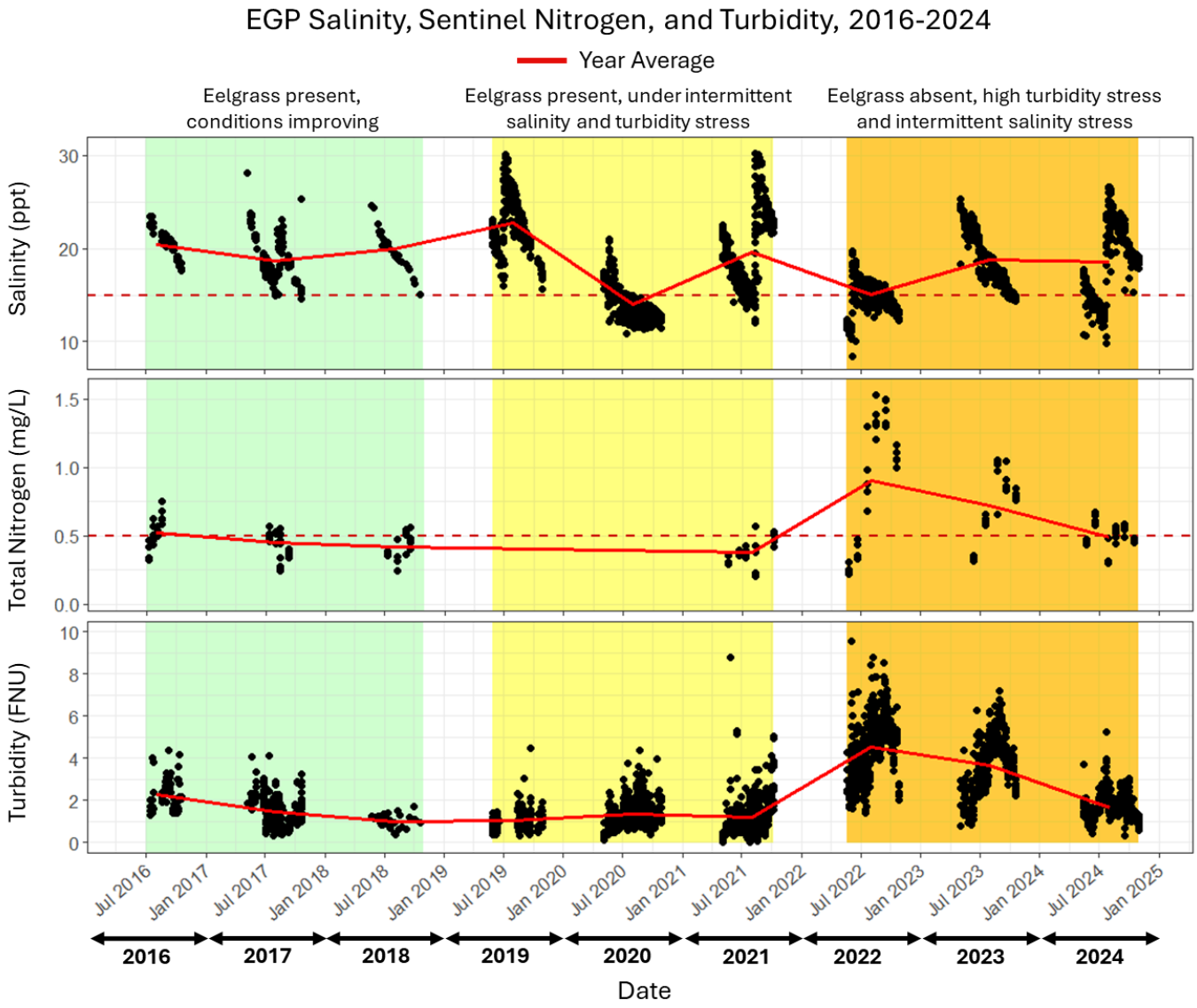


Figure 5. *Scatterplots of salinity, total nitrogen, and turbidity measurements taken during the core monitoring season (May-October) each year between 2016 and 2024. Overlying red lines represent the average of all collected measurements in a single year. Plotted TN points only pertain to stations included in the EGP "sentinel station" (EGP02, EGP03, EGP05, EGP06, & EGP09), as defined by the Pond's 2008 MEP report. Dashed red lines refer to the 15 ppt eelgrass salinity threshold and the State's 0.5 mg/L TN threshold, respectively. TN data for 2016, 2017 and 2018 was provided by the Martha's Vineyard Commission.*

The trends observed in EGP over the last decade ultimately reveal excess nutrient loading, specifically that of nitrogen, as the Pond's primary driver of impairment. As such, future management decisions must be made with nutrient mitigation in mind if the Pond is to see a return to health and the restoration of its historic eelgrass meadows. More specifically, using the years 2016 to 2018 as a model (**Figure 5**), several years of lowered nitrogen concentrations will be required to improve habitat quality to the point that eelgrass can once again flourish in EGP.

Works Cited

Howes, B., Samimy, R., Schlezinger, D., Ramsey, J., & Eichner, E. (2008, December). *Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Edgartown Great Pond System, Edgartown, MA*. SMAST/MassDEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. https://www.mass.gov/doc/edgartown-great-pond-system-edgartown-ma-2008/download

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Acknowledgements

We would like to give a special thanks to the Edgartown Shellfish Department for bringing us out onto the Pond during the offseason to conduct our pilot nutrient study. We'd also like to express our gratitude to the Edey Foundation for the funding this work; these data provide a vital baseline to inform future management and remediation. Finally, we'd like to thank the Martha's Vineyard Commission for providing nitrogen data for the years 2016-2018.

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.

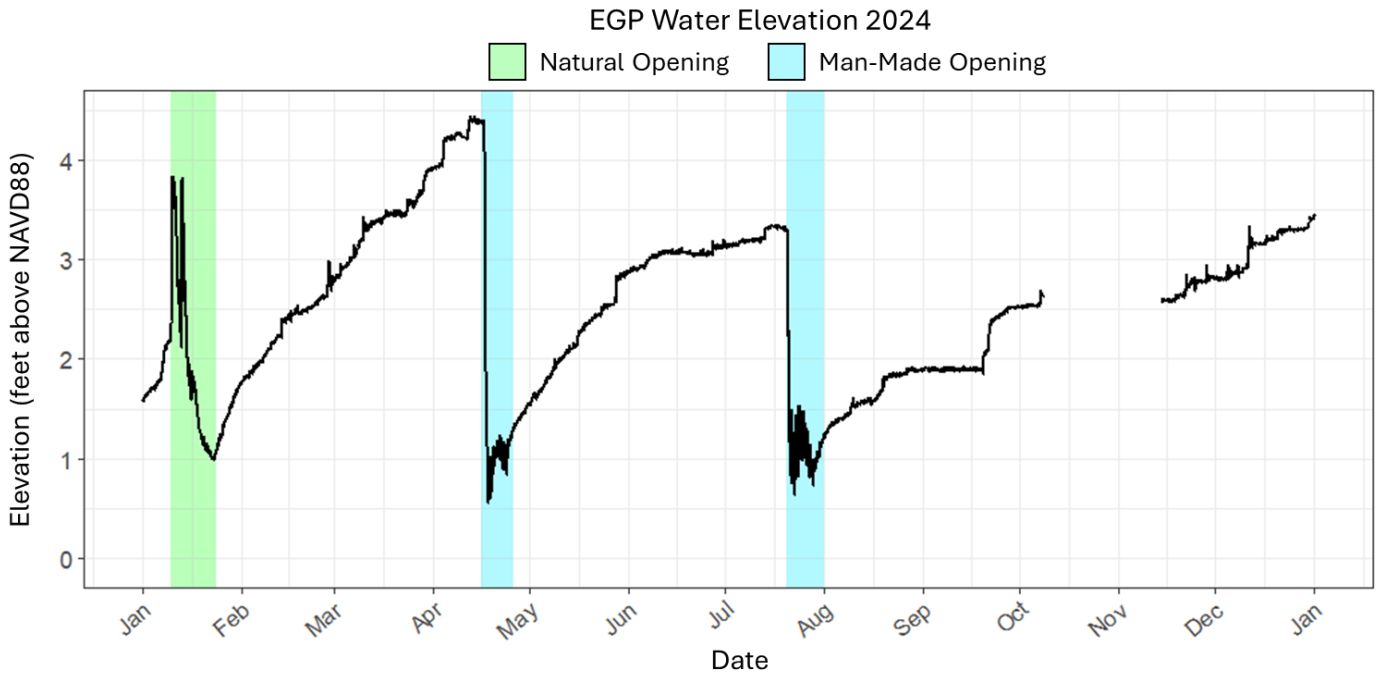

Figure A1. *Water elevation (in feet above the NAVD88 datum) in EGP for the year 2024. Green and blue shading indicate that the Pond was open to the ocean via a natural or man-made breach, respectively.*

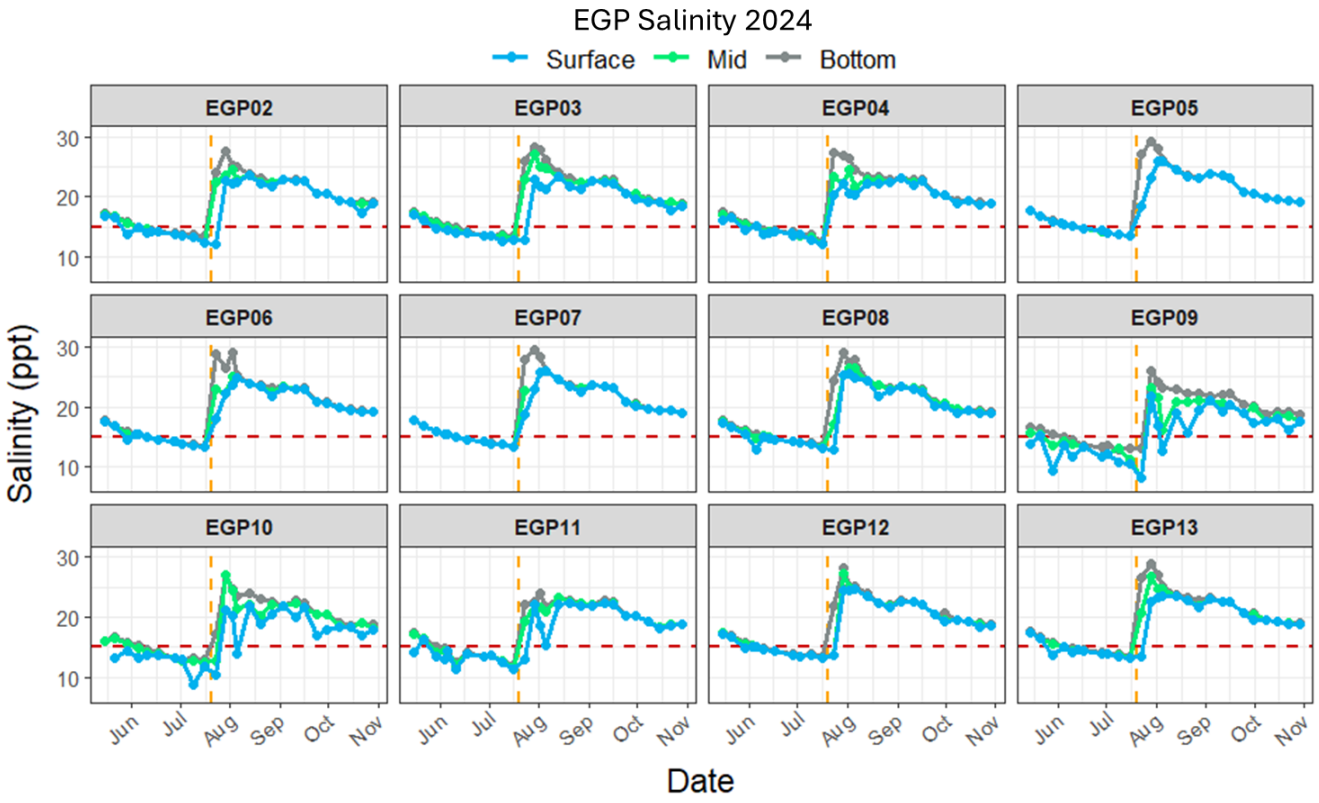

Figure A2. *Salinity in parts per thousand (ppt) for EGP's 12 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The horizontal dashed red line represents the management target for maintaining healthy eelgrass beds (15 ppt). The vertical dashed yellow line represents when the cut was opened on July 20th.*

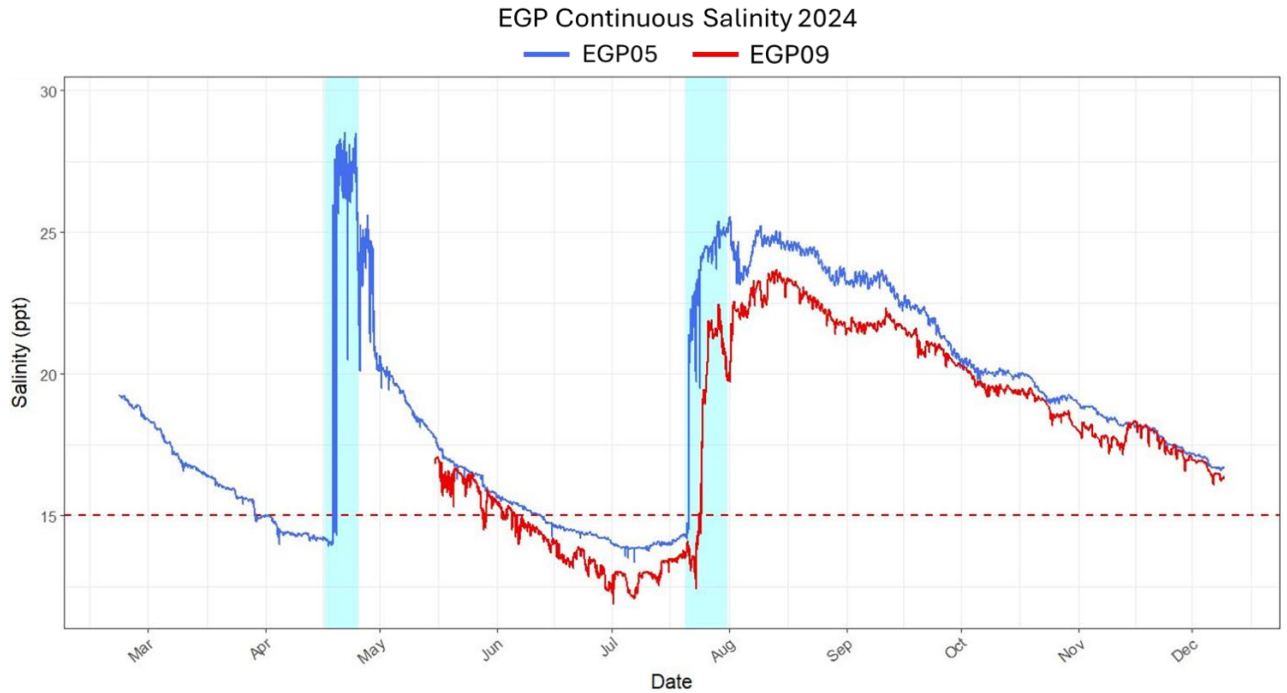

Figure A3. *Continuous salinity measurements (in ppt) recorded every 30 minutes at monitoring stations EGP05 (southern basin) and EGP09 (Wintucket Cove) in 2024. Shaded blue areas indicate an opening on the Pond. The dashed red line represents the target for maintaining healthy eelgrass beds (15 ppt).*

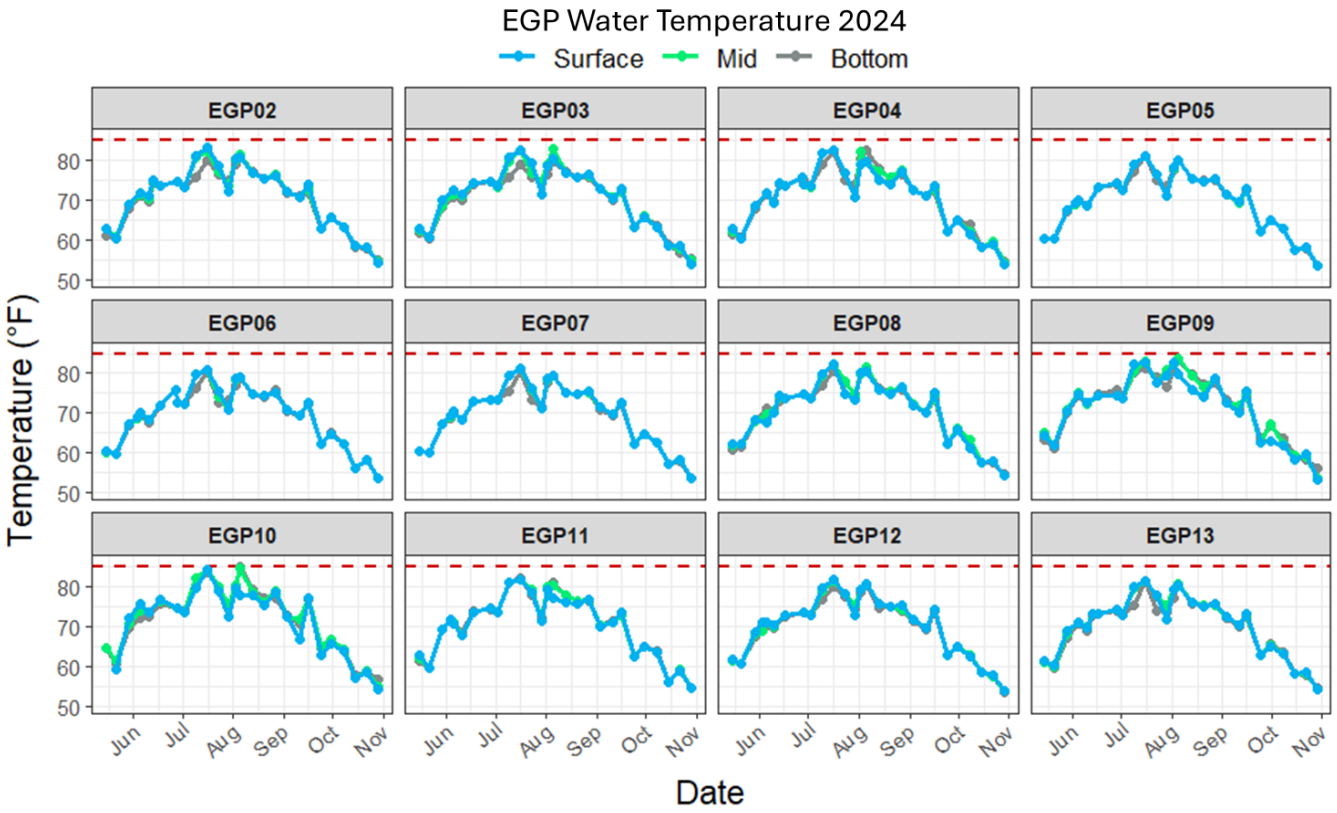

Figure A4. *Water temperature (in °F) for EGP's 12 monitoring stations during the 2024 field season. Data was measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed red line represents the State's 85 °F management threshold.*

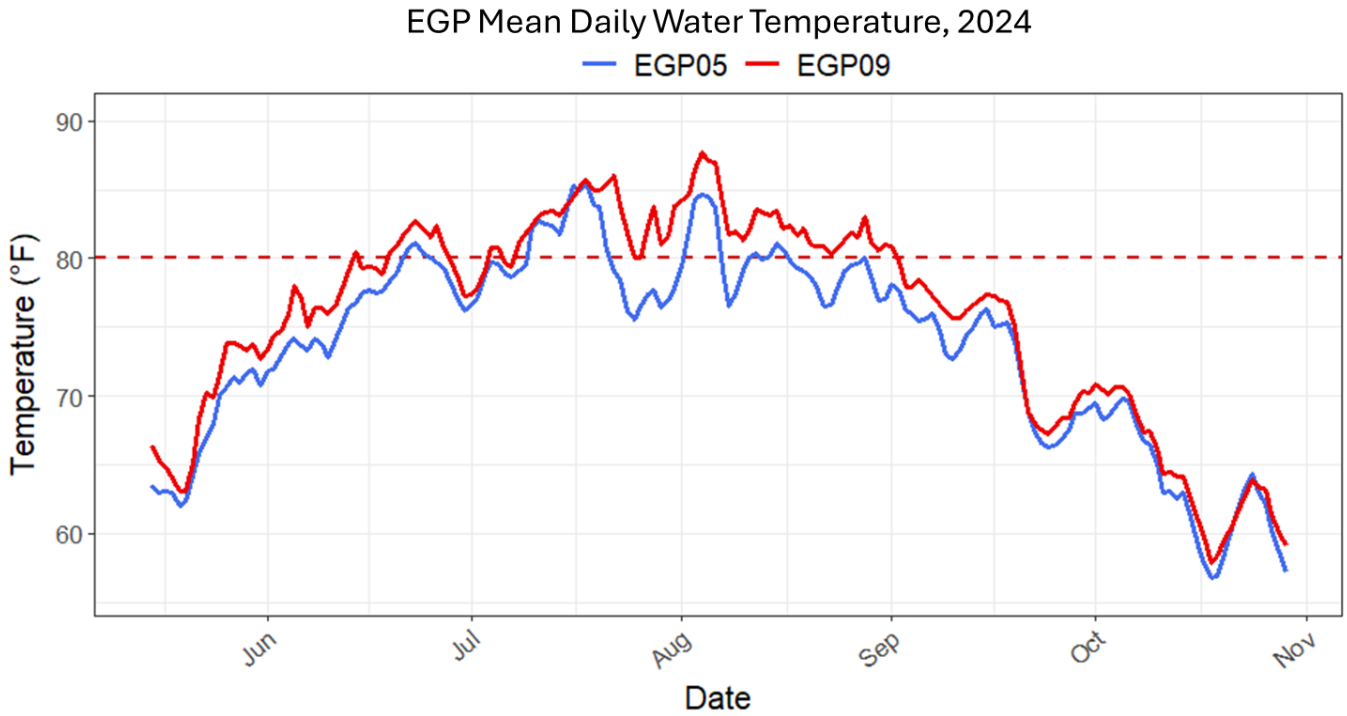

Figure A5. *Mean daily water temperature (in °F) at monitoring stations EGP05 (southern basin) and EGP09 (Wintucket Cove) during the 2024 field season. The dashed red line represents the State's 80 °F mean daily temperature threshold.*

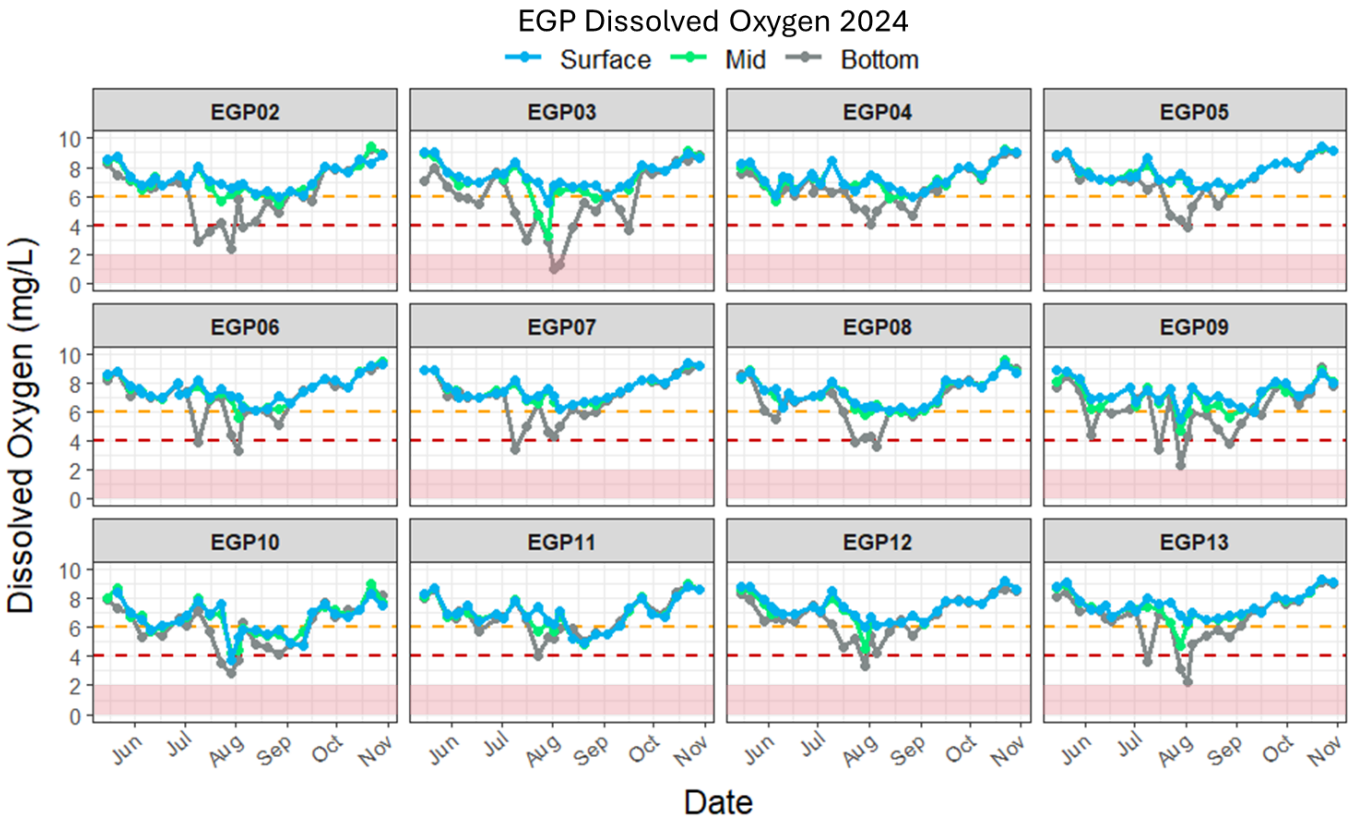

Figure A6. *Dissolved oxygen (DO) in mg/L for EGP's 12 monitoring stations during the 2024 field season. Data were measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed yellow line represents the State's 6 mg/L management threshold, the dashed red line indicates when DO levels dropped critically low (<4 mg/L), and the light red box indicates when hypoxia occurred (<2 mg/L).*

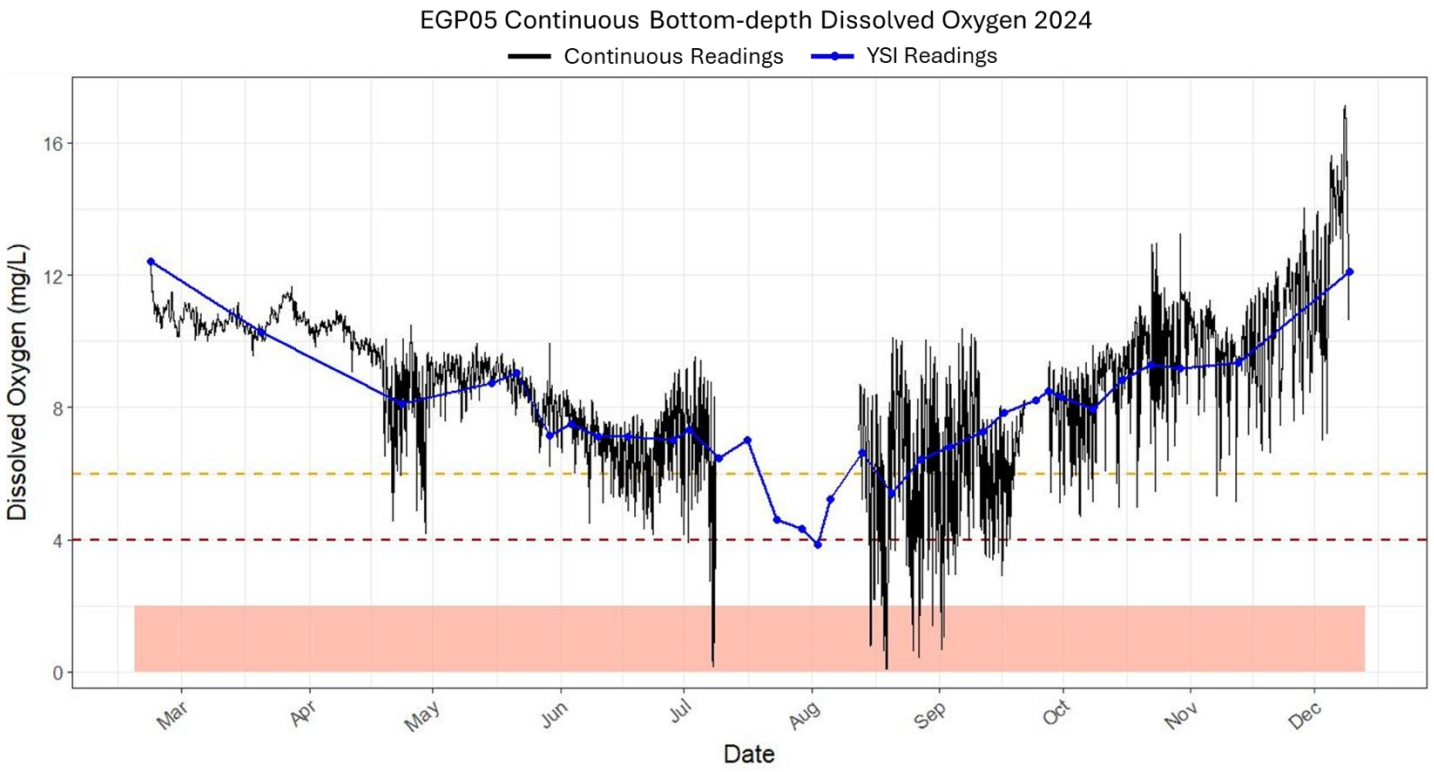

Figure A7. *Dissolved oxygen (DO) in mg/L in 2024. Data were obtained on the pond bottom at station EGP05. The black line represents the deployed logger's DO readings taken every 30 minutes, while the blue dotted line represents DO measurements taken with a handheld probe during weekly site visits. The 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.*

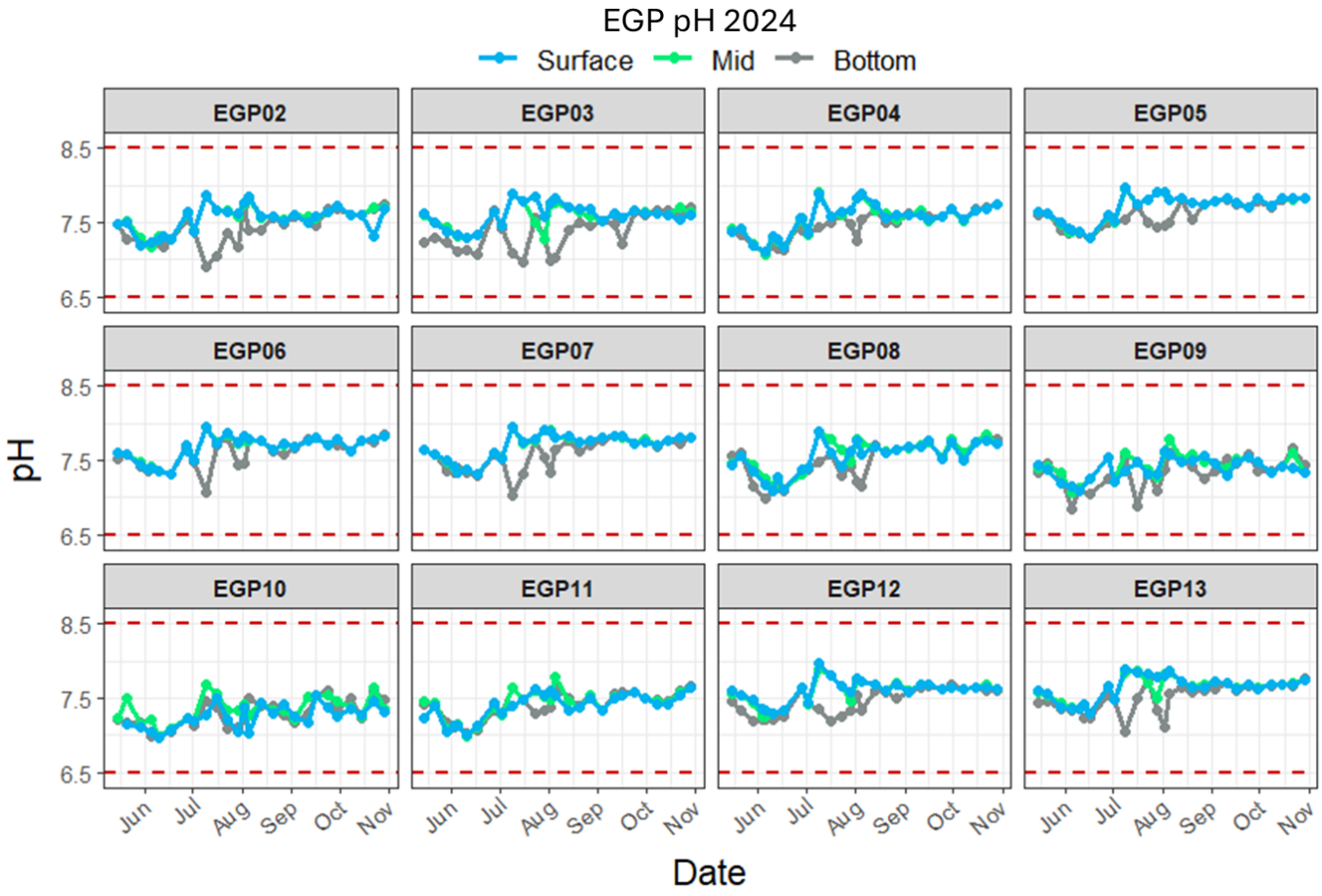

Figure A8. *pH for EGP's 12 monitoring stations during the 2024 field season. Data were measured using a handheld probe for 3 depths (surface, mid-depth, and bottom). The dashed red lines indicate the boundaries of the pH management target (6.5-8.5).*

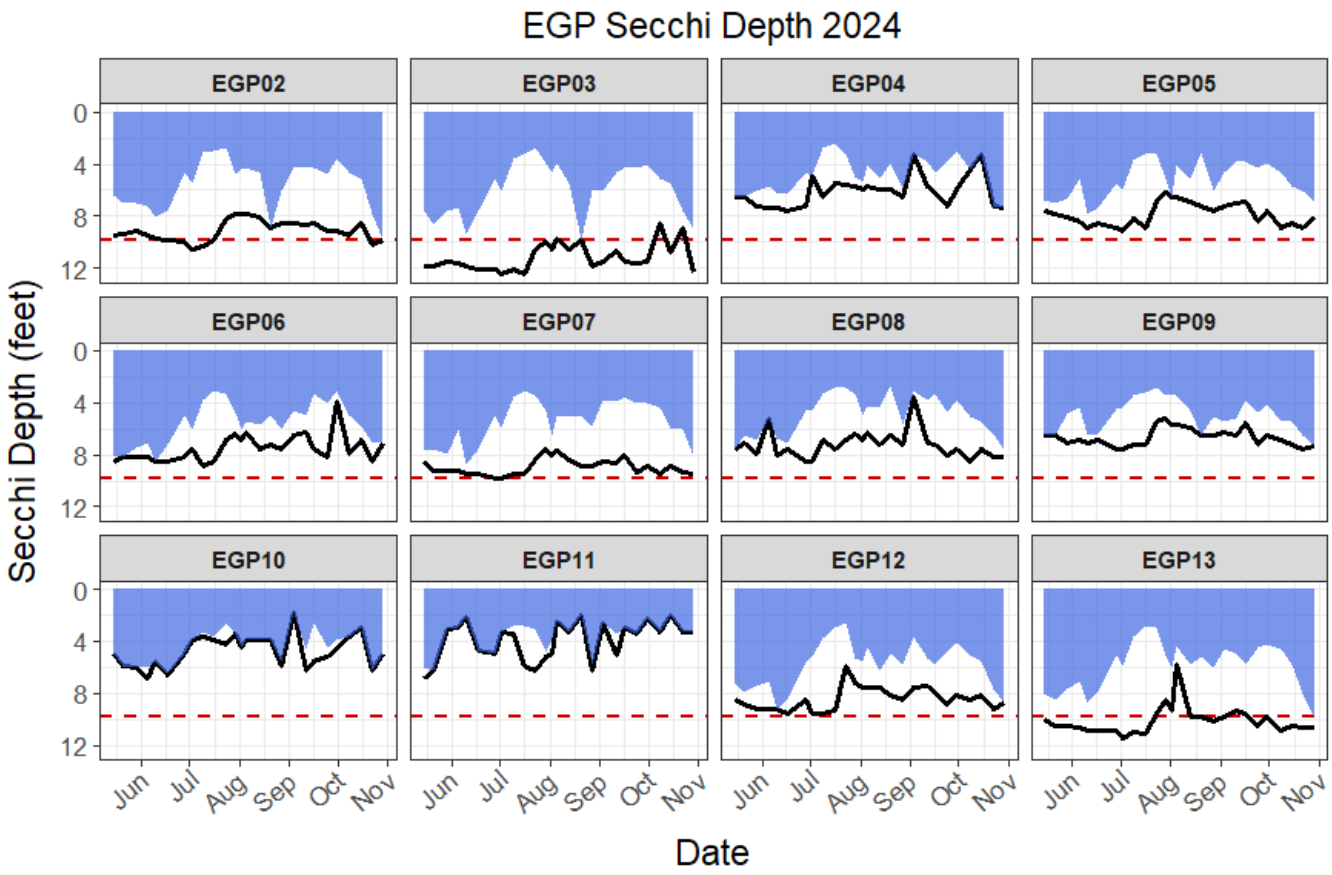

Figure A9. *Secchi depth and total depth in feet for EGP's 12 monitoring stations during the 2024 field season. Secchi depth is the depth at which a standardized disk disappears, thereby representing visibility into the water column. Total depth at each station is represented by a black line in these 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).*

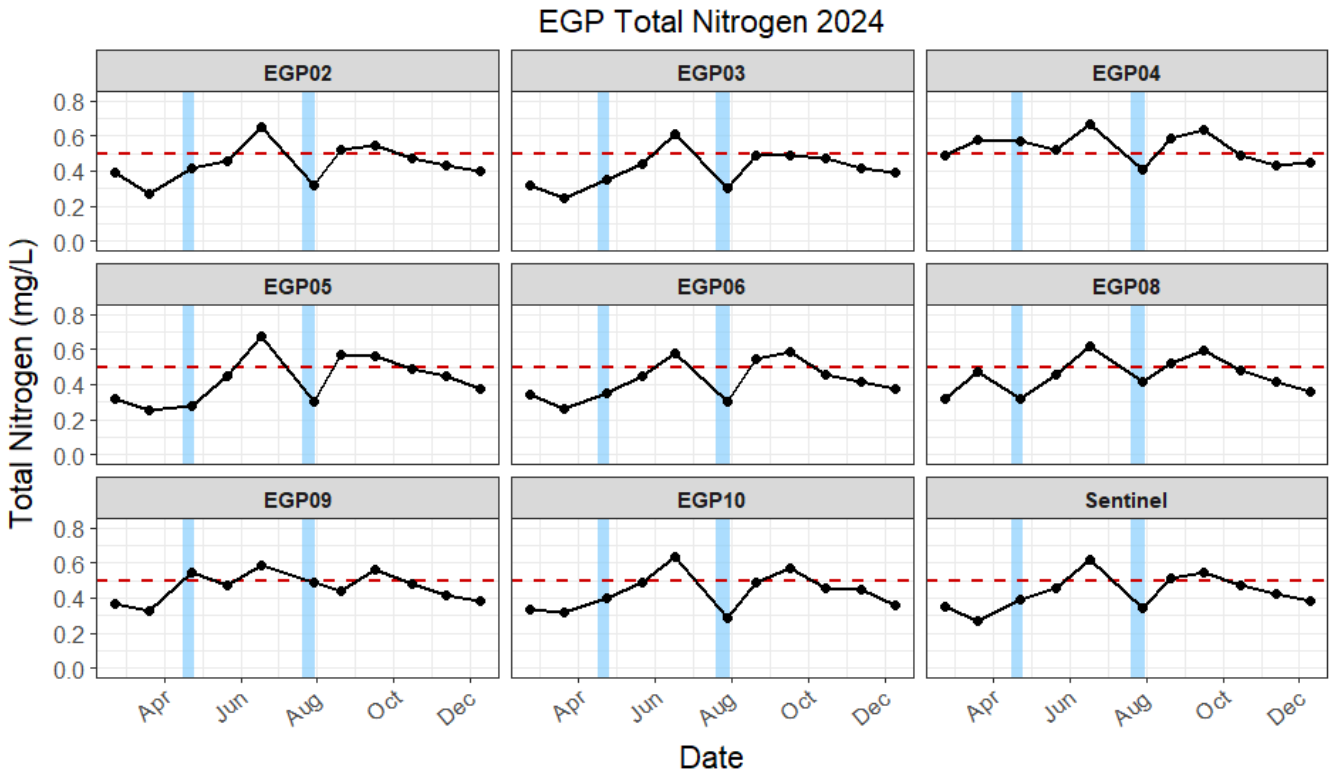

Figure A10. *Total nitrogen (in mg/L) for EGP's 8 nutrient monitoring stations and the "sentinel station" (average of EGP02, EGP03, EGP05, EGP06, & EGP09) in 2024. The dashed red line represents the State's management threshold (0.5 mg/L). Blue shading indicates an opening on the Pond.*

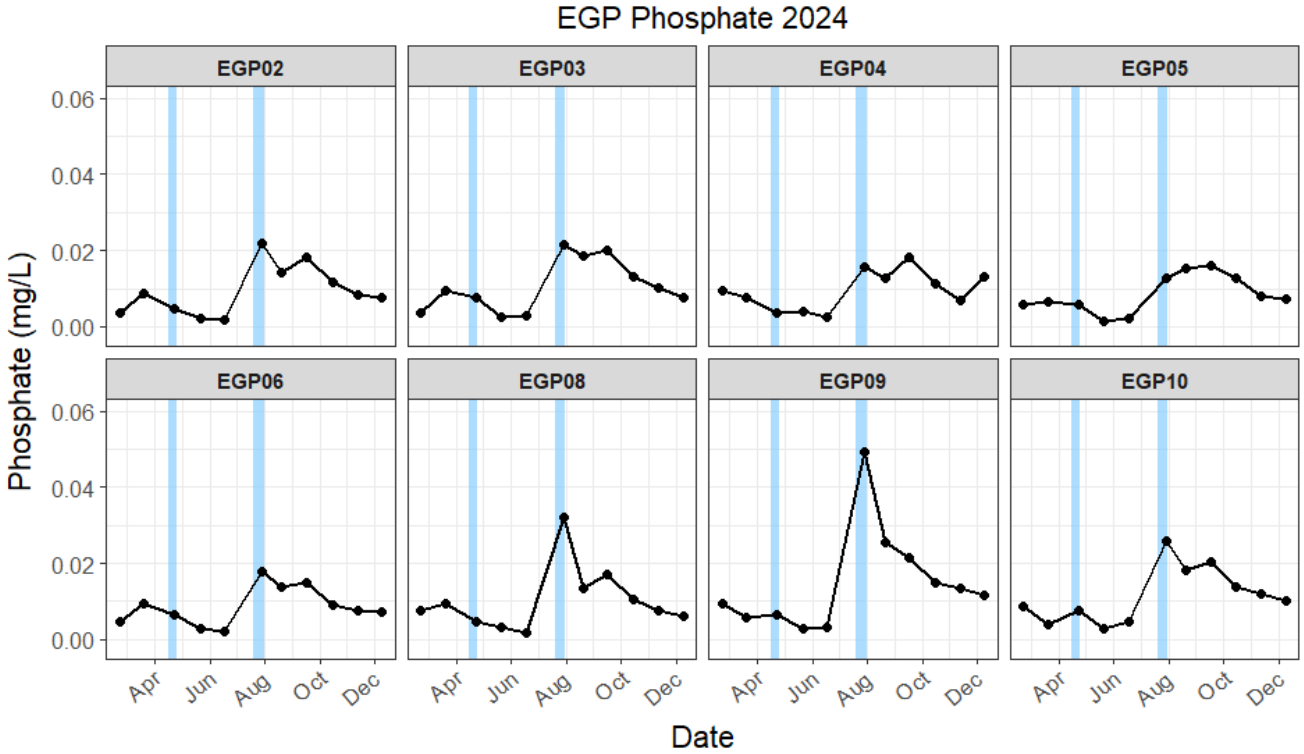

Figure A11. *Phosphate (in mg/L) for EGP's 8 nutrient monitoring stations in 2024. Blue shading indicates an opening on the Pond.*

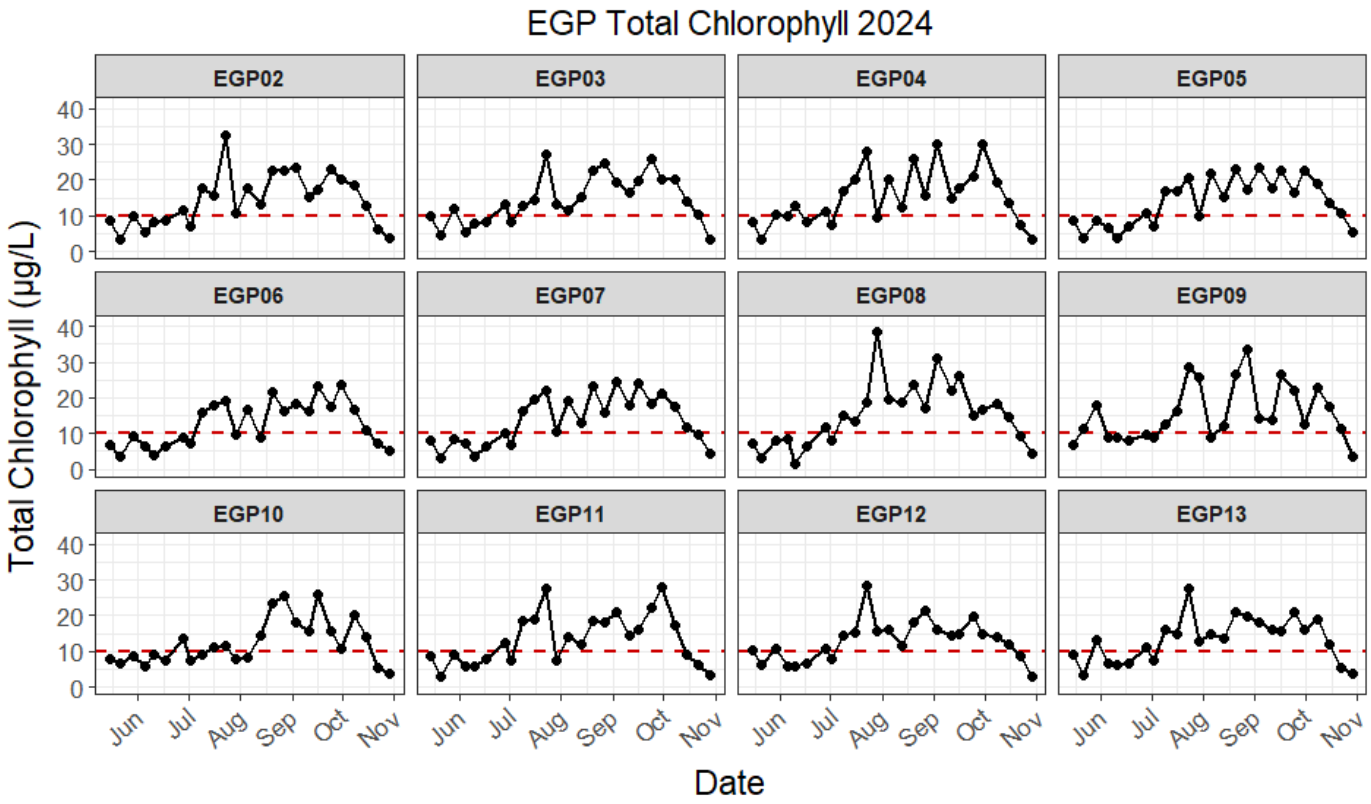

Figure A12. *Total chlorophyll (in ug/L) for EGP's 12 monitoring stations during the 2024 field season. The dashed red line represents the State's management threshold (10 ug/L).*

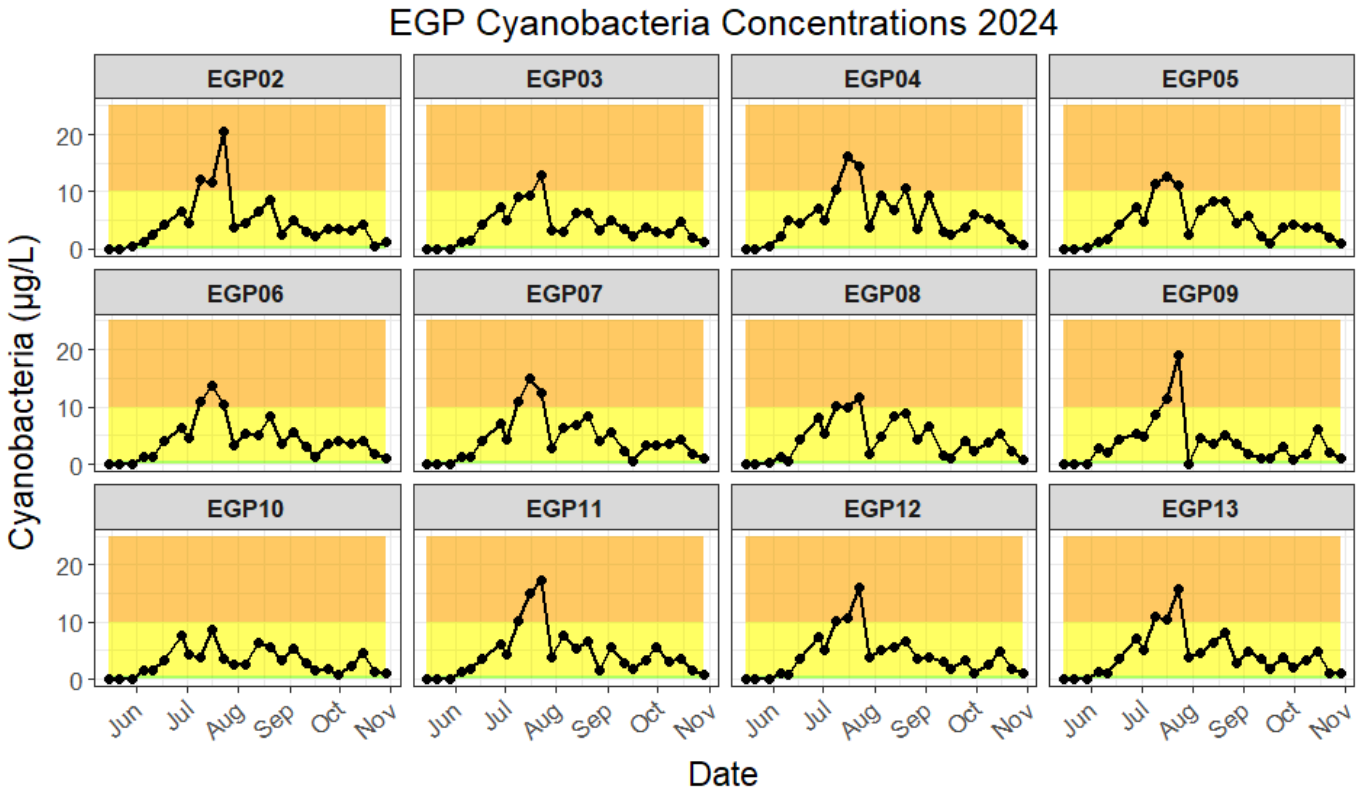

Figure A13. *Cyanobacteria (in µg/L) at EGP's 12 monitoring stations during the 2024 field season. Background colors pertain to the color-coded risk matrix used by the MV CYANO$_{TM}$ monitoring program (see* ***Figure A14****).*

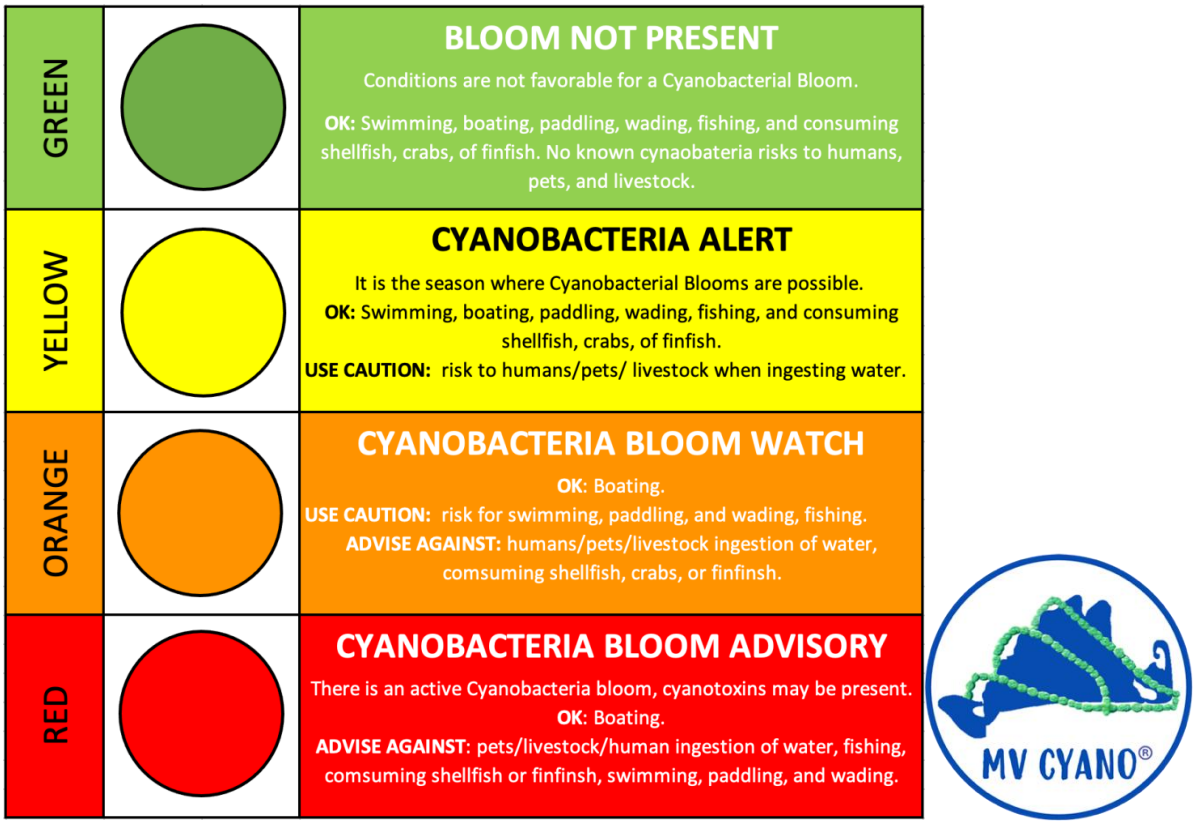

Figure A14. *The color-coded messaging & logo used by the MV CYANO™ monitoring program.*