2025 PEP Water Quality Monitoring Report

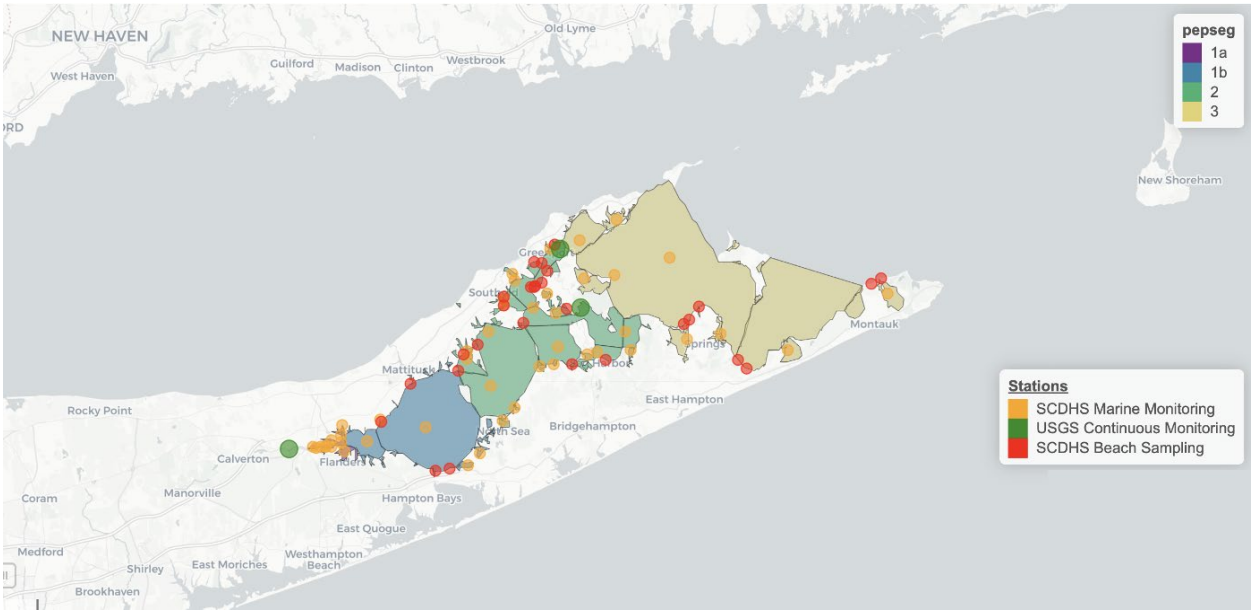
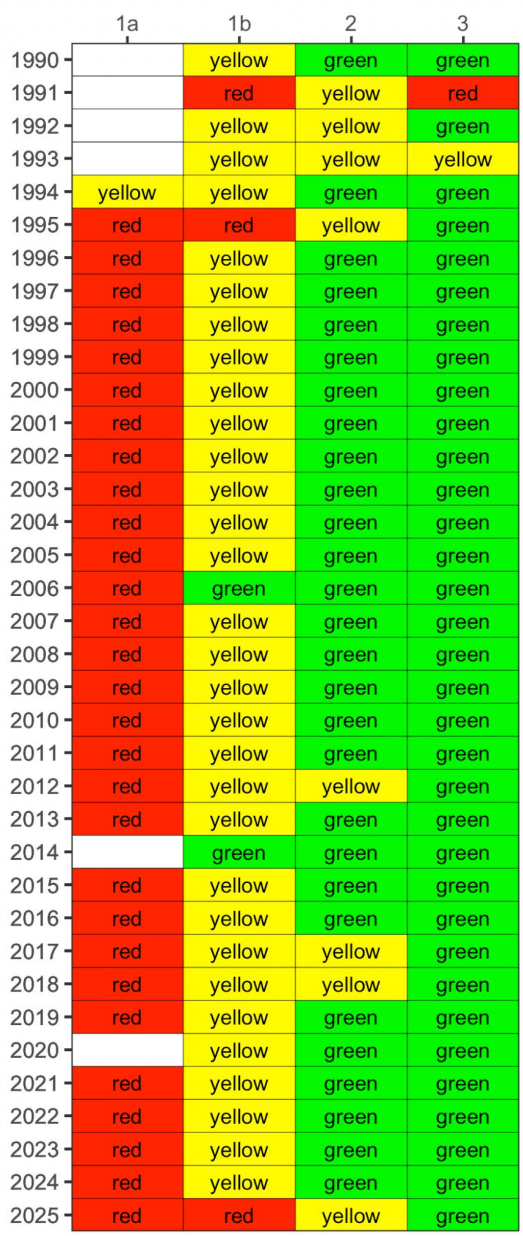


Figure 1. Water quality monitoring stations by PEP segment. Segments: 1a-Western-River Influence, 1b-Western, 2-Central and 3-Eastern.

Water Clarity & Chlorophyll-a

Increased algae blooms correlate with higher chlorophyll-a levels and lower water clarity leading to lower light availability. The duration of time and magnitude of exceedance of water clarity and chlorophyll-a targets are assessed together to track progress toward water quality goals. The Stop Light Graphic reflects the combined outcomes for chlorophyll-a and water clarity based on analysis of exceedance duration and magnitude of targets for each parameter. Water clarity and Secchi disk depth median values during the growing season at SCDHS stations were averaged within the Estuary segment. Tracking the attainment outcomes provides the framework from which Estuary management actions can be developed and initiated. For each year and segment, a color-coded management action is assigned. Segment 3 consistently meets PEP's water quality goals and has since 1990. Segment 2 has inconsistently met PEP's water quality goals since 1990, receiving a cautionary categorization in 2025. Segment 1b has inconsistently met PEP's water quality goals since 1990 and has received an alerting categorization in 2025. Segment 1a has consistently failed to meet water quality standards since 1995. Management action is in place for segment 1a and 1b.



	1a	1b	2	3
1990		yellow	green	green
1991		red	yellow	red
1992		yellow	yellow	green
1993		yellow	yellow	yellow
1994	yellow	yellow	green	green
1995	red	red	yellow	green
1996	red	yellow	green	green
1997	red	yellow	green	green
1998	red	yellow	green	green
1999	red	yellow	green	green
2000	red	yellow	green	green
2001	red	yellow	green	green
2002	red	yellow	green	green
2003	red	yellow	green	green
2004	red	yellow	green	green
2005	red	yellow	green	green
2006	red	green	green	green
2007	red	yellow	green	green
2008	red	yellow	green	green
2009	red	yellow	green	green
2010	red	yellow	green	green
2011	red	yellow	green	green
2012	red	yellow	yellow	green
2013	red	yellow	green	green
2014		green	green	green
2015	red	yellow	green	green
2016	red	yellow	green	green
2017	red	yellow	yellow	green
2018	red	yellow	yellow	green
2019	red	yellow	green	green
2020		yellow	green	green
2021	red	yellow	green	green
2022	red	yellow	green	green
2023	red	yellow	green	green
2024	red	yellow	green	green
2025	red	red	yellow	green

Figure 2. Stop Light Graphic of combined water clarity and chlorophyll-a at Peconic Estuary SCDHS stations by estuary segment.

Higher water clarity means that more sunlight can reach submerged aquatic vegetation (SAV), such as eelgrass, which need sufficient sunlight in order to grow and survive. SAV provides important habitat for fish, shellfish and invertebrates. Reduced water clarity can be caused by algal blooms, eroded sediments from runoff, or disturbed bottom sediments from wind or human activities. Water clarity is measured by the depth at which a Secchi disk is visible from the water's surface at SCDHS marine monitoring stations in the Peconic Estuary. A Secchi disk is a white and black disk that is lowered down into the water - the depth at which the disk is no longer visible is taken as a measure of the how clear the water is. Higher water clarity is signified by greater Secchi disk depths.

The PEP's target for water clarity: Median Secchi disk depths should be 2 meters (m)/ 6.5 feet (ft) or greater during the April 1 through October 31 growing season.

	1a	1b	2	3
1990		not met	met	met
1991		not met	not met	met
1992		not met	met	met
1993		not met	met	met
1994	met	not met	met	met
1995	not met	not met	met	met
1996	not met	not met	met	met
1997	not met	met	met	met
1998	not met	met	met	met
1999	not met	met	met	met
2000	not met	not met	met	met
2001	not met	met	met	met
2002	not met	met	met	met
2003	not met	not met	met	met
2004	not met	met	met	met
2005	not met	met	met	met
2006	not met	met	met	met
2007	not met	met	met	met
2008	not met	not met	met	met
2009	not met	not met	met	met
2010	not met	not met	met	met
2011	not met	not met	met	met
2012	not met	not met	not met	met
2013	not met	met	met	met
2014		met	met	met
2015	not met	met	met	met
2016	not met	met	met	met
2017	not met	met	met	met
2018	not met	not met	met	met
2019	not met	not met	met	met
2020		met	met	met
2021	not met	met	met	met
2022	met	met	met	met
2023	not met	met	met	met
2024	not met	met	met	met
2025	not met	not met	not met	met

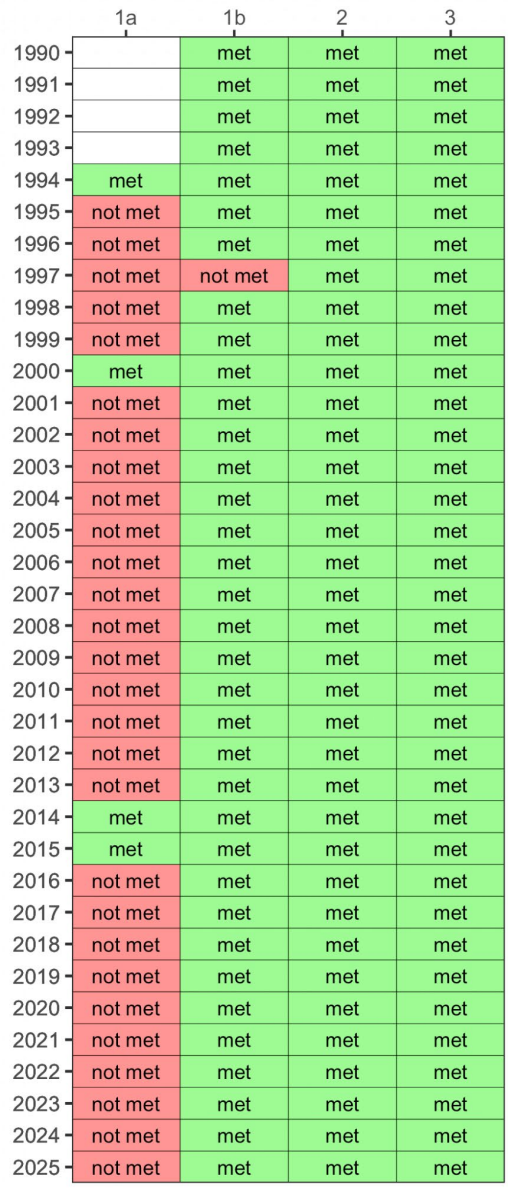
Figure 3. Water clarity at SCDHS stations per PEP segment as a function of Secchi disk depth.

Segment 3 has consistently met PEP's water quality target of a Secchi disk depth greater than 2m from 1990 to 2025. Segment 2 has mostly met the PEP's water quality target since 1990, with infrequent decreases, including 2025. In segment 1b the segment has not consistently met the PEP's water quality target since 1990, but has had a Secchi disk depth that is greater than 2m from 2020-2024, suggesting overall water quality improvement; Segment 1b did not meet PEP's water quality target for

2025. For segment 1a, it has not consistently met PEP's water quality target since 1990, and the last three years segment 1a has had a Secchi disk depth less than 2m.

The concentration of chlorophyll-a, the pigments in plants that absorb sunlight and facilitate photosynthesis, in the water is an indicator of the amount of algae in the water. Chlorophyll-a measurements can be used as an indirect indicator of algal presence and growth and interfered nutrient levels. Chlorophyll-a samples are collected at SCDHS marine monitoring stations in the Peconic Estuary.

The PEP's target for chlorophyll-a: Median chlorophyll-a concentrations should be no greater than 5.5 ug/L during the April 1 through October 31 growing season.



	1a	1b	2	3
1990		met	met	met
1991		met	met	met
1992		met	met	met
1993		met	met	met
1994	met	met	met	met
1995	not met	met	met	met
1996	not met	met	met	met
1997	not met	not met	met	met
1998	not met	met	met	met
1999	not met	met	met	met
2000	met	met	met	met
2001	not met	met	met	met
2002	not met	met	met	met
2003	not met	met	met	met
2004	not met	met	met	met
2005	not met	met	met	met
2006	not met	met	met	met
2007	not met	met	met	met
2008	not met	met	met	met
2009	not met	met	met	met
2010	not met	met	met	met
2011	not met	met	met	met
2012	not met	met	met	met
2013	not met	met	met	met
2014	met	met	met	met
2015	met	met	met	met
2016	not met	met	met	met
2017	not met	met	met	met
2018	not met	met	met	met
2019	not met	met	met	met
2020	not met	met	met	met
2021	not met	met	met	met
2022	not met	met	met	met
2023	not met	met	met	met
2024	not met	met	met	met
2025	not met	met	met	met

Figure 4. Chlorophyll-a concentrations at SCDHS stations per PEP segment.

Segments 1b, 2, and 3 have consistently met PEP's target of chlorophyll – a less than 5.5 µg/L since 1990. Segment 1a has consistently not met the PEP's target and has experienced median chlorophyll-a values of above 5.5 µg/L since 1990, including during 2025.

Water Quality and Chlorophyll-a Methodology

The water clarity and chlorophyll-a data analysis utilized the The Suffolk County Department of Health Services (SCDHS) Surface Water Monitoring data set. More detail on how the analysis was completed using the Peconic R-based open science package can be found here.

Water clarity and Secchi disk depth median values during the growing season (April 1 through October 31) at SCDHS stations were averaged within the Estuary segment. An outcome integer from zero to three is assigned to each Estuary segment for each annual estimate of chlorophyll-a and secchi depth. These outcomes are based on both the exceedance of the annual estimate above the threshold and duration of the exceedance of the threshold for the years prior. The final Stop Light Graphic created reflects these combined outcomes for chlorophyll-a and secchi depth. Tracking the attainment outcomes provides the framework from which bay management actions can be developed and initiated. For each year and segment, a color-coded management action is assigned and in this analysis secchi depth is used instead of light attenuation values.

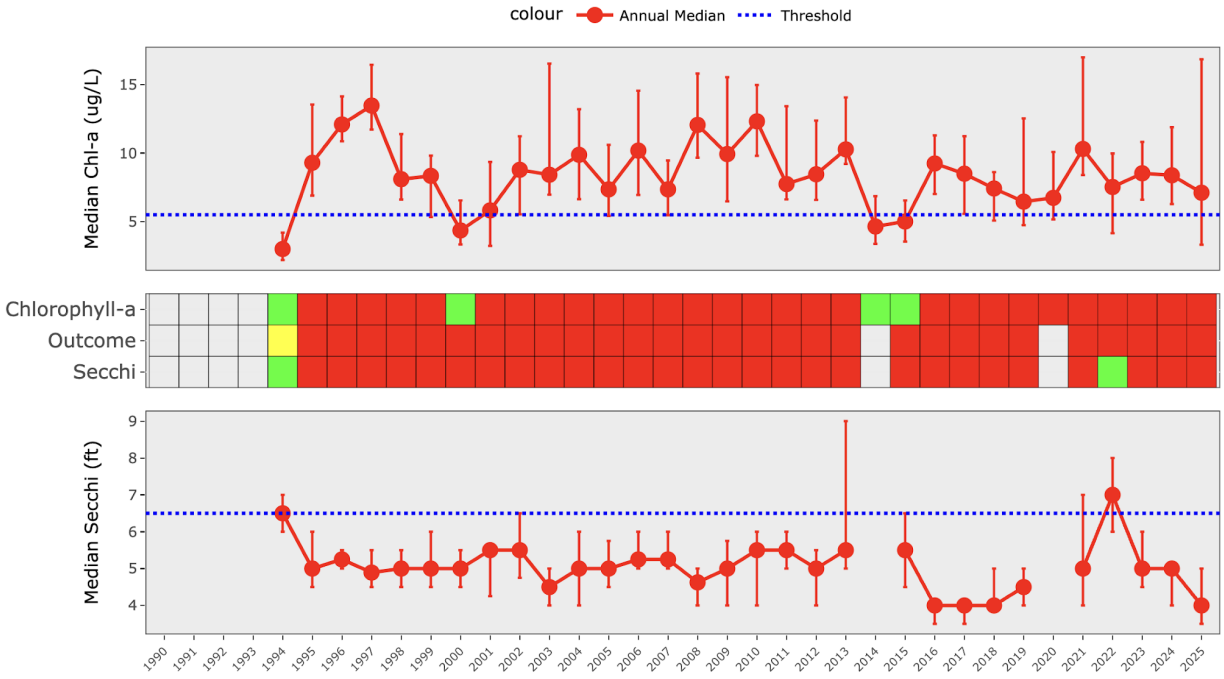


Figure 5. Stop light graphic reflecting the combined outcomes for chlorophyll-a and secchi depth in PEP segment 1a. The blue dotted line represents the threshold of 5.5 µg/L and 6.5ft for chlorophyll-a and secchi disk depth, respectively. The middle stoplight chart indicates the threshold outcomes each year for chlorophyll-a, Secchi depth, and combined water quality outcomes.

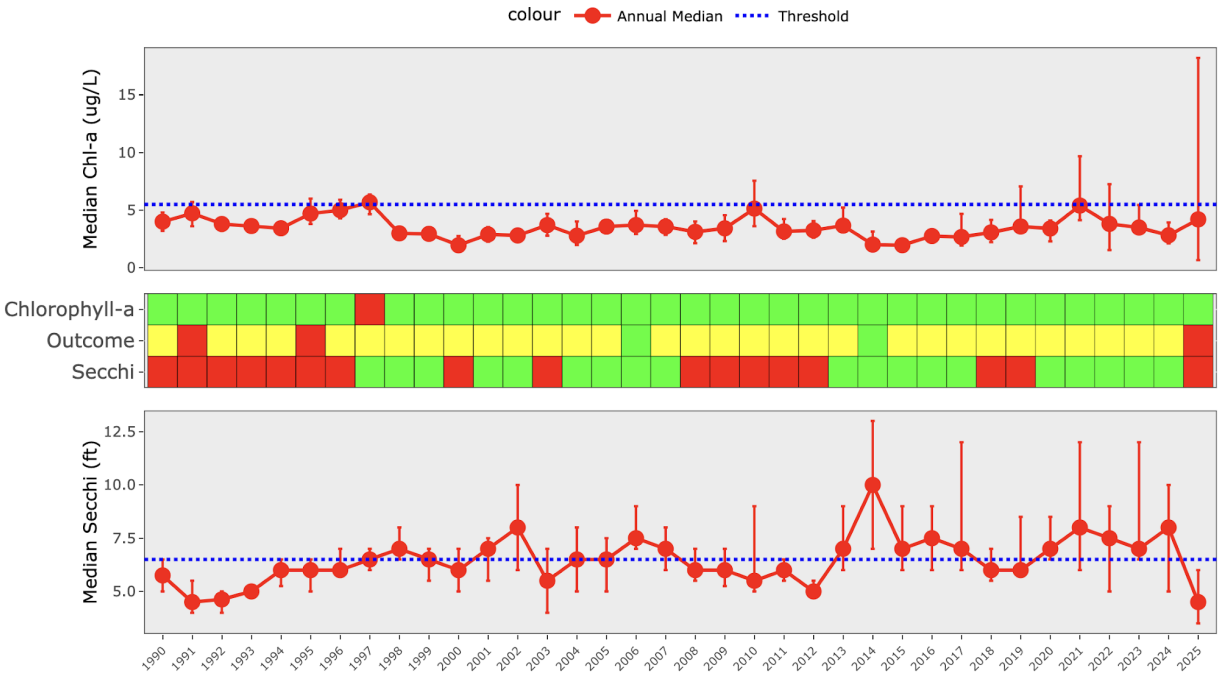


Figure 6. Stop light graphic reflecting the combined outcomes for chlorophyll-a and secchi depth in PEP segment 1b. The blue dotted line represents the threshold of 5.5 µg/L and 6.5ft for chlorophyll-a and secchi disk depth, respectively. The middle stoplight chart indicates the threshold outcomes each year for chlorophyll-a, Secchi depth, and combined water quality outcomes.

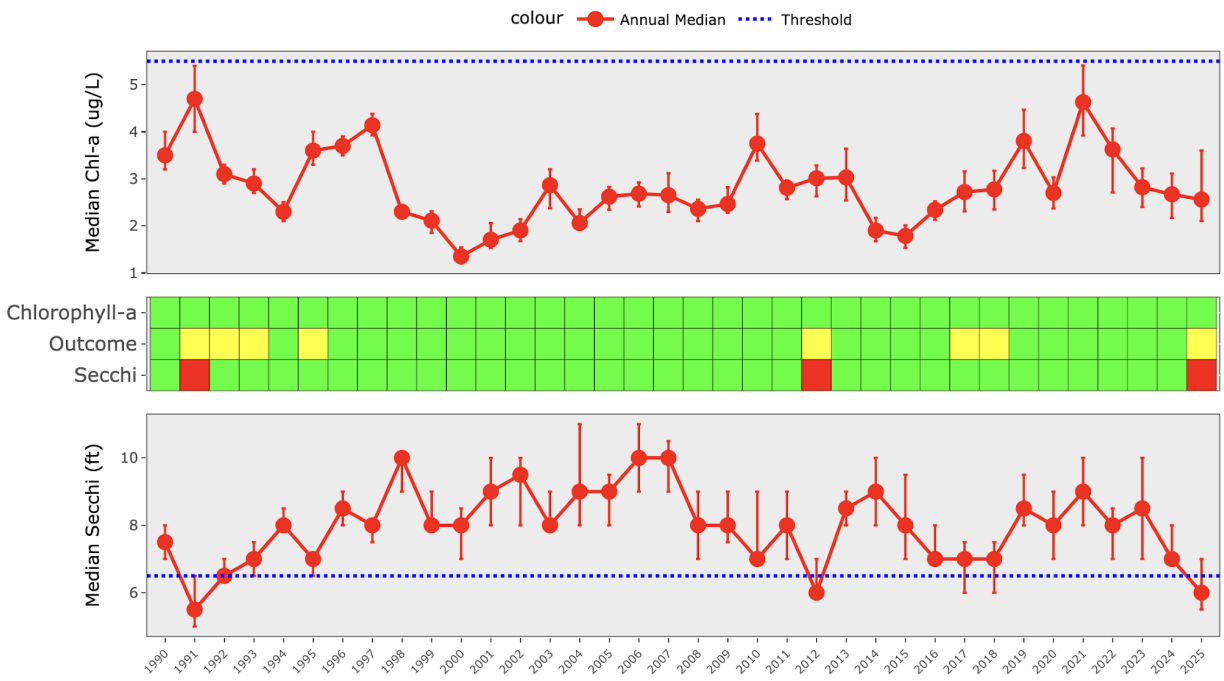


Figure 7. Stop light graphic reflecting the combined outcomes for chlorophyll-a and secchi depth in PEP segment 2. The blue dotted line represents the threshold of 5.5 µg/L and 6.5ft for chlorophyll-a and secchi disk depth, respectively. The middle stoplight chart indicates the threshold outcomes each year for chlorophyll-a, Secchi depth, and combined water quality outcomes.

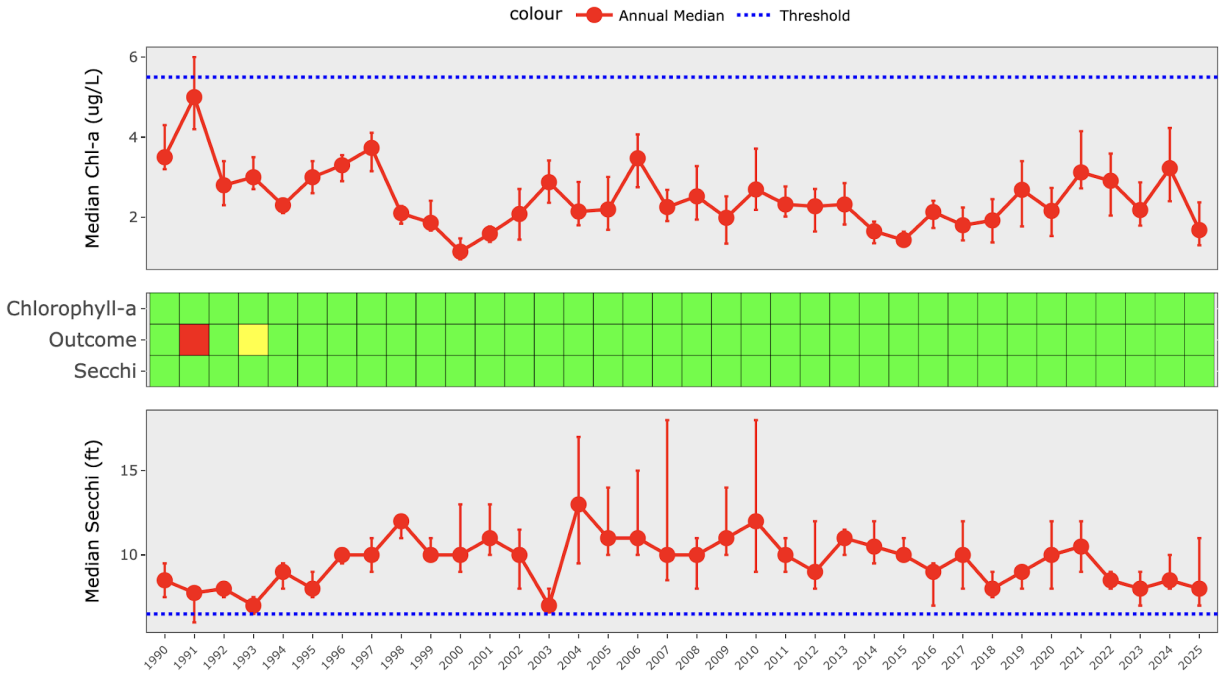


Figure 8. Stop light graphic reflecting the combined outcomes for chlorophyll-a and secchi depth in PEP segment 3. The blue dotted line represents the threshold of 5.5 µg/L and 6.5ft for chlorophyll-a and secchi disk depth, respectively. The middle stoplight chart indicates the threshold outcomes each year for chlorophyll-a, Secchi depth, and combined water quality outcomes.

Total Nitrogen

The concentration of total Nitrogen in surface water, which is a vital nutrient for algae and plant metabolism (photosynthesis) is an indicator of the amount of algae in the water, and it has been shown in the scientific literature that it directly correlates with impaired water quality. The United States Environmental Protection Agency's (EPA) National Coastal Condition Assessment (NCCA) uses 0.40 mg/L as a TN endpoint (threshold), which PEP has adopted. This value is based on the amount of TN in surface waters that would allow current eelgrass populations to survive. If the goal is to restore and recover the eelgrass populations within the estuary, a threshold of 0.30 mg/L is recommended.

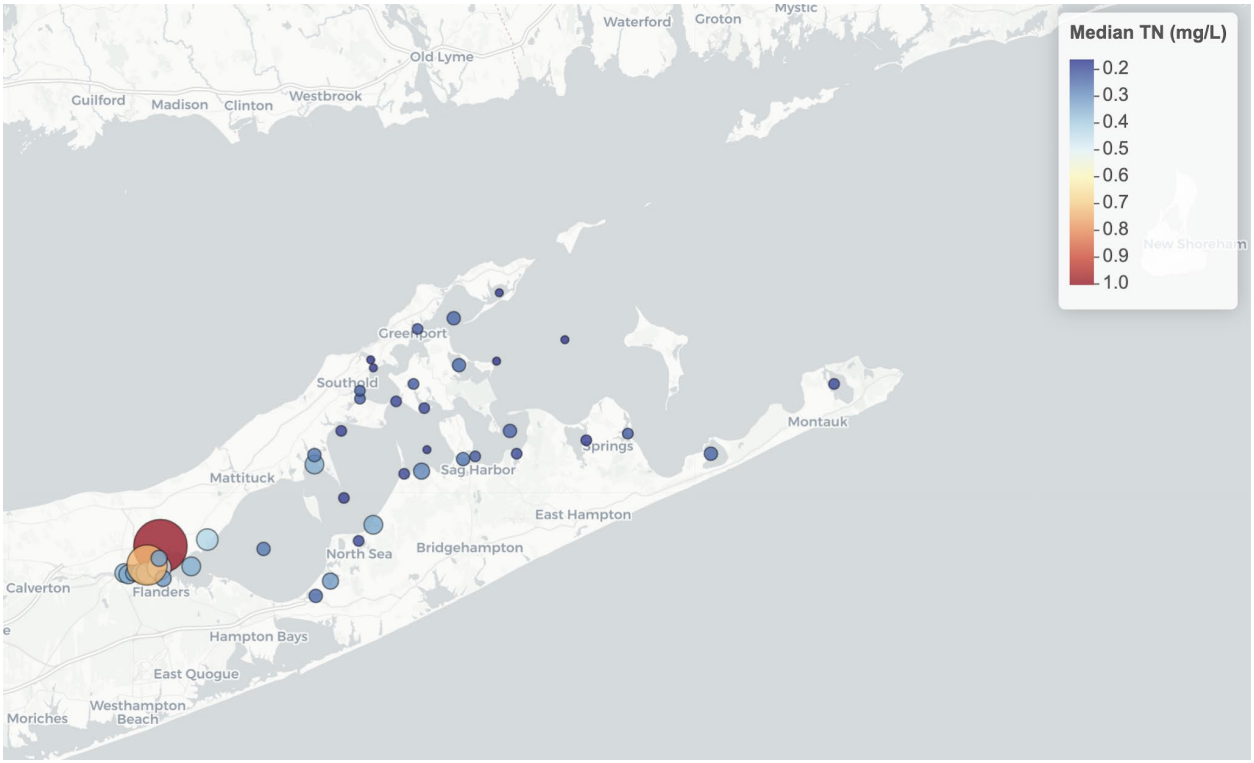


Figure 9. Median Total Nitrogen (TN, mg/L) at SCDHS surface water quality stations within the Peconic Estuary in 2025.

For the 2025 data, the highest TN values are in the 1a segment, and the values get lower as the segments move Eastward from 1a to 3. The TN values are close to the 0.40 mg/L threshold in segment 1a throughout the year with higher values during the summer and lower values during the winter. Segment 1a contained the highest TN values in 2025 at Meetinghouse Creek (1.75 mg/L) and Sawmill Creek (1.30 mg/L) in early April. The TN values in segment 1b are overall lower than segment 1a and only near the threshold in the summer and in April. The TN values in segment 2 are consistently lower than the 0.40 mg/L threshold throughout 2025, with higher values in the summer and lower values in the winter with an increase in October and December. The TN values in segment 3 are similar to segment 2 where the 2025 values are consistently below the threshold, with values that are higher in the summer and lower in the winter with an increase in October and December.

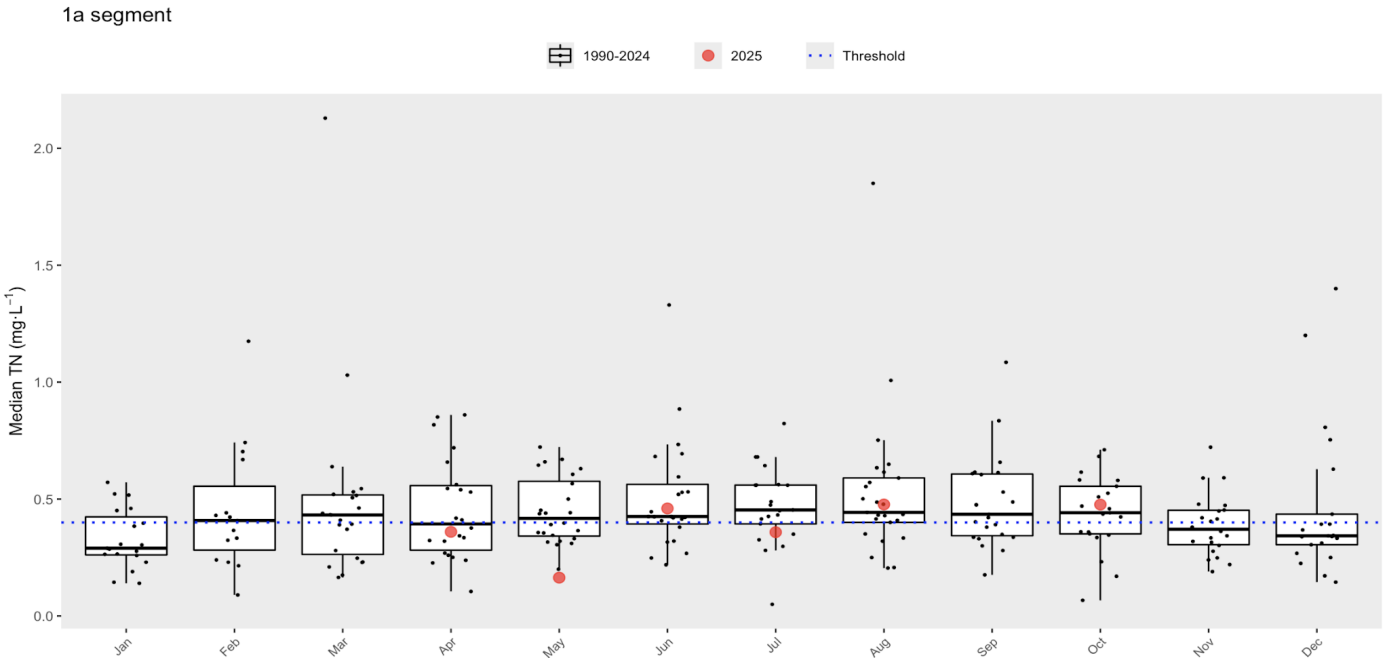


Figure 10. Total Nitrogen (TN, mg/L) at PEP station 1a across months. The blue dotted line indicates a TN threshold of 0.40 mg/L, box plots and individual black data points indicate values from 1990-2024, and the red point indicates data for 2025.

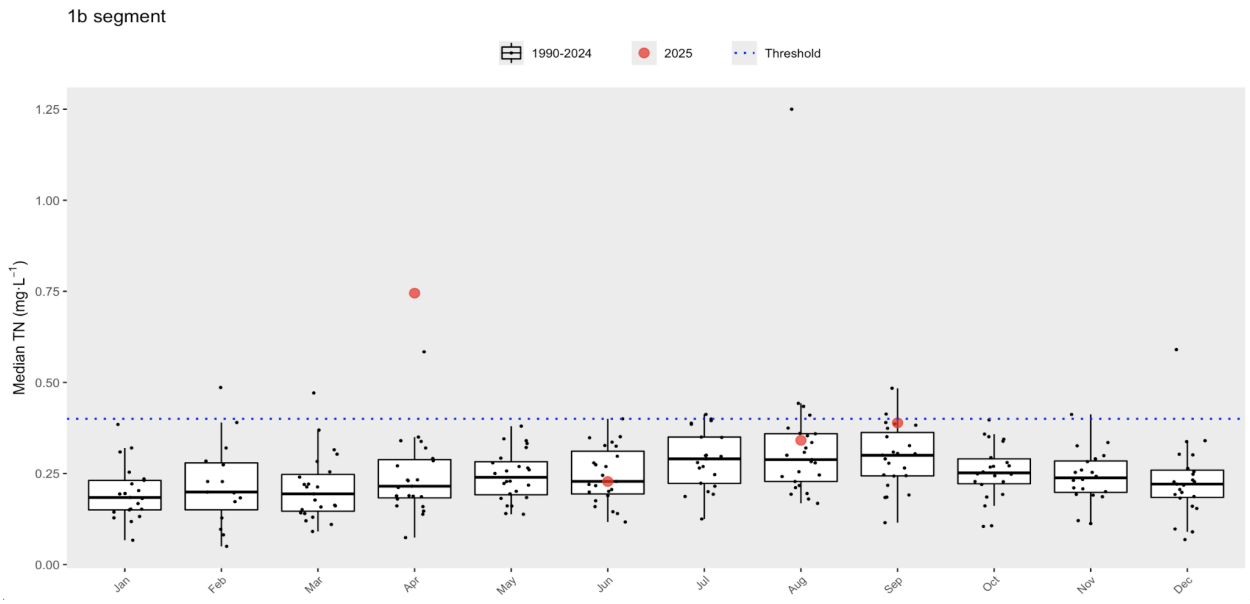


Figure 11. Total Nitrogen (TN, mg/L) at PEP station 1b across months. The blue dotted line indicates a TN threshold of 0.40 mg/L, box plots and individual black data points indicate values from 1990-2024, and the red point indicates data for 2025.

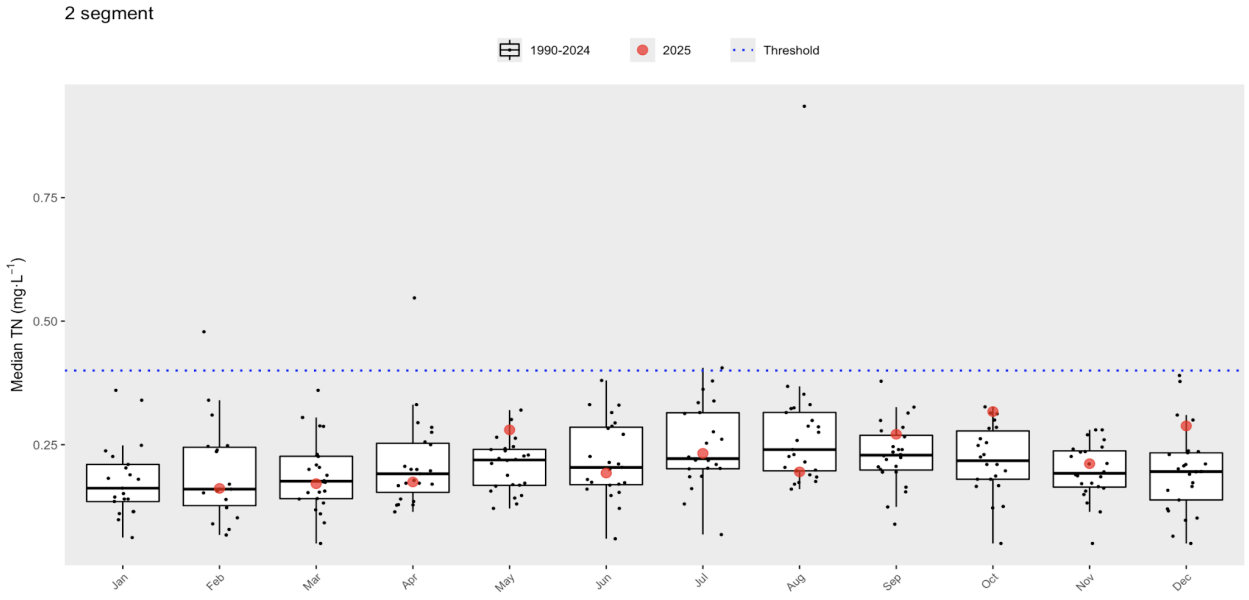


Figure 12. Total Nitrogen (TN, mg/L) at PEP station 1b across months. The blue dotted line indicates a TN threshold of 0.40 mg/L, box plots and individual black data points indicate values from 1990-2024, and the red point indicates data for 2025.

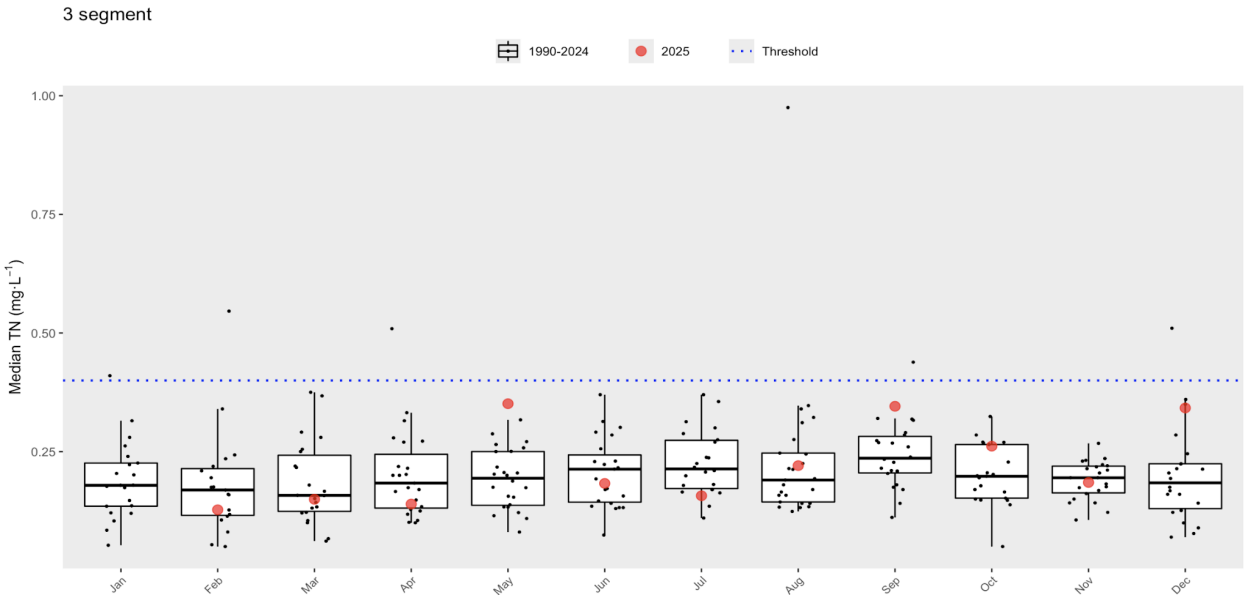


Figure 13. Total Nitrogen (TN, mg/L) at PEP station 1b across months. The blue dotted line indicates a TN threshold of 0.40 mg/L, box plots and individual black data points indicate values from 1990-2024, and the red point indicates data for 2025.

Dissolved Oxygen

Dissolved Oxygen (DO) in the water column is necessary for fish and other aquatic organisms to live. Concentrations can be impacted by the amount of algae that is in the water column, the associated photosynthesis and decomposition rates, natural variations in temperature, and wave action and mixing. DO concentrations indicate the amount of oxygen available for aquatic organisms in the Peconic Estuary. DO concentrations are measured every 6 minutes at the two USGS Continuous Water Quality Monitoring stations in the Peconic Estuary. The PEP's target for DO: DO concentrations should comply with New York State's acute (never less than 3 mg/L) and chronic (> 4.8 mg/L as daily average in 90% of measurements) DO criteria.

The Stop Light Graphic reflects the sequential number of days with a 24-hour mean measurement below 4.8 mg/L at Peconic River and Orient Harbor Stations, which is considered chronic low DO. For each month and station, a color-coded management action is assigned.

Figure 14. Stop light graphic of maximum sequential days monthly below DO concentration target at Peconic Estuary USGS stations 2013-2025 for the Peconic River (top) and Orient Harbor (bottom)

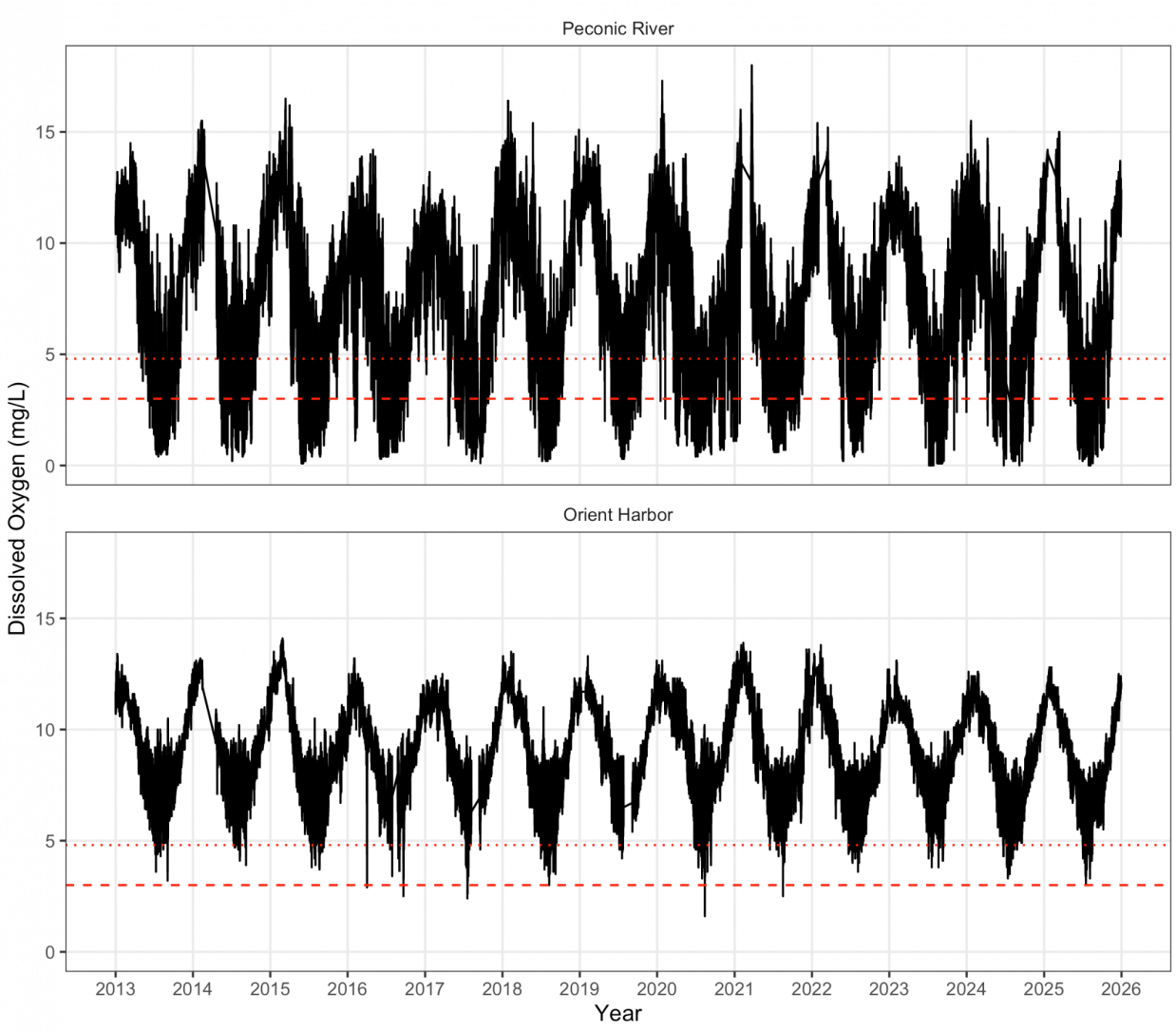


Figure 15. Annual cycles of dissolved oxygen (DO) at the Peconic River and Orient Harbor USGS continuous monitoring stations. Small dotted red lines indicate the NYSDEC chronic DO threshold and hashed red lines indicate the NYSDEC acute DO threshold. Across stations DO levels decrease during the spring and summer and increase during the fall and winter; however, Peconic River DO levels fall below the NYSDEC chronic and acute DO thresholds during the summer whereas Orient Harbor DO levels consistently remain above the acute DO threshold year-round and above the chronic DO threshold for much of the year.

Dissolved Oxygen Methodology

The DO data analysis utilized the USGS Orient Harbor and Riverhead Continuous Water Quality Monitoring Stations data set. More detail on how the analysis was completed using the Peconic R-based open science package can be found here.The data collected at the Riverhead and Orient Harbor USGS Continuous Water Quality

Monitoring Stations are summarized from the continuous (~6 minute observations) to daily averages. The data was analyzed relative to the chronic threshold of 4.8 mg/L. Within the R package the average DO concentration for each day is calculated and a 1 (yes) or 0 (no) is assigned to each day based on if the concentration was below the threshold value at any point during a day. Additionally, the R package calculates a cumulative tally of the number of days in each month at which DO fell below the threshold at any point during a day. The data is then summarized by month to be illustrated in the Stop Light Graphics. The R package calculates average of all daily DO averages across the month, the proportion of days in a month when concentrations in a given day fell below the threshold (1 would mean all days had an instance of DO below the threshold, 0 would mean none), and the maximum number of sequential days in a month when concentrations in a given day fell below the threshold (30 or 31, depending on month, would indicate all days in a month had an instance of DO below the threshold).

The DO data can be summarized differently depending on how hypoxia/anoxia conditions can be described relative to potential impacts on biological resources. Biota may be stressed differently depending on the number of times hypoxia occurs vs how long it may persist. The two measures may indicate similar information, but not always depending on characteristics of the DO time series. Using the same methodology, the data collected at the Riverhead and Orient Harbor USGS Continuous Water Quality Monitoring Stations can also be analyzed relative to the acute threshold of 3 mg/L.

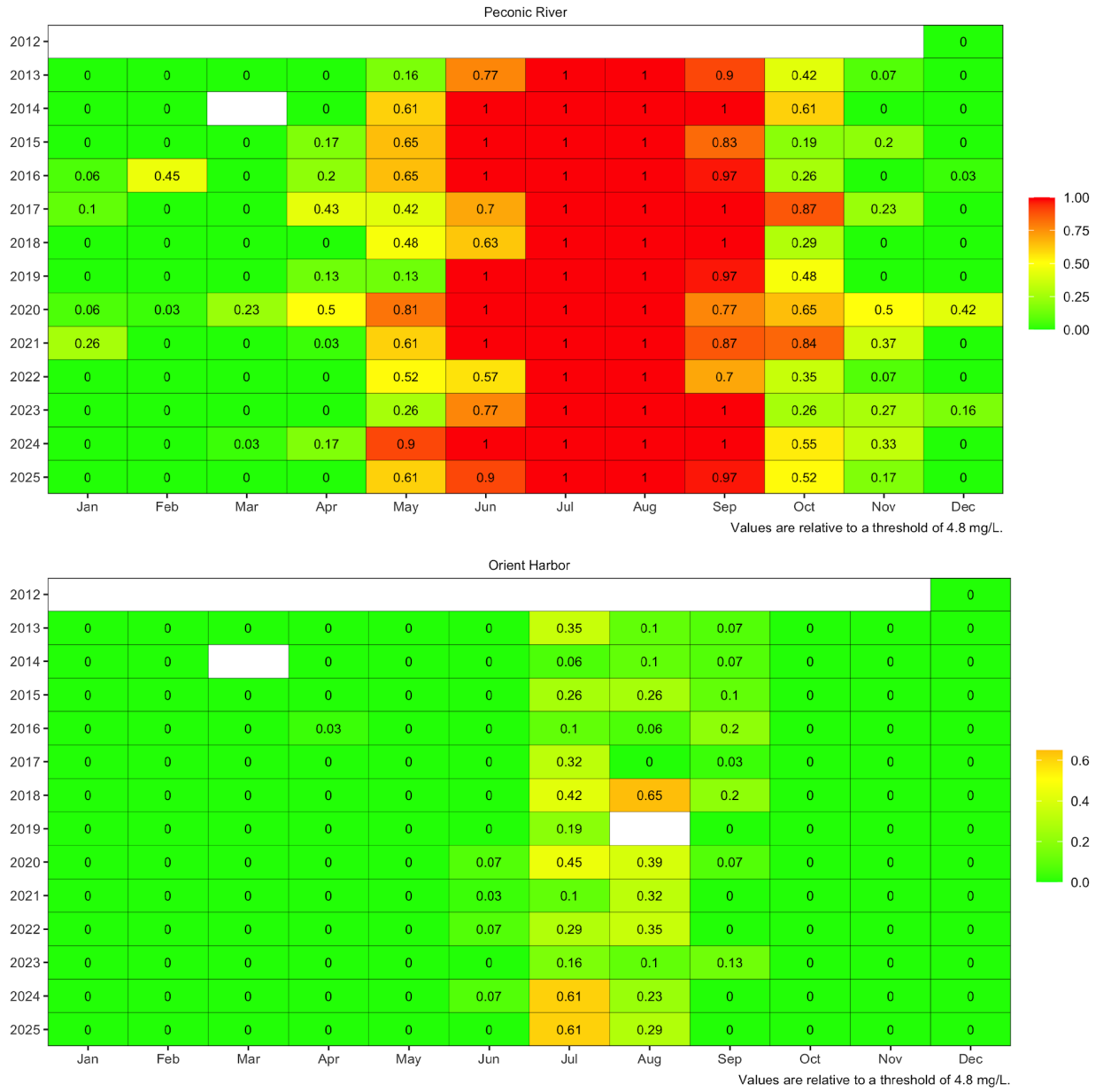


Figure 16. Stop light graphic for the Peconic River (top) and Orient Harbor (bottom) indicating the proportion of days within a month when concentrations in a given day fell below the chronic threshold of 4.8 mg/L.

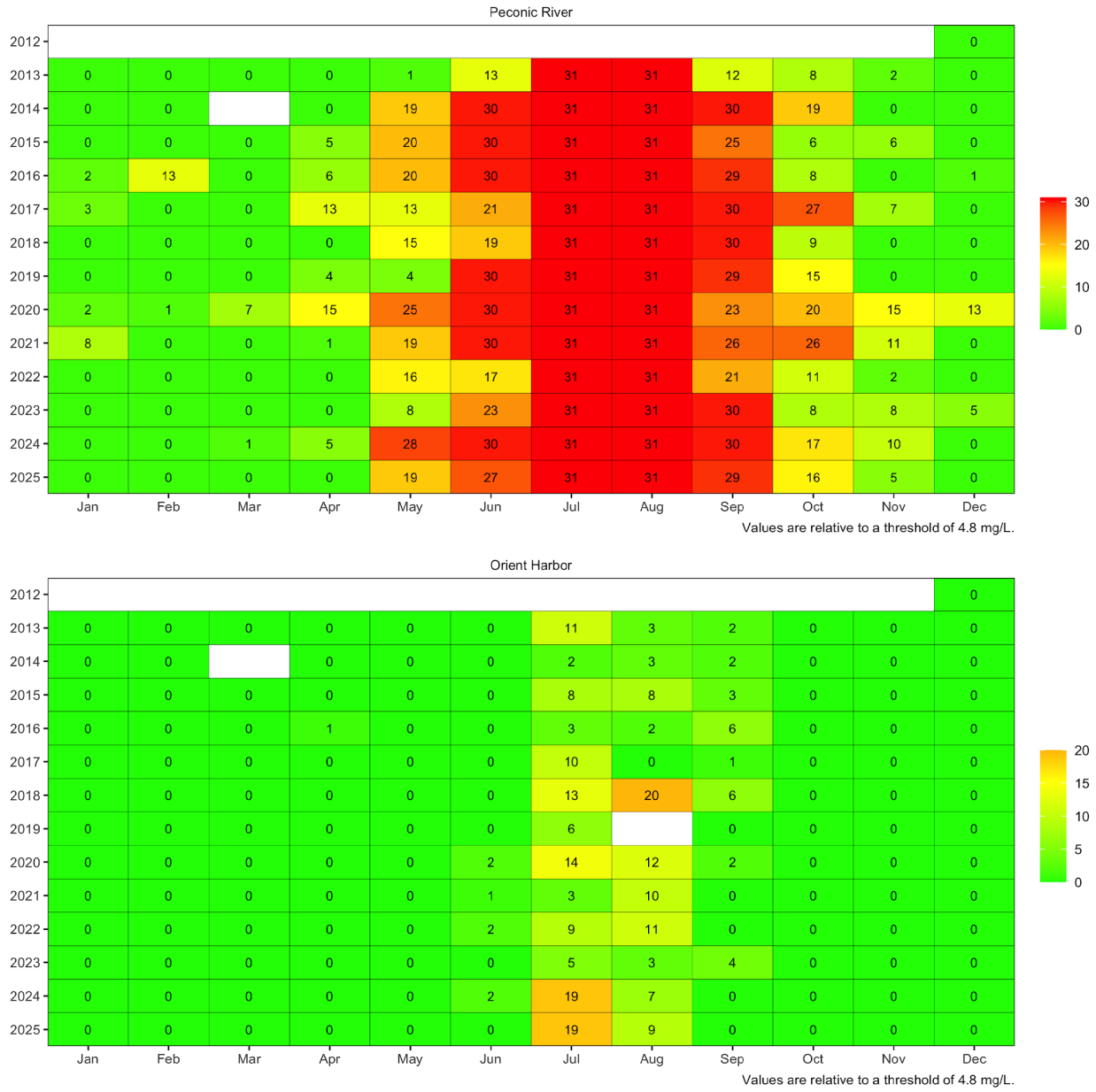


Figure 17. Stop light graphic for the Peconic River (top) and Orient Harbor (bottom) indicating the number days within a month when concentrations in a given day fell below the chronic threshold of 4.8 mg/L.

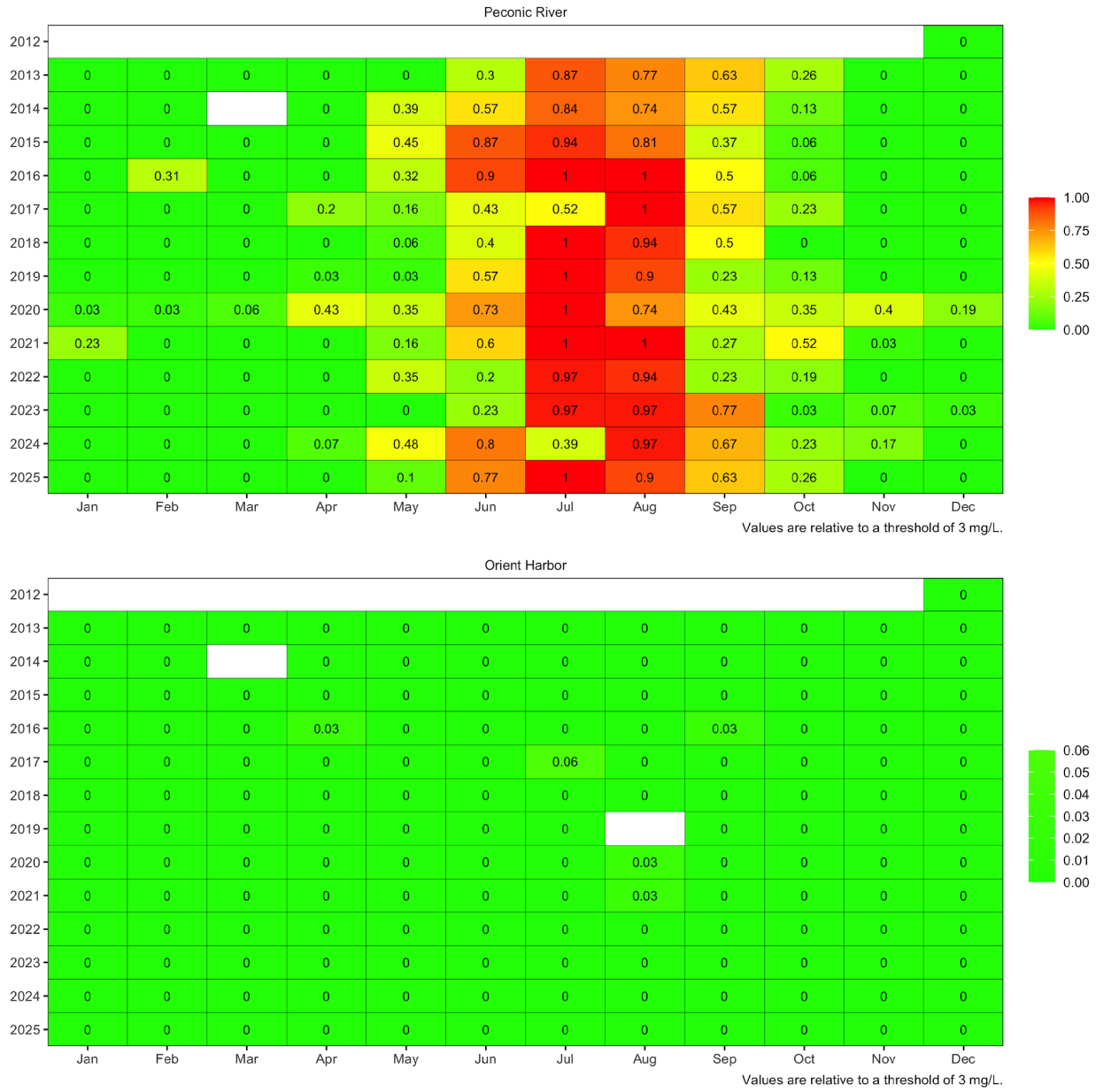


Figure 18. Stop light graphic for the Peconic River (top) and Orient Harbor (bottom) indicating the proportion of days within a month when concentrations in a given day fell below the acute threshold of 3.0 mg/L.

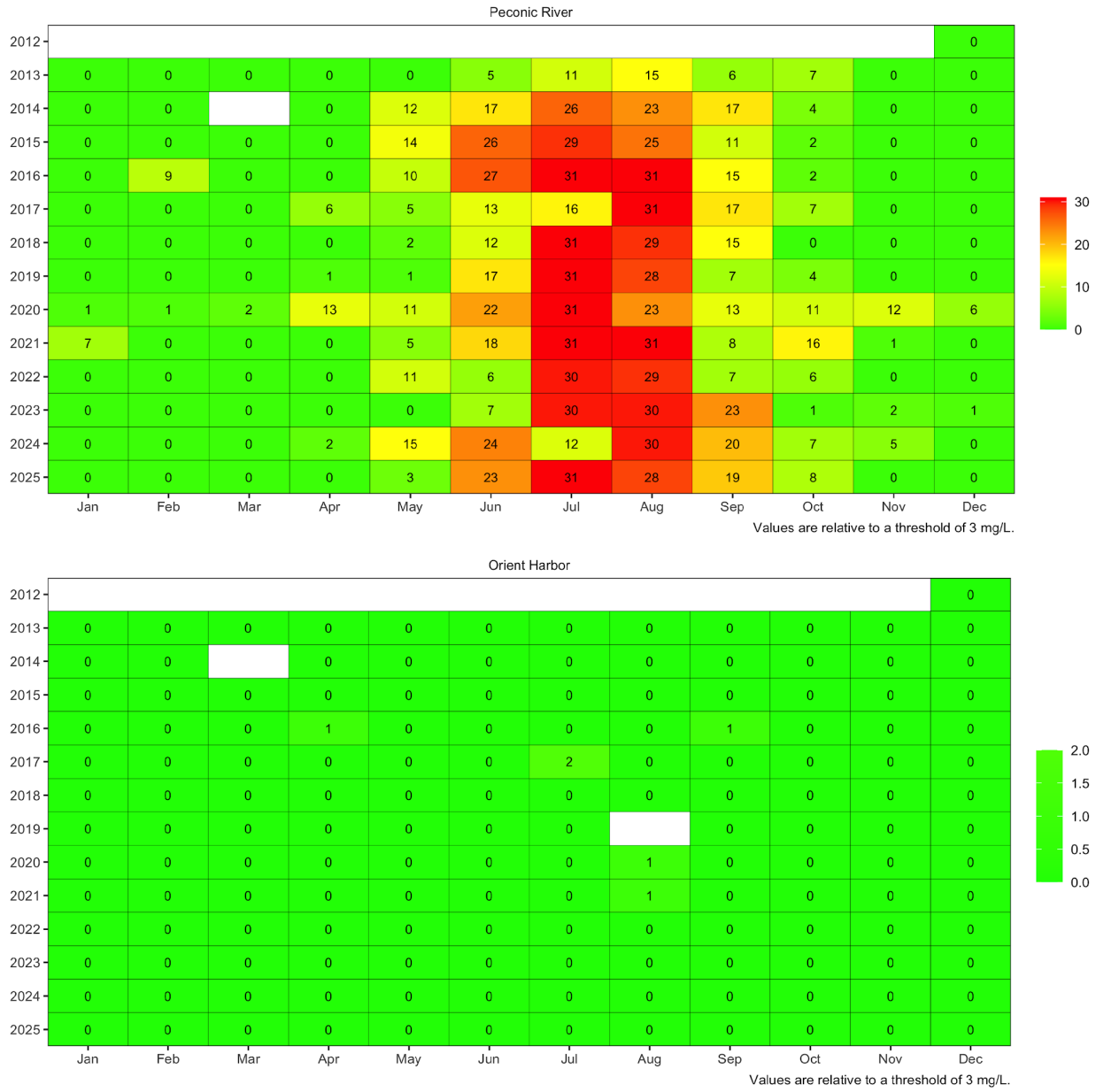


Figure 19. Stop light graphic for the Peconic River (top) and Orient Harbor (bottom) indicating the number days within a month when concentrations in a given day fell below the acute threshold of 3.0 mg/L

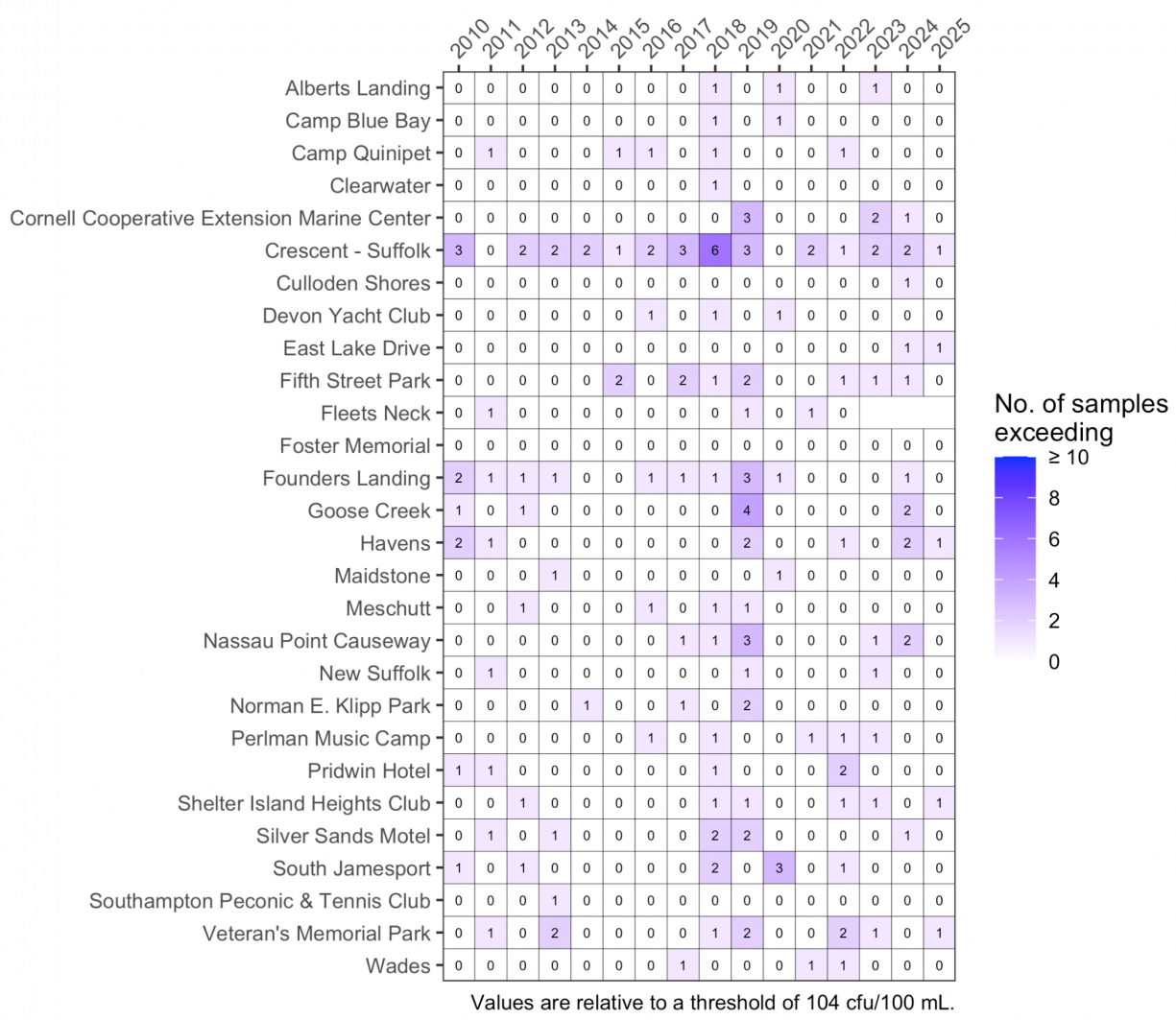
Figure 20. Stop light graphic for the Peconic River (top) and Orient Harbor (bottom) indicating the maximum number of sequential days in a month when concentrations in a given day fell below the chronic threshold of 4.8 mg/L.

Pathogens

Pathogens are viruses, bacteria, fungi, and protozoans that cause diseases in humans, other animals or plants. It is difficult to directly measure the concentration of specific pathogens in sea water due to the variable nature of their occurrence. Instead, the potential for the presence of human pathogens in the water is measured using bacterial indicator species. Fecal indicator bacteria, total and fecal coliform bacteria, originate in the intestines of warm-blooded animals. Their presence in the water indicates that the waste of a warm-blooded animal, which may include pathogens, has entered the water. A type of fecal indicator bacteria that is monitored at the Suffolk County bathing beaches in the Peconic Estuary is Enterococcus bacteria. The PEP's target for pathogens: Enterococcus counts at estuarine/marine swimming beaches should not exceed 104 colony forming units per 100 milliliter water sample (104 cfu/100mL). There were 5 occurrences of bathing beaches exceeding the criteria regarding acceptable levels of Enterococci adopted by the NYS Health Department (104 cfu/100mL) occurring at 5 different beaches in 2025**.** The Suffolk County Bathing beaches in the Peconic Estuary are overall clean. Note the beaches represented in the Report are only those beaches that are monitored by the SCDHS as part of the Bathing Beach Monitoring Program. The Suffolk County bathing beaches in the watershed are

Tier 2 and Tier 3 beaches- meaning the beaches have a moderate to low relative risk associated with their use.

Figure 21. Number of samples that exceeded enterococcus counts of 104 cfu/100 mL within 24 hours at bathing beaches from 2010-2025.



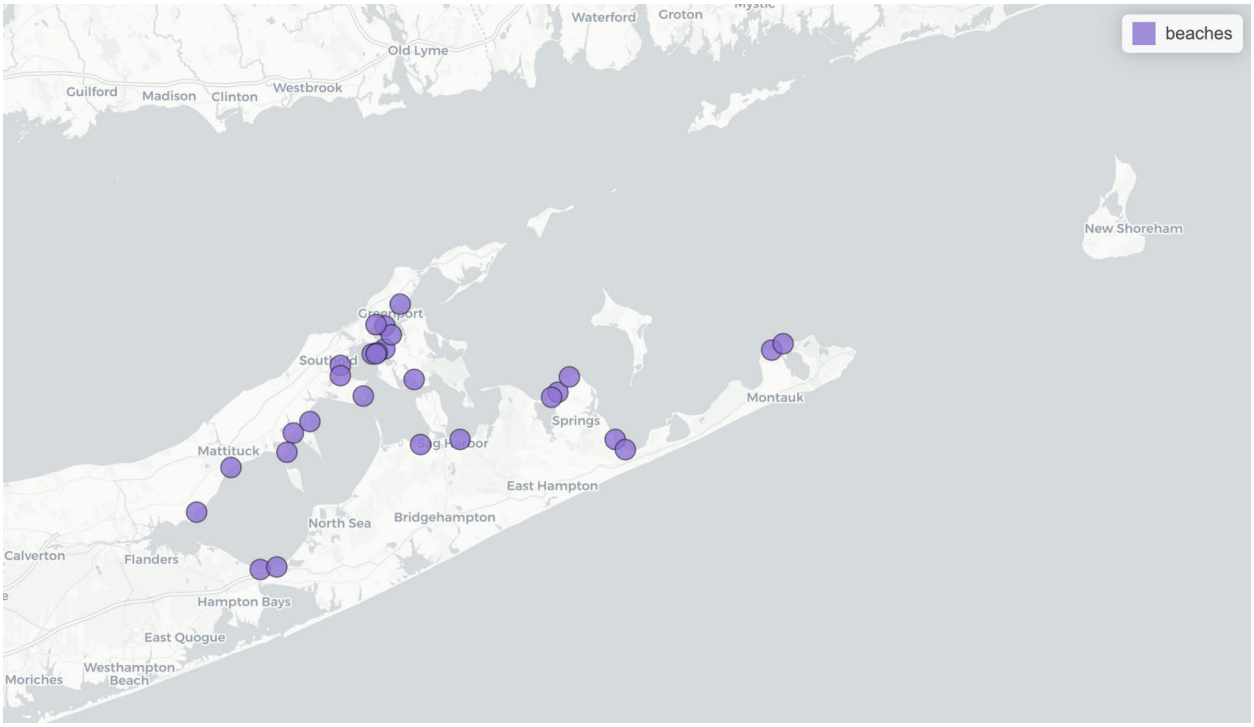


Figure 22. Pathogen exposure risk at Suffolk County bathing beaches in the Peconic Estuary from 2010-2025.

Harmful Algal Blooms

While harmful algal blooms have been a serious issue for the Peconic Estuary for more than 40 years, the past decade has seen a series of first ever events for the estuary regarding HABs including fish kills, turtle kills, and shellfish bed closures due to elevated levels of biotoxins from HABs. While excessive nutrient loading if often cited as the primary cause of HABs, this subject has been grossly under studies in the Peconic Estuary. This project was designed to address this informational short-coming defining the spatial and temporal variability of the three distinct HABs in the Peconic Estuary. *Alexandrium catenella* and *Dinophysis acuminata* can cause paralytic shellfish poisoning (PSP) and diarrhetic shellfish poisoning (DSP), respectively, and are known to bloom during the months of March through June in the Peconic Estuary. Meanwhile, *Margalefinidium polykrikoides*, formerly *Cochlodinium*, is an ichthyotoxic dinoflagellate that has caused finfish and shellfish kills during summer.

For this project, we monitored five locations in the Peconic Estuary (Meetinghouse Creek, Reeves Bay, Jockey Creek, Sag Harbor Cove, and Three Mile Harbor) as a time series from April through September, 2022-2025. We sought to fully characterize the nutrient regime within each site, before, during, and after these HABs. We then performed incubation experiments with water from these sites to assess the impact of added and reduced nitrogen (N) and phosphorus (P) concentrations on HAB growth.

In 2025, this project detected and documented the largest PSP event in the history of NYS and perhaps anywhere as *Alexandrium* densities exceeded 10 million cells per liter and shellfish samples during the bloom reached 2 mg saxitoxin per 100 g, both higher than any observation ever in NYS. This event also caused the longest shellfish bed closure in the history of NYS at four months, from April 16, 2025 for Town and Jockey Creeks and April 30th, 2025 for Goose Creek until August 5th, 2025.

During experiments performed for this project, nutrient enrichment with N, and to a far lesser extent P, could increase total algal biomass within all sites. N was also found to specifically stimulate each of the individual HABs. Nutrient levels in these systems, especially Meetinghouse Creek and Jockey Creek, were so high (> 30 µM nitrate + ammonium) that in many cases, nutrient reductions of 50% to 90% were needed to significantly reduce the intensity of these HABs, with reductions needed being both site and HAB specific. Additional work is needed to clarify spatial nutrient-HAB dynamics and to establish HAB-nutrient dynamics in other HAB prone regions. Ultimately, this project is generating data to support managerial recommendations on precise nutrient load reductions required to mitigate HABs within specific regions of the Peconic Estuary.

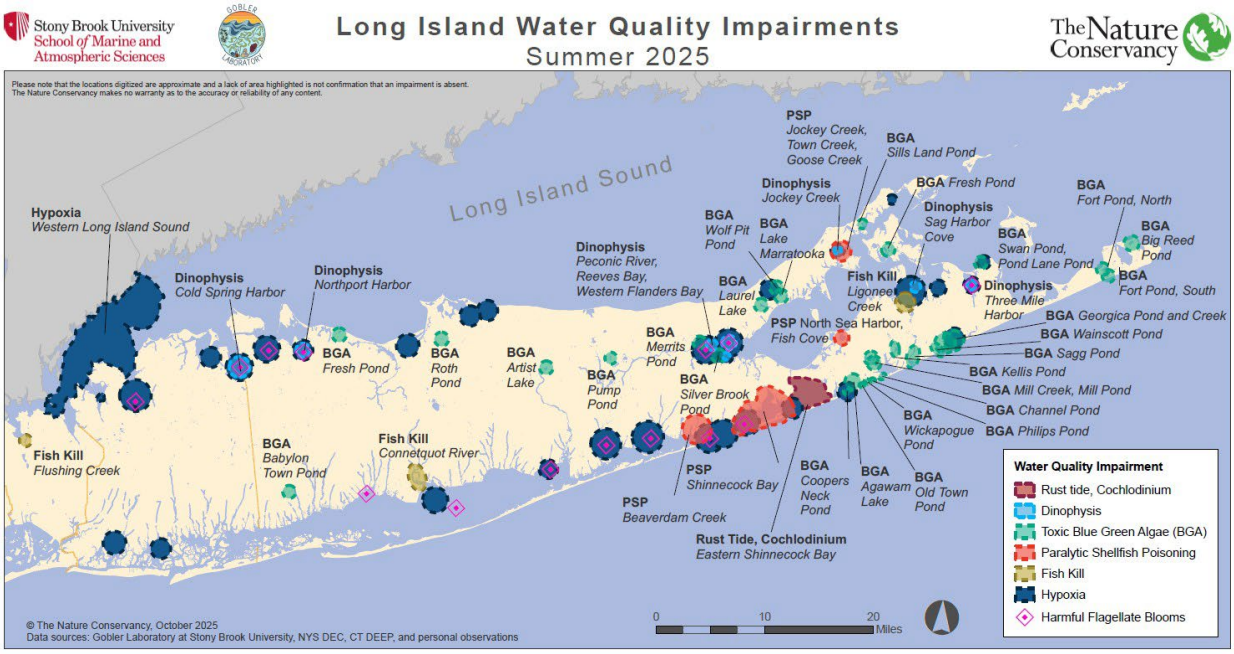


Figure 23. Long Island water quality impairments and harmful algal blooms during 2025.

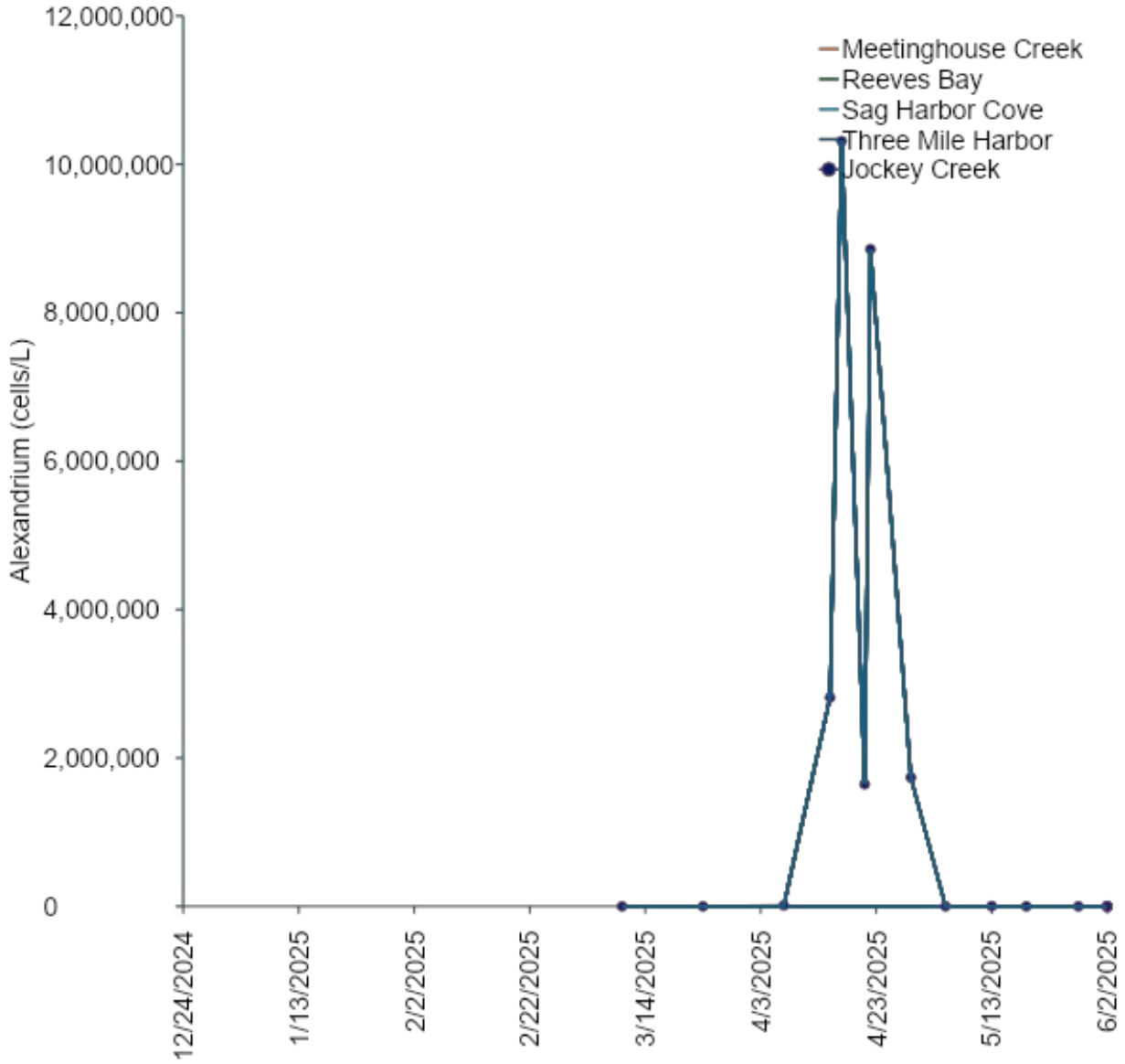


Figure 23. Cell densities of *Alexandrium catenella* across embayments within the Peconic Estuary in 2025.

Figure 24. *Alexandrium catenella* bloom in Jockey Creek.

Figure 25. Shellfish bed closures in Town, Jockey, and Goose creek effective April, 2025 and lasting through August 2025. Shellfish bed closures were a result of extremely high cell densities of *Alexandrium catenella*.

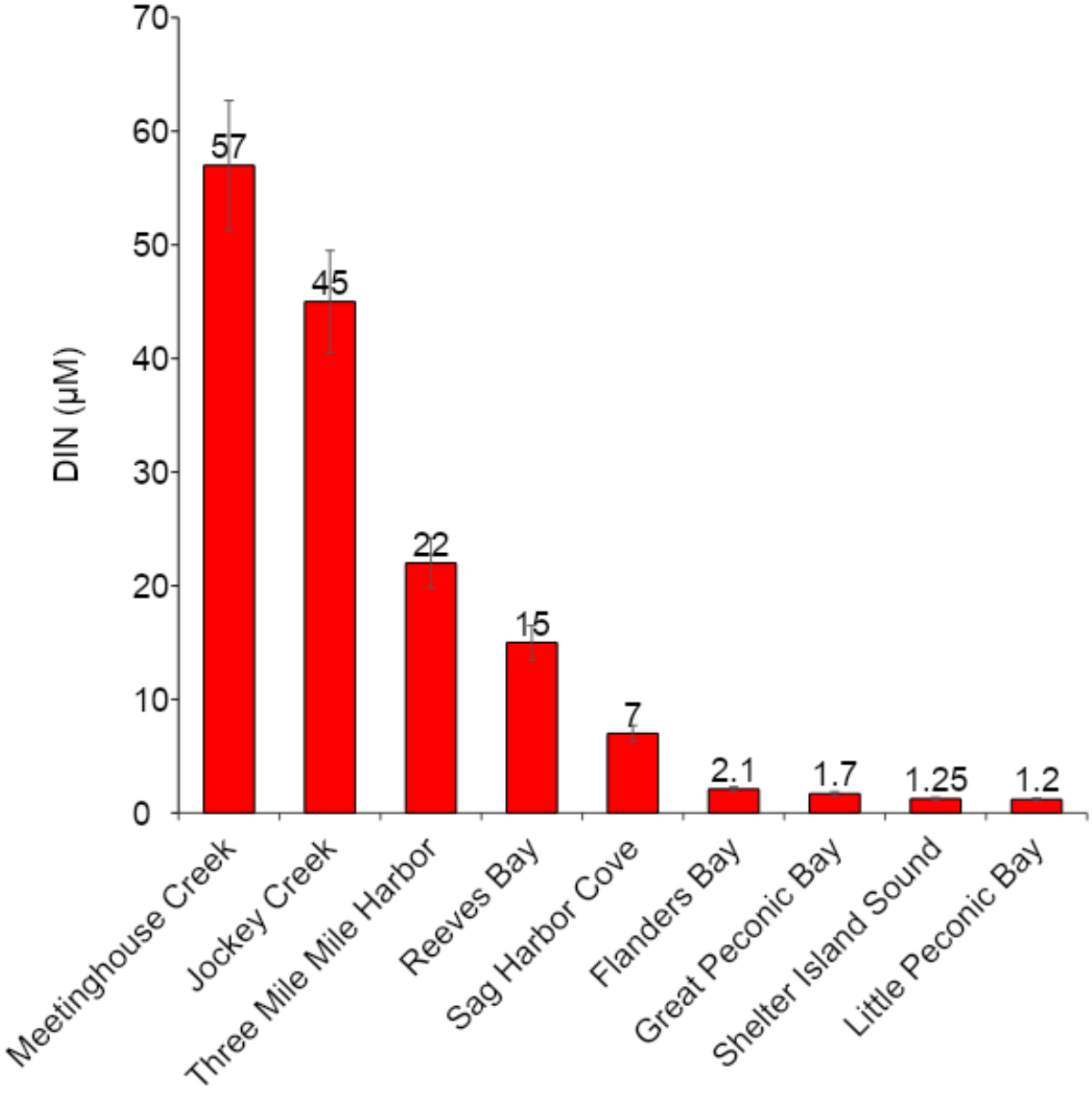


Figure 26. Dissolved inorganic nitrogen (DIN) concentrations across embayments during spring and summer of 2025.

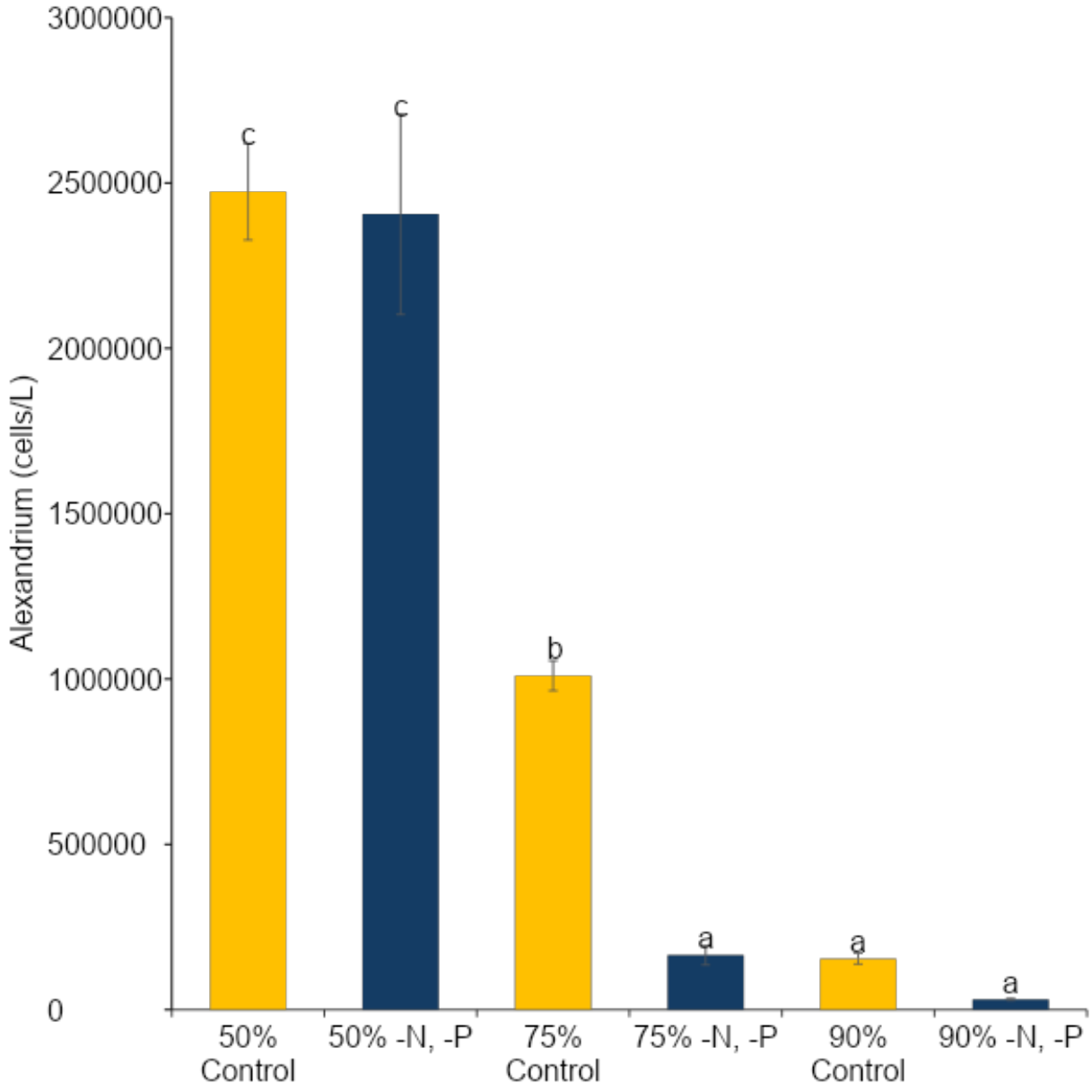


Figure 27. Percent nitrogen and phosphorous dilution required to reduce *Alexandrium* cell densities in water sources from Jockey Creek.