Choctawhatchee Bay 2024 Water Chemistry Report

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Contents

1 Introduction

1.1 Background

The Choctawhatchee Bay is a large estuary within the Floridian panhandle residing in Okaloosa and Walton Counties. The Choctawhatchee River and Bay system historically has supported a rich and diverse ecology housing a complex mosaic of freshwater and saltwater marsh habitats, unstructured sand flats, and expansive submersed aquatic vegetation (SAV) meadows comprised primarily of shoal grass *Halodule wrightii* and occasional wideon grass *Rupia maritima*. All serve as critical nursery habitats for ecologically and economically important fish and invertebrate species (FNAI, 2010). These characteristics, among others, have provided substantial economic and quality-of-life benefits to local residents (Northwest Florida Water Management District, 1996). It is therefore no surprise that the Choctawhatchee Bay area has become a highly desired area for relocation, particularly compared to localities in southern Florida which are commonly perceived as overly developed. Indeed, the estuary, at least in part, may be responsible for observed population trends in Walton County Florida, which is one of the fastest growing counties in the state (U.S. Census Bureau 2024).

The Choctawhatchee River supplies approximately 90% of freshwater input to the Bay system, with minor secondary inflows from multiple bayous (NWFWMD, 1996; Livingston, 2010). The river has an average annual discharge of 6,948 cubic feet per second (cfs) near the discharge into bay, the third largest in Florida (Northwest Florida Water Management District, 1996). The river begins in southern Alabama and extends into Florida and southward to the Gulf of Mexico. Within Florida, the watershed (total area which surface water runoff drains into the Bay) encompasses all of Holmes County, as well as large portions of Walton and Washington counties, with smaller, but significant portions occurring in Okaloosa, Bay, and Jackson counties (Fig. 1). Among states, 41% of the watershed falls within Florida state lines while the remaining 59% falls within Alabama.

Meanwhile, an influential pass to the Gulf of Mexico (East Pass) in the western region, immediately west of the City of Destin (Fig. 1) is currently the dominant connection to the marine realm and supplies the majority of saline water to the ecosystem. This has not always been the case. Historically, marine waters entered the Bay only through sporadic breaks in the barrier islands located within what is now the Destin Harbor (Hemming and Brown, 2004), functioning similar to intermittently connected lakes and lagoons found in Australia, South Africa, New Zealand, and Walton County, Florida (McSweeny et al., 2017; Hyman and Stephens, 2020). However, artificial opening of the estuary began in 1929 to alleviate flooding when the intermittent openings alone were insufficient. East Pass is now maintained by the U.S. Army Corps of Engineers to provide a permanent connection to the Gulf of Mexico. This has substantially altered the hydrology of the estuary; resulting in increased salinity and the subsequent loss of freshwater marshes as well as SAV throughout the Bay (Ruth and Handley, 2002; Livingston, 2010). Additionally, the Choctawhatchee Bay retains hydrologic connectivity in the east with the St. Andrews Bay system in the neighboring Panama City Beach, Florida, via the Gulf Intracoastal Waterway (GIWW), and in the west to East Bay in the Pensacola Bay system via the Santa Rosa Sound (Blaylock, 1983).

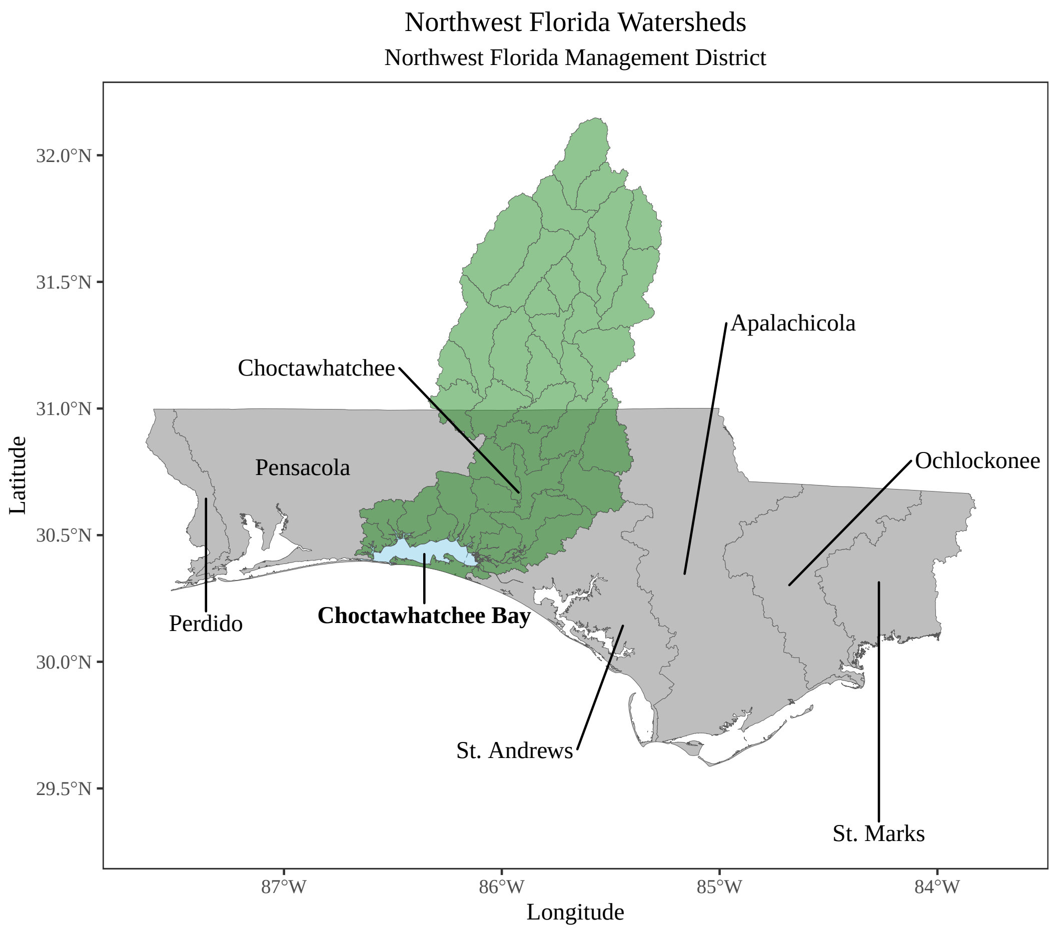

Figure 1: Map of Choctawhatchee Bay (blue), Choctawhatchee watershed (green), and surrounding watersheds in Northwest Florida

1.2 Importance of monitoring

Due in large part to their delicate balance of fresh and saltwater mixing and the unique water chemistry properties that result, estuaries are susceptible to habitat destruction from humans. In addition to alterations to salinity regimes, estuaries can be damaged or destroyed by shifts in water chemistry through changes in the runoff supplying them. This primarily occurs through alterations in land-use, such as development, which can alter the balance of nutrients such as nitrogen and phosphorus washing into the habitat (e.g., Hyman and Stephens, 2020). In addition to direct effects of nutrient increases on aquatic systems, nutrients may also indirectly affect physicochemical variables such as dissolved oxygen and water acidity. Such alterations in water chemistry frequently result in loss of aquatic and semi-aquatic habitat, which drive cascading changes to local animal communities and can substantially affect local economies. Consequently, it is important for both ecological and economic reasons to protect this fragile habitat through vigilant water quality monitoring of both nutrient and physicochemical variables to ensure these balances are maintained. The Choctawhatchee Basin Alliance (CBA) water quality monitoring program is an extensive monitoring effort that covers 135 stations throughout the Choctawhatchee Bay watershed, Choctawhatchee Bay and River, Walton County coastal dune lakes, small tributaries, and freshwater lakes. Citizen scientist volunteers are a vital component of the program, helping to collect data on over 75% of CBA's water quality monitoring stations.

1.3 Numeric nutrient criteria

Numeric nutrient criteria are quantitative expressions of water quality management goals, established by the US Environmental Protection Agency (EPA) and the Florida Department of Environmental Protection (FDEP, 2010). These criteria serve as numeric thresholds for water chemistry nutrients nitrogen, phosphorus, and chlorophyll and are derived based on numerous considerations. For example, distance from the marine realm is an important factor, as upland freshwater tends to be naturally nutrient enriched from runoff absorbing sediments and decaying organic material as it flows across watersheds, especially compared to marine waters, which tend to be relatively nutrient depleted. When measurements of nitrogen and phosphorus routinely exceed numeric nutrient criteria allowed in monitoring locations, it is cause for apprehension among managers concerned with anthropogenic eutrophication of water chemistry, and may be indicative of waterbody impairment (i.e., poor estuarine health).

1.4 Numeric nutrient criteria for the Choctawhatchee Bay

Estuary-specific numeric nutrient criteria set by FDEP's surface water quality standards delineate 11 water chemistry regions (4 major, 7 lesser) in the Choctawhatchee Bay (Fig. 2). The concentration-based estuary interpretations are open water, area-wide averages. The interpretations are expressed as load per million cubic meters of freshwater inflow and indicate the total allowable load of a nutrient (i.e., total nitrogen, total phosphorus, and total chlorophyll) to the estuary region divided by the total volume of freshwater inflow to that estuary region. All bay regions possess criteria expressed as annual geometric means (AGM), indicating that these values shall not be exceeded more than once in a three-year period.

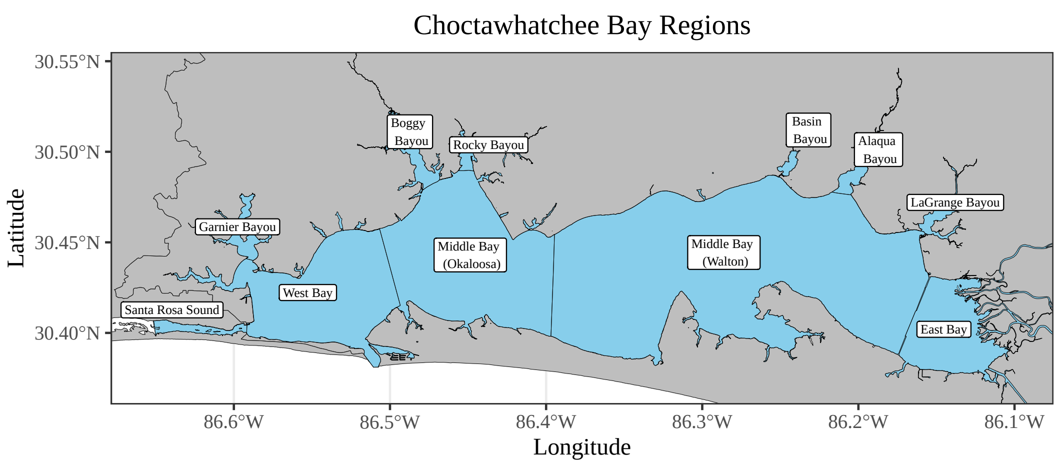

Figure 2: DEP estuarine regions in the Choctawhatchee Bay. Individual stations are included in the individual region results.

The Choctawhatchee River and Bay watersheds fall under the jurisdiction of multiple local and county governments. These entities not only manage natural resources, but also shape their expression across the landscape by establishing conservation lands, implementing land use and land management regulations, and establishing best management practices that directly influence water quality and habitat integrity. The middle region of the Choctawhatchee Bay falls between two regional municipalities, Okaloosa and Walton Counties. As a result the middle region has been divided into two sub-regions, Okaloosa-Middle and Walton-Middle, highlighting the regional authorities responsible for these areas.

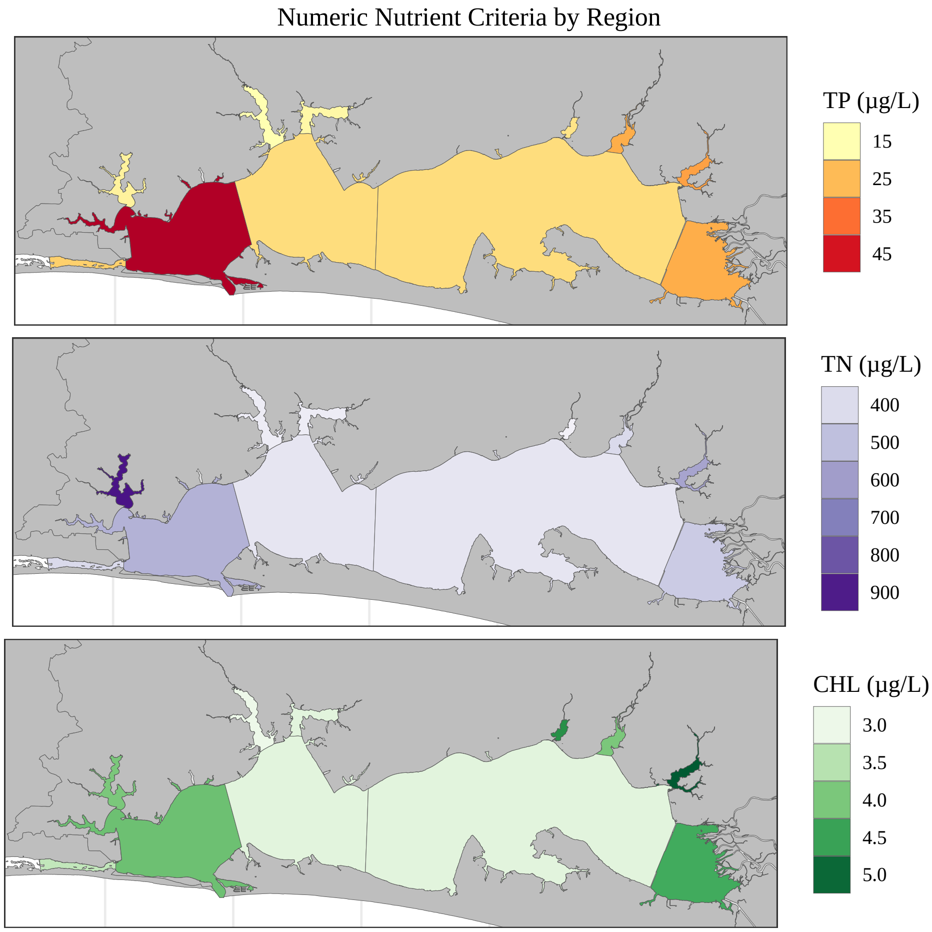

Figure 3: Map displaying DEP numeric nutrient criteria zones for Walton and Okaloosa counties. Top: total phosphorus, middle: total nitrogen, bottom: total chlorophyll. Numeric nutrient criteria for the Choctawhatchee River are not included because adding this region to the map would compress the Choctawhatchee Bay, reducing interpretability. Total phosphorous and total nitrogen thresholds for the Choctawhatchee River are 60 and 670 (µg/L), respectively. There is no total chlorophyll threshold for the Choctawhatchee River.

1.5 Objectives

The major objective of this report is to summarize annual spatial patterns in water chemistry for 2024 within the Choctawhatchee Bay and River.

2 Methods

A combination of physical and chemical variables were collected at each water quality monitoring station. Open water surface samples were collected in the field by Choctawhatchee Basin Alliance (CBA) staff and citizen scientists. Water samples were analyzed for total phosphorus and total nitrogen, total chlorophyll, true color, and conductivity at the Florida LAKEWATCH laboratory, located at University of Florida's Institute of Food and Agricultural Sciences. Sample collection, storage, transportation, and water chemistry analyses followed Florida LAKEWATCH Standard Operating Procedures (Hoyer and Brown, 2017) in Gainesville, Florida. In the field, at monitoring sites where water samples were collected, staff and citizen scientists also estimated water transparency data by use of a Secchi disk. A multi-variable data sonde was used to collect surface and bottom temperature, dissolved oxygen, pH, salinity, and turbidity.

2.1 Water samples

- One, 250-mL, acid-cleaned, triple-rinsed opaque plastic bottle was used to collect a water sample analyzed for total phosphorus (µg/L) and total nitrogen (µg/L).
- One, 1000-mL, opaque plastic bottle was used to collect a water sample for total chlorophyll analysis.
- Secchi Disk — Measures the attenuation of light within the water column, or transparency, in meters.

2.1.1 Nutrient parameters

- **Total Phosphorus (µg/L)** — Sum of all phosphorus compounds in the water column, organic and inorganic, at the time of collection. phosphorus is an essential nutrient for alga and plant growth.
- **Total Nitrogen (µg/L)** — Sum of the all nitrogen compounds in the water column, organic and inorganic, at the time of collection. Nitrogen is an essential nutrient for alga and plant growth.

2.1.2 Algal concentration estimation

- **Total Chlorophyll (µg/L)**— Sum of all chlorophyll (common pigment found in alga frequently used as a proxy for aquatic flora abundance) in the water column at the time of sampling. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here.

2.2 In-situ water chemsitry monitoring

Multi-probe data sondes (Hydrolab Quanta 1996-2022; YSI ProDSS 2022-present) measured physical and chemical variables temperature (C), dissolved oxygen (mg/L), pH, and salinity (ppt).

- **Temperature ($^\circ$C)** — Temperature of the waterbody in degrees Celsius.
- **Dissolved oxygen (mg/L)** — Concentration of dissolved oxygen in water.
- **pH** — Measurement of hydrogen ions within the water indicating the level of acidic or basic condition of the waterbody.
- **Salinity (ppt)** — Measurement of dissolved sodium chloride content in the water. Measurements recorded in parts per thousand.

2.3 Morphometry

Metrics for the Choctawhatchee Bay morphological characteristics were derived from the Northwest Florida Water Management District and the USGS National Hydrological Dataset. The Choctawhatchee Bay exhibits a morphological pattern typical of drowned river valleys (Roy et al., 2001). The estuary has an approximate length of 50 kilometers (km), and a width varying between 2 and 10 km (Fig. 4). Meanwhile, its watershed encompasses nearly 1.4×10^4 square kilometers (km^2) and spans portions of northwest Florida (41%) and southern Alabama (59%). The surface area of the Bay is approximately 360 km^2. Water depths range from 0 to 14 meters (m), with a mean depth of 4.8 m, and an average volume of 1.728 km^3. The Bay has shallow shelves along its shorelines which belie relatively steep slopes to deeper waters. Average depths in eastern portions reach 3 m, gradually increasing longitudinally to 10 m in western potions of the Bay, which house the deepest waters in the estuary.

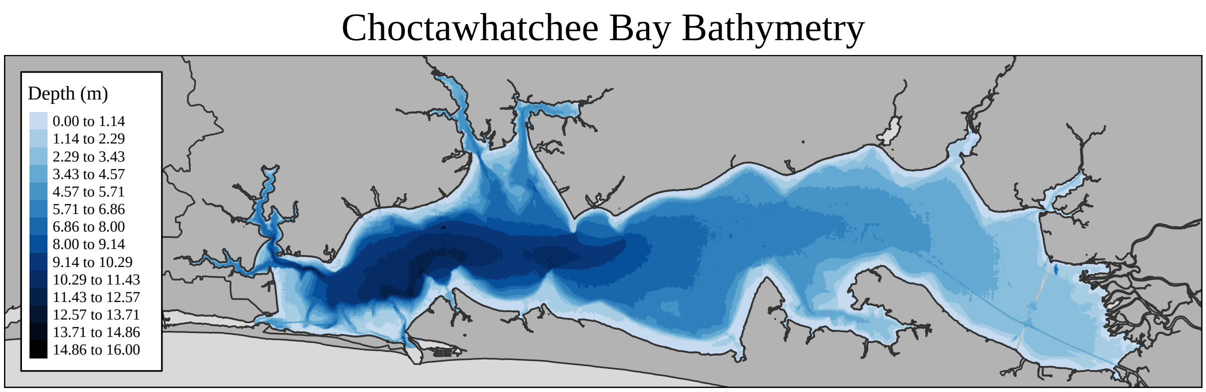

Figure 4: Map bathymetry of the Choctawhatchee Bay

2.4 Analyses

2.4.1 Trend analysis

While trophic state indices are useful for evaluating the current health of an estuary, often managers are interested in whether estuarine health is improving or deteriorating over time. Trend analyses are commonly used to evaluate changes in water quality parameters over time to assess long-term estuary health. CBA uses Kendall Rank Correlation Test to assess trends over time.

$$T = \frac{C - D}{C + D}$$

Where T represents the trend and is a function of C (the concordant pairs minus) D (the number of discordant pairs), divided by the sum of C and D. Essentially, it measures how often an increase in one variable corresponds to an increase in another variable. T values approaching one indicate a **strong positive trend**, while T values approaching negative one indicate a **strong negative trend**, and T values near zero indicate **no trend**. For this report, we use the last 10 years of data for each station to inform our analysis ($n \approx 120$).

2.4.2 Spatial patterns

A common phenomenon in spatially indexed (i.e., georeferenced latitude and longitude coordinates) data is that measurements from samples geographically closer together are often more similar than those of samples farther apart. This pattern is attributed to spatially varying unmeasured variables which influence observations in variables of interest. To correctly model spatial patterns, these latent variables must be accounted for in the form of a dependence structure. Here, this is accomplished with kriging (or Gaussian process regression), which is a method of spatial modeling for which the interpolated values are modeled by a Gaussian process (linear or nonlinear trend) governed by covariances, or dependence relationships of spatially autocorrelated data. By accounting for spatial dependence in the form of a covariance function, kriging gives the best linear unbiased estimator (BLUE) of the intermediate values. Kriging can be thought of as a linear (or nonlinear) model with a spatially correlated residual error structure (Pebesma 2004).

$$y(s) = \beta_0 + \beta_1 x_1(s) + \beta_2 x_2(s) + ... \beta_i x_i(s) + \Sigma(s) + \epsilon(s)$$

where

- (s) denotes the spatial indexing of the data
- $y(s)$ denotes the spatially indexed response variable to be predicted
- β_0 denotes the intercept
- $x_i(s)$ denote spatially indexed explanatory variables 1 to i
- β_i denote linear estimates of slope coefficients of predictors
- $\Sigma(s)$ denotes the covariance matrix describing dependence among measurement values
- $\epsilon(s)$ denotes the residual error (white noise) with a mean of 0 and a variance of σ^2

Covariance matrix estimation Covariance matrices are modeled by fitting a covariance function to the data. Dependence of spatial data usually decays asymptotically: after a certain distance, the measurements of one point no longer influence the measurements of another. Covariance functions are fit by examining variograms, or scatter plots of the difference in measurements of two points and the geographic distance between points. All covariance functions modeled for variables considered here were exponential covariance functions, indicating that spatial dependence exponentially decayed to 0 as geographic distances between points approached a specified value.

Best linear unbiased estimators (BLUE) Best linear unbiased estimators (BLUE) represent the linear coefficients (intercept and slopes) once spatial covariance is estimated. BLUE, standard errors, and 95% confidence intervals are listed for each water chemistry variable of interest.

2.4.3 Water chemistry tables

Summary statistics for both 2024 and for long-term time-spans (2003 - 2024) are included in this report.

For 2024 summary statistics, mean, maximum (Max), minimum (Min), and standard error (Std Error) are reported for temperature (top and bottom), dissolved oxygen (top and bottom), pH (top and bottom), salinity (top and bottom), total phosphorus (TP), total nitrogen (TN), and total chlorophyll (CHL) measurements.

For long-term (2003 - 2024) summary statistics, mean, maximum, minimum, and standard error (Std Error) are reported on an annual basis using monthly data for dissolved oxygen, pH, salinity, total phosphorus (TP), total nitrogen (TN), and total chlorophyll (CHL). 10-year trends determined using Kendall's Rank Order Correlation Test (Kendall's Tau) are also reported. Significant ($\alpha = 0.05$) trends are indicated as increasing trend in a variable over time (**Increasing**) or decreasing trend in variable over time (**Decreasing**). Trends that are not statistically significant are identified as a period. Results are summarized both in the **Long-Term Trends** table for all regions, as well as in the **Long-Term Water Chemistry** tables for each region individually.

2.4.4 Trophic state index

The trophic state index is a classification system that is used to estimate the biological productivity of a waterbody based on concentrations of **chlorophyll**, **phosphorus**, and **secchi disk**. It is defined as the total weight of living biological material (biomass) in a waterbody at a specific location and time. Algal biomass is the most common basis for trophic state classification

- **Equation 1 (chlorophyll)**: $\text{TSI}_{CHL} = 9.81 \cdot \ln(CHL) + 30.6$
- **Equation 2 (phosphorus)**: $\text{TSI}_{TP} = 14.42 \cdot \ln(TP) + 4.15$
- **Equation 3 (secchi disk)**: $\text{TSI}_{SD} = 60–14.41 \cdot \ln(SD)$

Note that the *best* trophic state indicator is **chlorophyll**, so we use **Equation 1** as our metric for TSI. This is because chlorophyll is directly related to algal biomass.

Trophic state classification

- **TSI <40: Oligotrophic** - Clear, oxygen-rich water within minimal algal biomass
- **TSI 40-50: Mesotrophic** - Water moderately clear; increasing probability of anoxia (lack of oxygen) during summer at deeper depths; moderate algal biomass
- **TSI 50-70: Eutrophic** - Cloudy water characterized by high levels of algal biomass and anoxia at depth; possibly indicative of nutrient problems
- **TSI 70+: Hyper-Eutrophic** - Water characterized by dense mats of algal scum floating on top of the water; water very murky and almost perpetually anoxic at depth; region may be impaired

2.4.5 Analysis changes

Over time, incremental changes in the development of annual reports have led to differences in water chemistry summary statistics and time series for key waterbodies. Beginning in 2024, modifications to the formal analysis workflow are documented as follows.

- **2024 Data Cleaning**: Prior to 2024, data points falling outside the 95% interdecile range at each station were automatically flagged and excluded from analyses. This dynamic filtering introduced inconsistencies in regional time series: as new data were added, previously flagged outliers could appear more extreme—prompting their exclusion—or less extreme—resulting in their retention. These shifting criteria subtly altered long-term trends. To ensure consistency, reports produced from 2024 onward no longer apply automatic outlier removal. Instead, potential outliers are identified during a dedicated pre-processing step and evaluated manually by the analyst.

3 Results

3.1 Long-term trends

Long term trends in top and bottom physical water chemistry variables in the Choctawhachee Bay are found in Table 1 and Table 2, while trends in nutrient variables total phosphorus (TP), total nitrogen (TN), total chlorophyll of are displayed in Table 3. 10-year trends were determined using Kendall's rank order correlation analysis (Kendall's Tau). Significant trends are indicated with increasing trend in variable over time ("Increase") or decreasing trend in variable over time ("Decrease"). Trends that are not statistically significant ($\alpha = 0.5$) are identified as "." in table below.

Table 1: Ten Year Trends of Choctawhatchee Bay Water Chemsitry Variables (Surface)

	Temp (C)	DO (mg/L)	pH	Salinity (ppt)
East Bay	.	Increasing	.	.
Middle Bay (Walton)	.	.	.	Increasing
Middle Bay (Okaloosa)	.	Increasing	Decreasing	.
West Bay	.	.	Decreasing	Increasing
LaGrange Bayou	.	.	.	Increasing
Alaqua Bayou	.	.	.	.
Basin Bayou	.	.	Increasing	Increasing
Rocky Bayou	.	.	.	Increasing
Boggy Bayou	.	.	.	Increasing
Garnier Bayou	.	.	Decreasing	Increasing
Santa Rosa Sound	.	.	.	Increasing

Table 2: Ten Year Trends of Choctawhatchee Bay Water Chemsitry Variables (Bottom)

	Bottom Temp (C)	Bottom DO (mg/L)	Bottom pH	Bottom Salinity (ppt)
East Bay	.	.	.	Increasing
Middle Bay (Walton)	.	.	.	Increasing
Middle Bay (Okaloosa)	.	Increasing	.	Decreasing
West Bay	.	Increasing	.	.
LaGrange Bayou	.	.	.	.
Alaqua Bayou	.	.	.	Increasing
Basin Bayou	.	.	Increasing	Increasing
Rocky Bayou	.	.	.	Increasing
Boggy Bayou	.	Increasing	.	.
Garnier Bayou	.	.	.	Increasing
Santa Rosa Sound	.	.	.	Increasing

3.2 Bay-wide spatial patterns for 2024

Universal kriging models of averaged salinity, pH, bottom dissolved oxygen, phosphorus, nitrogen, and chlorophyll exhibit marked spatial structure oriented primarily along the east-west latitudinal gradient (Fig. 5 and 6). This gradient is a result of the orientation of the Choctawhatchee River in the east supplying nutrient-rich, low pH, low salinity water, and the East pass supplying high salinity, elevated pH, and nutrient-poor waters in the west and are consistent with previous work (Hoyer et al. 2013).

Table 3: Ten Year Trends of Choctawhatchee Bay Nutrient Variables

	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Total Chlorophyll (µg/L)
East Bay	.	Decreasing	.
Middle Bay (Walton)	.	Decreasing	.
Middle Bay (Okaloosa)	Increasing	Decreasing	.
West Bay	.	Decreasing	Decreasing
LaGrange Bayou	.	Decreasing	.
Alaqua Bayou	.	Decreasing	.
Basin Bayou	.	Decreasing	.
Rocky Bayou	Increasing	Decreasing	.
Boggy Bayou	Increasing	.	.
Garnier Bayou	.	Decreasing	Decreasing
Santa Rosa Sound	.	Decreasing	Decreasing

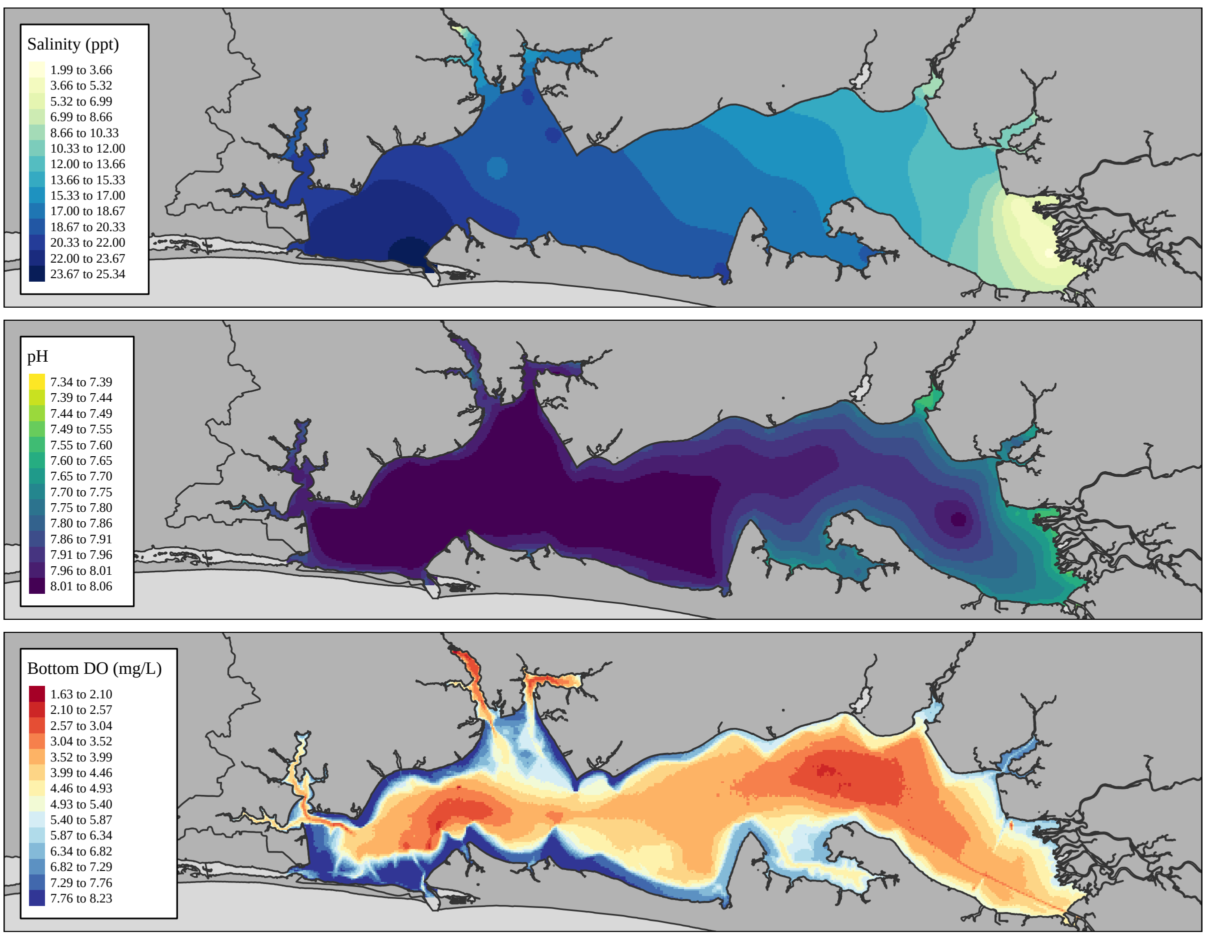

Figure 5: Maps displaying water chemistry variables salinity (top), pH (middle), and bottom dissolved oxygen (bottom) averaged across months for each CBA station within the Choctawatchee Bay. Raster imagery generated from universal kriging models.

Salinity and pH in the Choctawhatchee Bay decreased as function of linear distance (km) from the East Pass and increased as a function of log-transformed distance from shoreline with spatially autocorrelated errors

(Fig. 5; Table 4 and 5). Declining salinity values with increasing distance from East Pass is unsurprising, as this is the primary source of seawater in the Choctawhatchee Bay. Similarly, surface seawater pH is elevated compared to surface pH of Florida freshwater.

Table 4: Best Linear Unbiased Predictor Estimates of intercept and predictors for salinity

	BLUE	Std. error	Lower	Upper
Intercept	23.429	10.392	3.061	43.796
Distance from East Pass (m)	-0.389	0.004	-0.397	-0.381
log-transformed Shore distance (m)	0.066	0.258	-0.440	0.572

Divergence in pH of seawater and freshwater is most apparent when comparing seawater to acidic fluvial waters dominated by high dissolved organic carbon content driven by water input from the surrounding watershed (Hyman and Stephens 2020). However, while the dominant source of freshwater in the Choctawhatchee Bay is the Choctawhatchee River, roughly 10% of freshwater supplied to the Bay is derived from other sources from shoreline runoff or smaller tributaries. This explains the positive gradient in pH and salinity as a function of distance from shoreline, as localities in the middle of the system are insulated from perturbations in water chemistry due to runoff relative to localities closer to shore.

Table 5: Best Linear Unbiased Predictor Estimates of intercept and predictors for pH

	BLUE	Std. error	Lower	Upper
Intercept	7.686	0.008	7.670	7.701
Distance from East Pass (m)	-0.009	0.000	-0.009	-0.009
log-transformed Shore distance (m)	0.062	0.000	0.062	0.062

Meanwhile, bottom dissolved oxygen within the Choctawhatchee Bay is primarily a function of depth (Fig. 5; Table 6). Oxygen enters the water column as a byproduct of photosynthesis via phytoplankton or through diffusion along the air-sea boundary. As a result, dissolved oxygen usually declines with increasing distance from the surface. However, heterotrophic bacteria in water can consume oxygen as organic matter decays, which can exacerbate poor bottom dissolved oxygen conditions if excessive nutrients in the water column trigger algal blooms. Dissolved oxygen is typically measured as a metric of "health" in the water column. Comparisons of spatial distributions of bottom dissolved oxygen through time may help identify deteriorating waterbody conditions.

Table 6: Best Linear Unbiased Predictor Estimates of intercept and predictors for bottom dissolved oxygen

	BLUE	Std. error	Lower	Upper
Intercept	6.857	0.618	5.646	8.068
Depth (m)	-0.534	0.009	-0.550	-0.517

It should be noted that while patterns in bottom dissolved oxygen largely mirrored patterns in bathymetry (Fig. 4), several anomalies were present, such as low oxygen localities in shallower depths in the eastern portion of the Bay (Fig. 5).

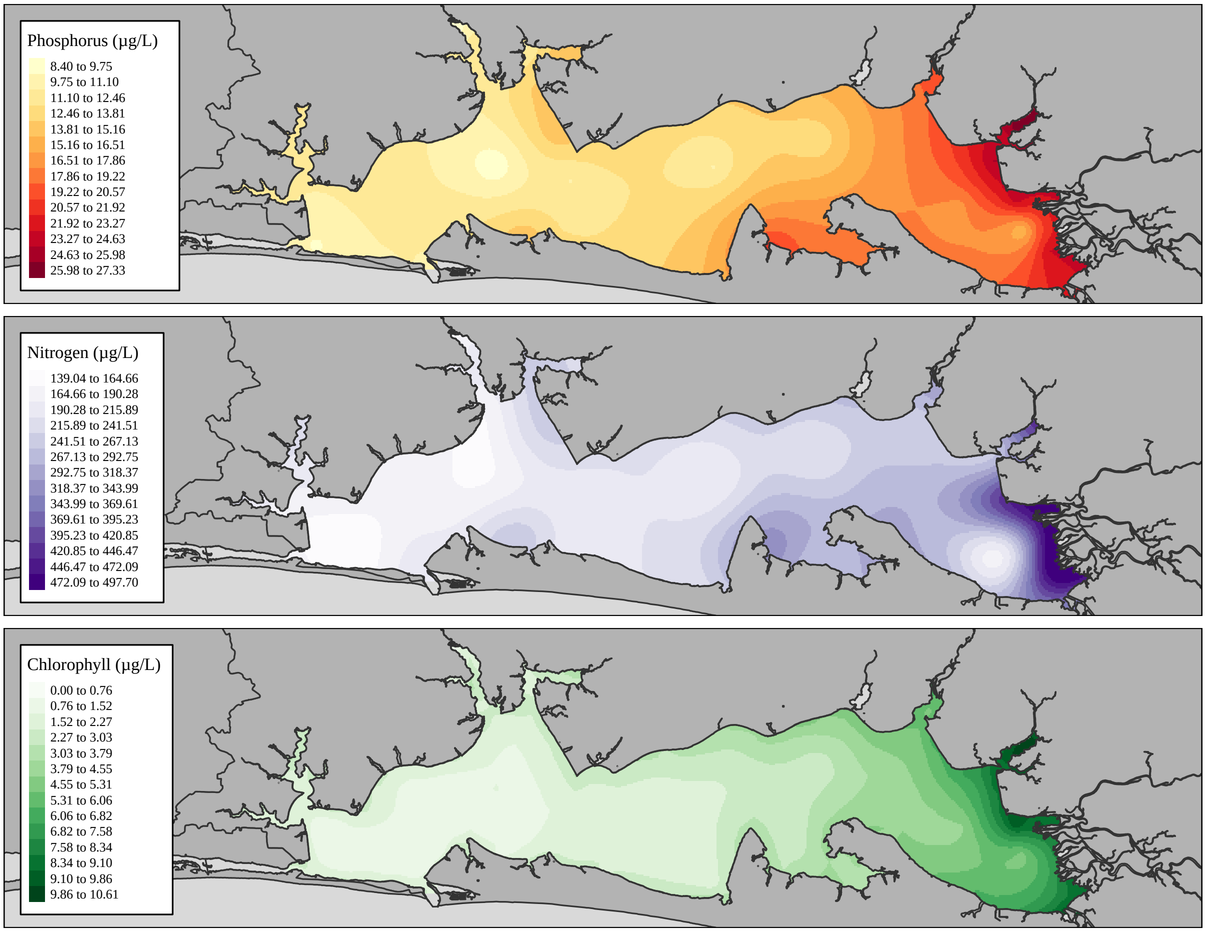

Figure 6: Maps displaying water chemistry variables total phosphorus (top), total nitrogen (middle), and total chlorophyll (bottom) averaged across months for each CBA station within the Choctawhatchee Bay. Raster imagery generated from universal kriging interpolation algorithm models.

Table 7: Best Linear Unbiased Predictor Estimates of intercept and predictors for total phosphorus

	BLUE	Std. error	Lower	Upper
Intercept	8.531	4.872	-1.017	18.080
Distance from East Pass (m)	0.362	0.010	0.342	0.381

Similar to salinity and pH, nutrient variables nitrogen and phosphorus exhibited latitudinal patterns oriented along the freshwater-seawater interface, although in the opposite direction (Fig. 6; Tables 7 and 8). Gradients of increased nitrogen and phosphorus concentrations at landscape scales, moving from open ocean to estuarine to inland river systems have been established (Frazer et al. 2001; Hoyer at el. 2013) and are generally attributed to the differences in relative concentrations of nutrients between seawater (nutrient poor) and freshwater (nutrient rich).

Finally, chlorophyll increased with distance from East Pass (Fig. 6, Table 9). This is largely a function of patterns in nutrient variables. Interestingly, chlorophyll also decreased with distance from shoreline. Similar to salinity and pH, localities in the middle of the system are insulated from perturbations in water chemistry due to runoff relative to localities closer to shore, and may be more nutrient depleted.

However, this spatial trend was not observed in nitrogen and phosphorus in exploratory data analyses, and

Table 8: Best Linear Unbiased Predictor Estimates of intercept and predictors for total nitrogen

	BLUE	Std. error	Lower	Upper
Intercept	144.238	556.752	-946.995	1235.472
Distance from East Pass (m)	5.657	1.229	3.248	8.066

Table 9: Best Linear Unbiased Predictor Estimates of intercept and predictors for total chlorophyll

	BLUE	Std. error	Lower	Upper
Intercept	3.135	0.825	1.518	4.752
Distance from East Pass (m)	0.185	0.000	0.184	0.185
log-transformed Shore distance (m)	-0.497	0.020	-0.536	-0.457

distance from shoreline was removed from consideration in the final models for these variables. It is possible that similar patterns (distance from shoreline) are present in nitrogen and phosphorus, but were too weak to be reliably detected with the statistical power of our sampling design. Alternatively, spatial distribution of additional micro-nutrients not sampled may be responsible for these trends.

3.3 Region 1: East Bay

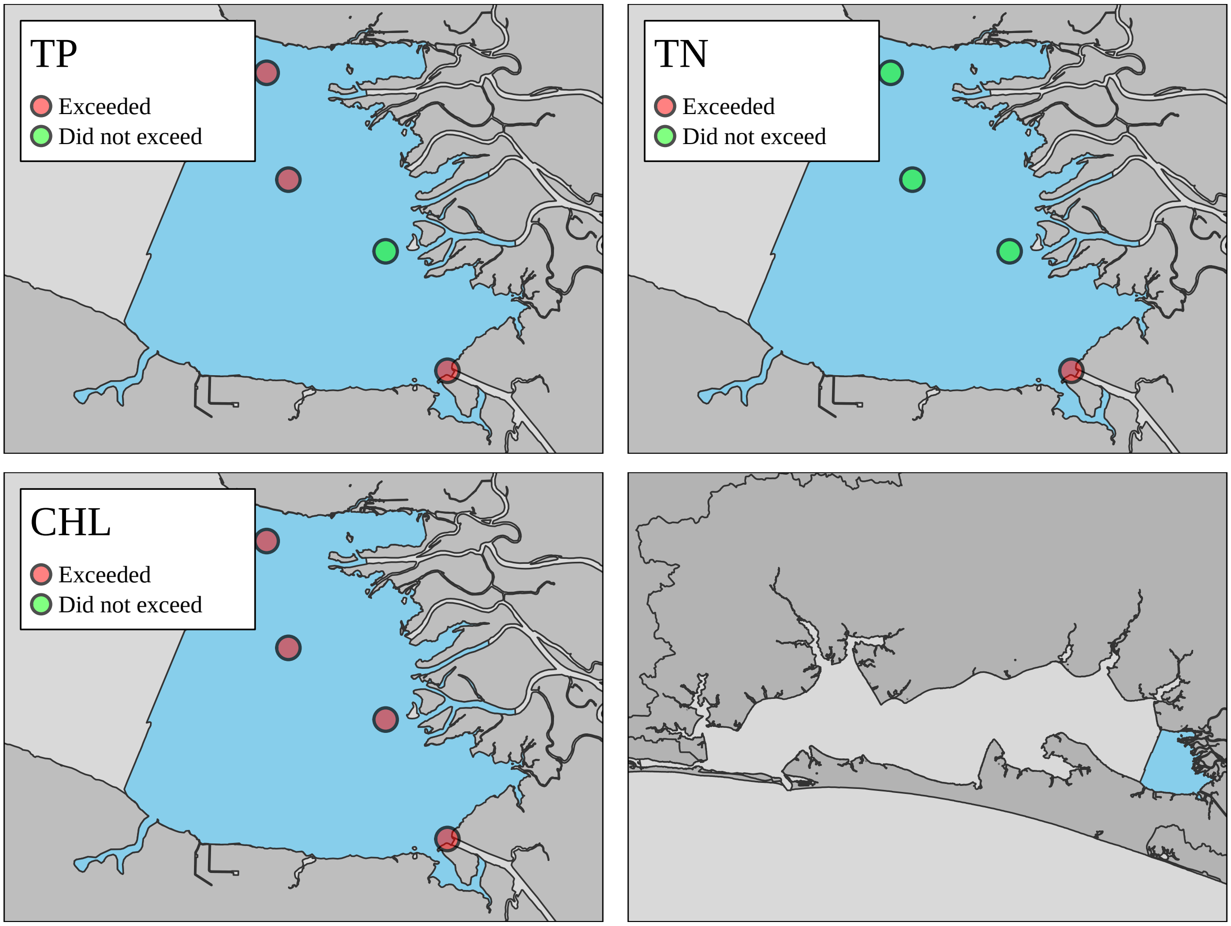

Figure 7: Choctawhatchee Bay Region 1: Upper Region with sampling stations. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.3.1 Description

The east region of the Choctawhatchee Bay includes all areas of the Bay east of the SR 331 bridge and resides entirely in Walton County (Fig. 2 and Fig. 7), which includes the Choctawhatchee River Delta area, the primary source of fresh water to the Bay. As a result, it is a relatively intermediate salinity (7.08 ppt) region. The Choctawhatchee River discharge dominates the circulation pattern of the Bay (Northwest Florida Water Management District, 1996), and is the dominant nutrient source for this area. Water depth averages 3 m in this region. The GIWW for this portion of the Bay continues to the east out of Choctawhatchee Bay to the St. Andrews Bay system, just south of the delta near Point Washington.

3.3.2 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in East Bay exceeded the recommended threshold in 19 months out of the last 36 months (53%). Phosphorus in this region has been stable over the last decade.

- **Nitrogen**: On average, TN values in East Bay exceeded the recommended threshold in 4 months out of the last 36 months (11%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in East Bay exceeded the recommended threshold in 22 months out of the last 36 months (61%). Chlorophyll in this region has been stable over the last decade.

3.3.3 Trophic state index

For summer, 2024, total chlorophyll in the East Bay region averaged 9.53, yielding a TSI classification of 52.72 and indicating that the region is currently eutrophic.

Table 10: 2024 Water Chemistry values for East Bay

	Min	Mean	Max	Std Error
Surface Temperature (C)	14.08	23.73	31.90	1.95
Bottom Temperature (C)	14.00	23.57	31.56	1.86
Surface DO (mg/L)	7.13	8.38	9.40	0.21
Bottom DO (mg/L)	1.65	5.20	8.35	0.60
Surface pH	7.30	7.77	8.42	0.10
Bottom pH	7.08	7.52	8.03	0.09
Surface Salinity (ppt)	0.40	8.43	19.00	1.81
Bottom Salinity (ppt)	13.50	20.21	26.10	0.94
Surface Phosphorus (µg/L)	10.00	27.24	49.67	2.98
Surface Nitrogen (µg/L)	139.00	392.08	542.50	33.31
Surface Chlorophyll (µg/L)	2.75	9.53	19.50	1.56

Table 11: Long-Term Water Chemistry values for East Bay

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	6.96	22.87	33.06	0.39	.
Bottom Temperature (C)	7.94	22.78	31.81	0.38	.
Surface DO (mg/L)	2.84	7.36	11.1	0.09	Increasing
Bottom DO (mg/L)	0.45	5.21	10.38	0.14	.
Surface pH	6.43	7.65	9.03	0.03	.
Bottom pH	6.48	7.49	8.75	0.03	.
Surface Salinity (ppt)	0	7.08	22.8	0.38	.
Bottom Salinity (ppt)	0	16.25	31.5	0.45	Increasing
Surface Phosphorus (µg/L)	10	27.38	51	0.46	.
Surface Nitrogen (µg/L)	139	437.23	710	5.58	Decreasing
Surface Chlorophyll (µg/L)	1	5.65	21	0.28	.

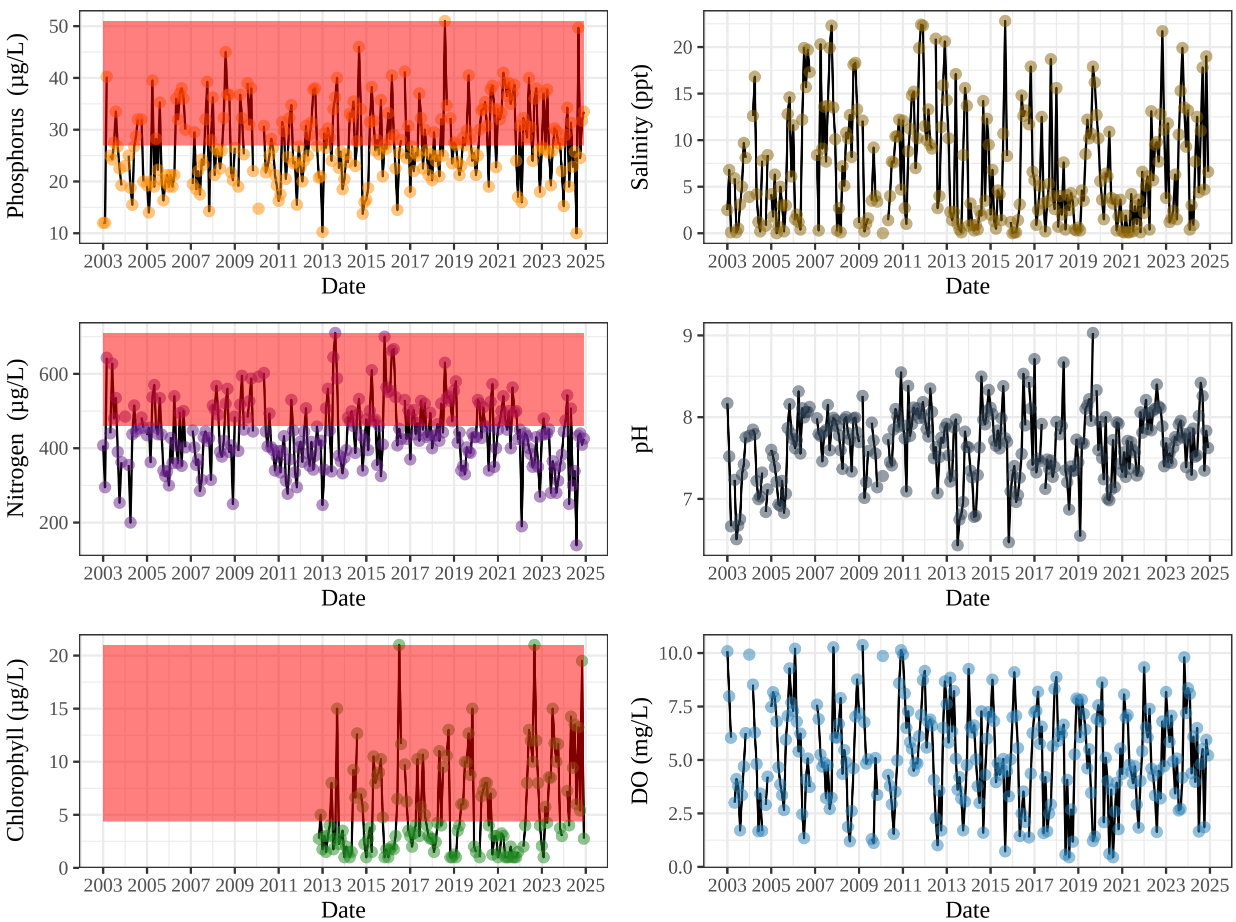

Figure 8: Timeseries of water chemistry variables in East Bay. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

3.4 Region 2: Middle Bay (Walton)

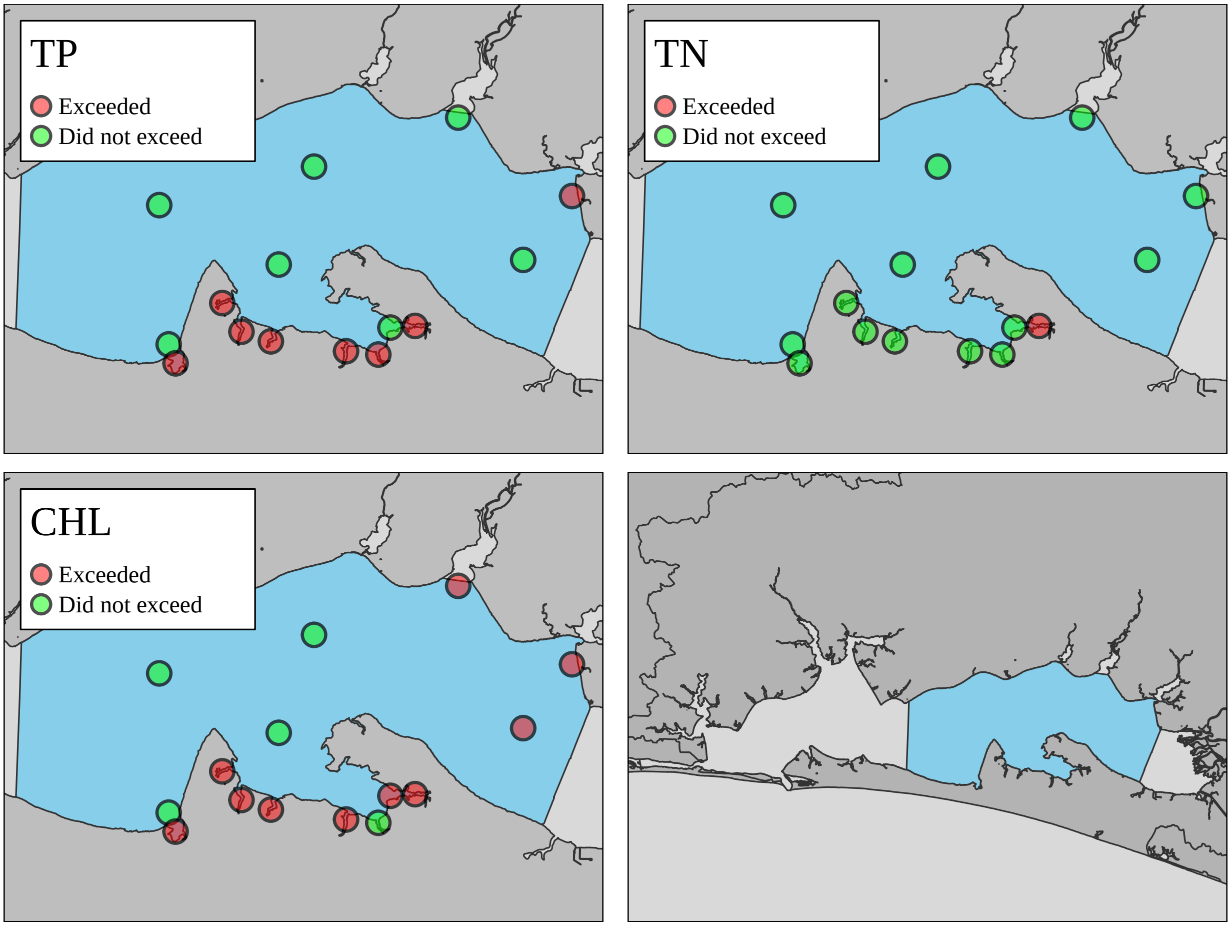

Figure 9: Choctawhatchee Bay Region 2: Middle Bay (Walton) with sampling stations. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.4.1 Description

The Walton County portion of the Middle Bay Region includes all areas of the Bay between the State Road (SR) 331 bridge and the Okaloosa County-Walton County boarder. Residing in between East Pass and the Choctawhatchee River, the middle region of the Bay is mostly brackish. The Walton County portion of the Middle Bay Region is geographically closer to the Choctawhatchee River, and is a relatively high salinity (16.72 ppt) region slightly fresher than the Okaloosa County portion, which lies closer to East Pass. Much of the northern shore consists of Eglin AFB property. Basin Bayou, Alaqua Bayou, and LaGrange Bayou, plus several smaller creeks, drain into the Walton County portion of the Middle Bay Region. The southern shore includes Horseshoe and Hogtown Bayous.

3.4.2 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Middle Bay (Walton) exceeded the recommended threshold in 18 months out of the last 36 months (50%). Phosphorus in this region has been stable over the last decade.

- **Nitrogen**: On average, TN values in Middle Bay (Walton) exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Middle Bay (Walton) exceeded the recommended threshold in 27 months out of the last 36 months (75%). Chlorophyll in this region has been stable over the last decade.

3.4.3 Trophic state index

For summer, 2024, total chlorophyll in the Middle Bay (Walton) region averaged 4.02, yielding a TSI classification of 44.25 and indicating that the region is currently mesotrophic.

Table 12: 2024 Water Chemistry values for Middle Bay (Walton)

	Min	Mean	Max	Std Error
Surface Temperature (C)	13.67	23.69	32.53	1.87
Bottom Temperature (C)	13.77	23.35	31.39	1.78
Surface DO (mg/L)	6.21	7.50	9.30	0.30
Bottom DO (mg/L)	3.51	5.70	8.27	0.46
Surface pH	7.64	7.81	8.02	0.03
Bottom pH	7.37	7.72	8.02	0.05
Surface Salinity (ppt)	14.30	19.12	26.10	1.23
Bottom Salinity (ppt)	20.00	23.21	27.90	0.79
Surface Phosphorus (µg/L)	13.42	20.60	28.54	1.17
Surface Nitrogen (µg/L)	251.27	297.91	339.13	7.68
Surface Chlorophyll (µg/L)	2.50	4.02	6.07	0.33

Table 13: Long-Term Water Chemistry values for Middle Bay (Walton)

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	9.04	23.01	32.53	0.4	.
Bottom Temperature (C)	10.55	22.87	31.75	0.37	.
Surface DO (mg/L)	4.39	7.18	10.58	0.08	.
Bottom DO (mg/L)	1.7	5.46	12.84	0.1	.
Surface pH	7.2	7.84	8.47	0.01	.
Bottom pH	6.92	7.72	8.33	0.02	.
Surface Salinity (ppt)	0.4	16.72	28.6	0.38	Increasing
Bottom Salinity (ppt)	1.1	21.15	31.3	0.33	Increasing
Surface Phosphorus (µg/L)	8.85	19.7	34.67	0.3	.
Surface Nitrogen (µg/L)	180	314.04	490	4.05	Decreasing
Surface Chlorophyll (µg/L)	1	4.14	8.54	0.11	.

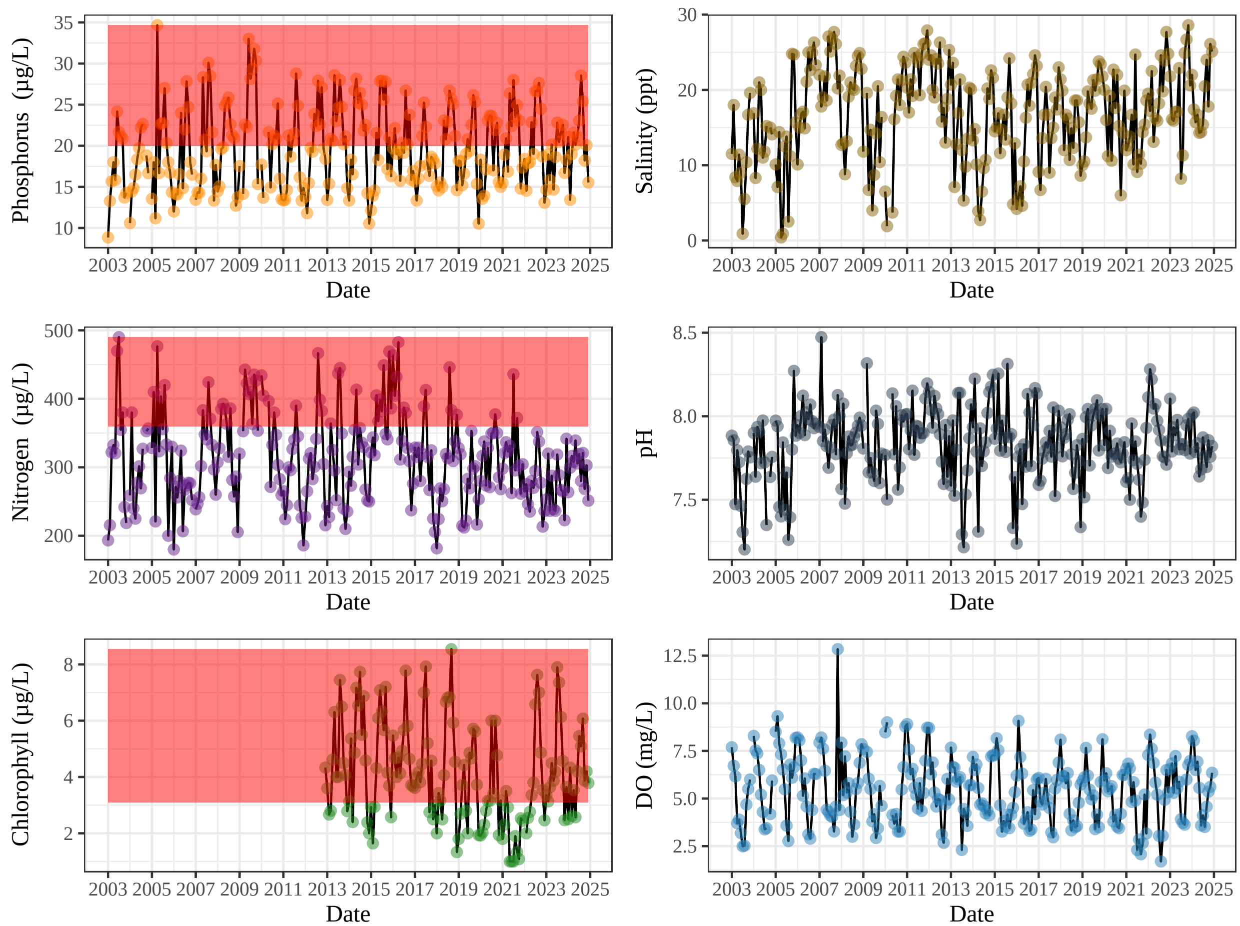

Figure 10: Timeseries of water chemistry variables in Middle Bay (Walton). CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

3.5 Region 3: Middle Bay (Okaloosa)

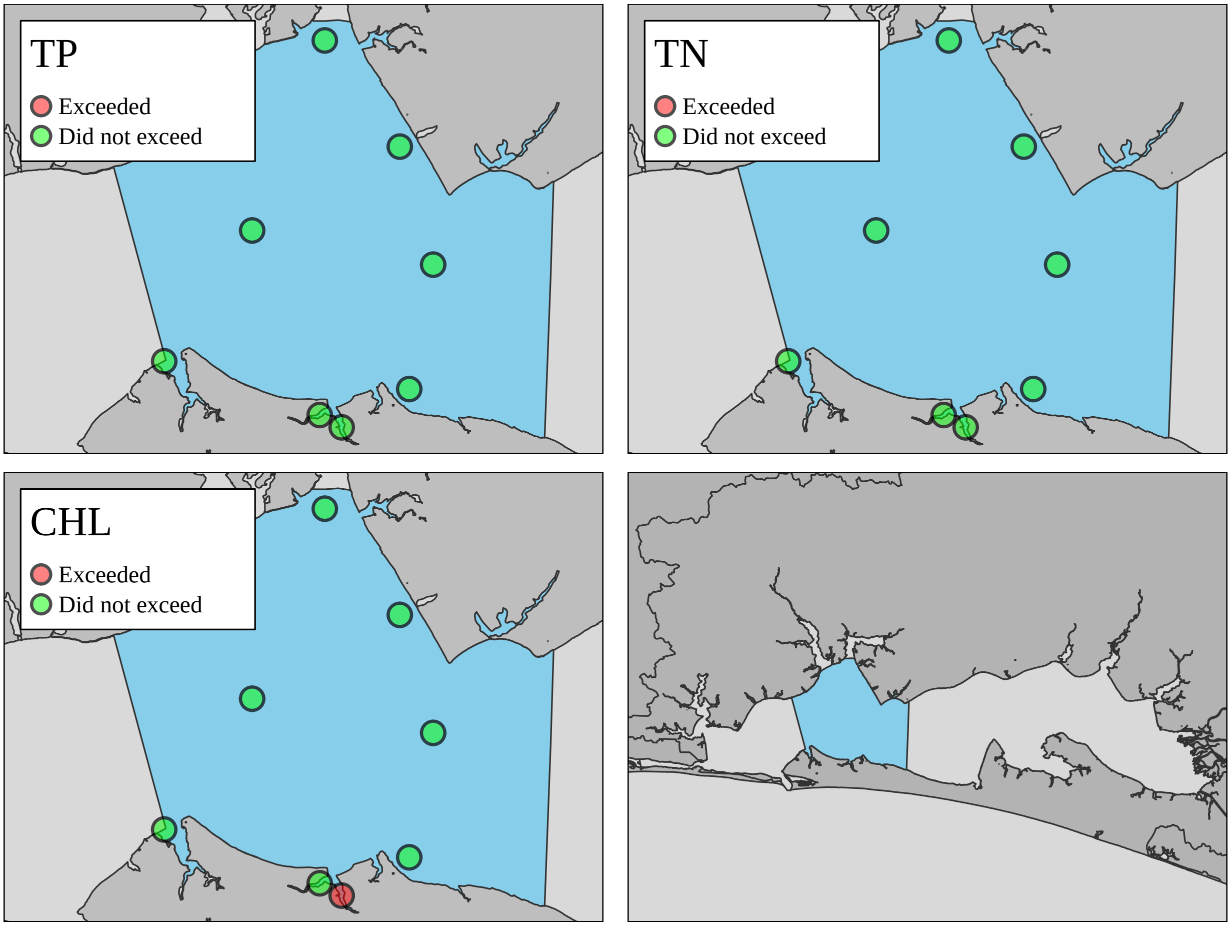

Figure 11: Choctawhatchee Bay Region 3: Middle Bay (Okaloosa) with sampling stations. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.5.1 Description

The Okaloosa County portion of the Middle Bay Region includes all areas of the Bay between the Okaloosa County-Walton County boarder and an imaginary boundary between Joe's Bayou (south) and Jack's Lake (north). Residing in between East Pass and the Choctawhatchee River, the middle region of the Bay is mostly brackish. The Okaloosa County portion of the Middle Bay Region is geographically closer to East Pass, and is a relatively high salinity (19.48 ppt) region slightly saltier than the Walton County portion, which lies closer to the Choctawhatchee River. Much of the northern shore consists of Eglin AFB property. Boggy Bayou and Rocky Bayou, in addition to smaller creeks, drain into the Okaloosa County portion of the Middle Bay Region. The southern shore includes much of Destin propper.

3.5.2 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Middle Bay (Okaloosa) exceeded the recommended threshold in 0 months out of the last 36 months (0%). Phosphorus in this region has been increasing over the last decade.

- **Nitrogen**: On average, TN values in Middle Bay (Okaloosa) exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Middle Bay (Okaloosa) exceeded the recommended threshold in 7 months out of the last 36 months (19%). Chlorophyll in this region has been stable over the last decade.

3.5.3 Trophic state index

For summer, 2024, total chlorophyll in the Middle Bay (Okaloosa) region averaged 2.53, yielding a TSI classification of 39.71 and indicating that the region is currently oligotrophic.

Table 14: 2024 Water Chemistry values for Middle Bay (Okaloosa)

	Min	Mean	Max	Std Error
Surface Temperature (C)	12.36	23.06	31.28	1.92
Bottom Temperature (C)	12.23	22.75	30.53	1.87
Surface DO (mg/L)	6.18	7.97	10.38	0.36
Bottom DO (mg/L)	4.78	6.95	9.41	0.45
Surface pH	7.87	7.99	8.22	0.03
Bottom pH	7.82	7.94	8.15	0.03
Surface Salinity (ppt)	15.00	20.62	27.00	1.17
Bottom Salinity (ppt)	20.20	24.38	28.00	0.74
Surface Phosphorus (µg/L)	10.75	13.49	15.67	0.53
Surface Nitrogen (µg/L)	174.12	224.19	273.75	9.65
Surface Chlorophyll (µg/L)	1.00	2.53	3.50	0.21

Table 15: Long-Term Water Chemistry values for Middle Bay (Okaloosa)

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	9.19	22.8	32	0.38	.
Bottom Temperature (C)	12.23	22.6	31.26	0.34	.
Surface DO (mg/L)	3.58	7.4	11.24	0.08	Increasing
Bottom DO (mg/L)	0.12	5.36	9.41	0.11	Increasing
Surface pH	7.55	8.1	8.61	0.01	Decreasing
Bottom pH	7.5	7.99	8.55	0.01	.
Surface Salinity (ppt)	2.1	19.48	29.7	0.34	.
Bottom Salinity (ppt)	9.8	26.8	33.5	0.21	Decreasing
Surface Phosphorus (µg/L)	5.25	12.78	21	0.19	Increasing
Surface Nitrogen (µg/L)	110	242.96	420	3.32	Decreasing
Surface Chlorophyll (µg/L)	1	2.35	6	0.06	.

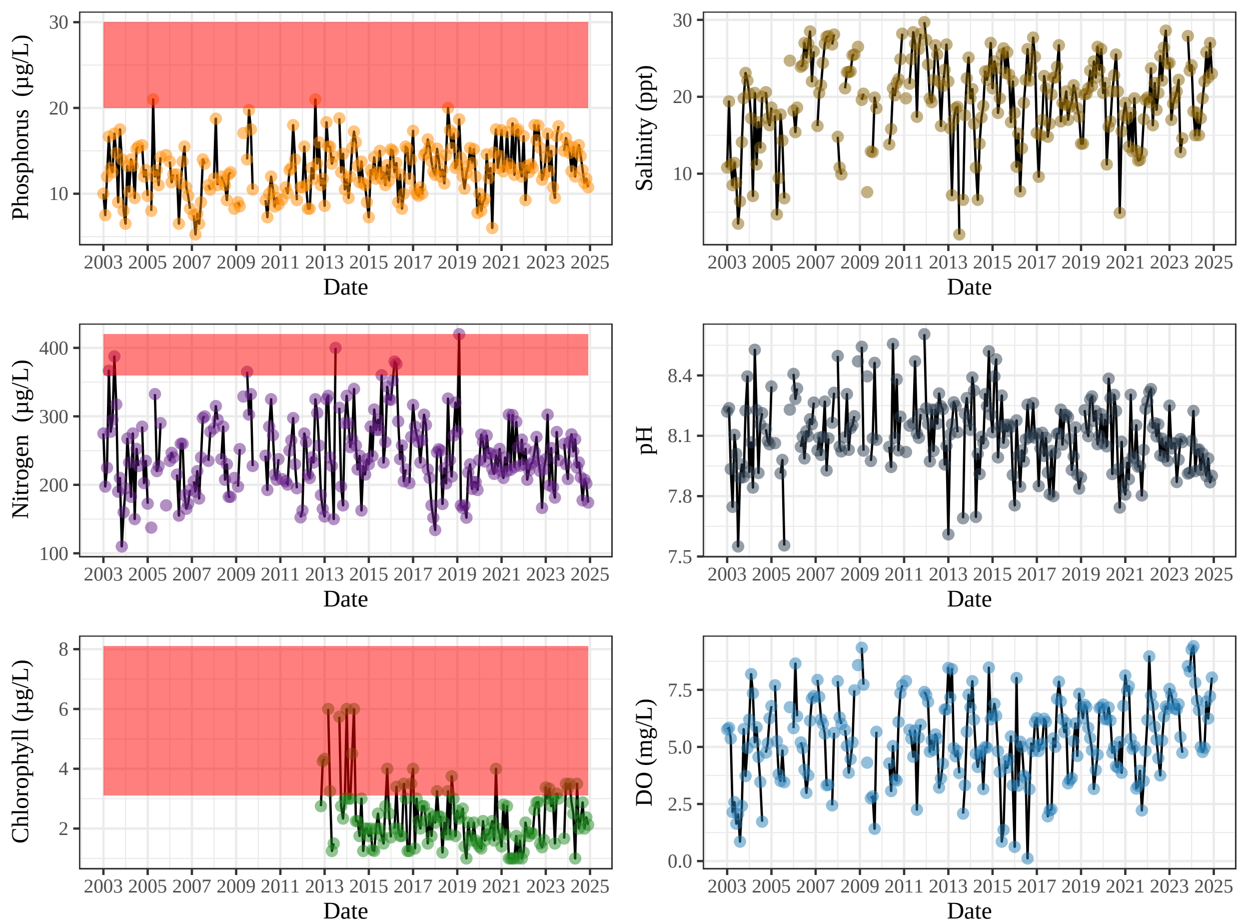

Figure 12: Timeseries of water chemistry variables in Middle Bay (Okaloosa). CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

3.6 Region 4: West Bay

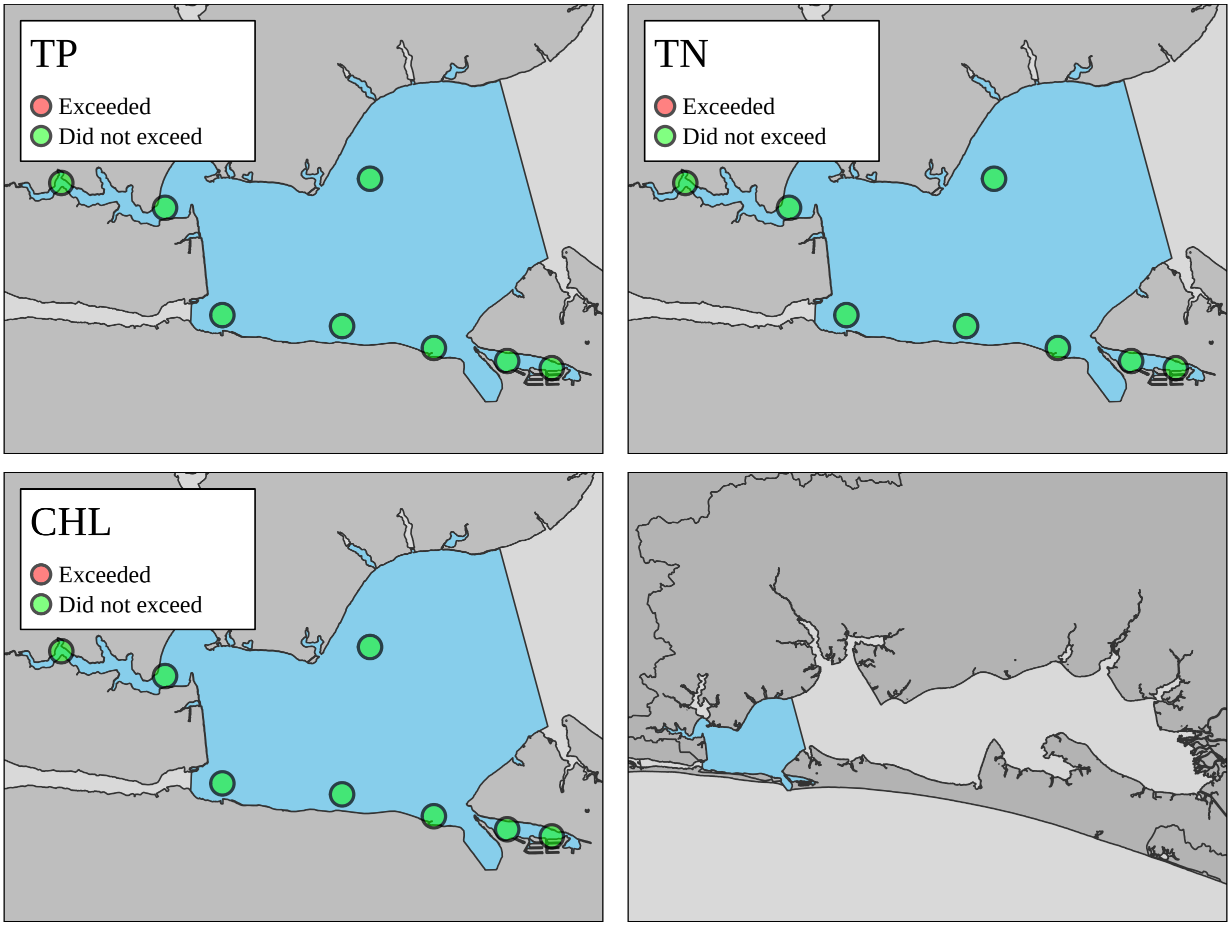

Figure 13: Choctawhatchee Bay Region 4: West Bay with sampling stations. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.6.1 Description

The West Bay Region resides entirely within Okaloosa County, and includes all areas west an imaginary boundary between Joe's Bayou (south) and Jack's Lake (north). As the region which contains East Pass, it is the more saline (21.61 ppt) region of the Bay. The region includes Cinco Bayou and parts of the Santa Rosa Sound, and is fed by Garnier Bayou and Don's Bayou.

3.6.2 Numeric ntrient criteria

- **Phosphorus**: On average, TP values in West Bay exceeded the recommended threshold in 0 months out of the last 36 months (0%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in West Bay exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.

- **Chlorophyll**: On average, total chlorophyll values in West Bay exceeded the recommended threshold in 0 months out of the last 36 months (0%). Chlorophyll in this region has been decreasing over the last decade.

3.6.3 Trophic state index

For summer, 2024, total chlorophyll in the West Bay region averaged 2.44, yielding a TSI classification of 39.35 and indicating that the region is currently oligotrophic.

Table 16: 2024 Water Chemistry values for West Bay

	Min	Mean	Max	Std Error
Surface Temperature (C)	9.88	22.25	30.69	2.03
Bottom Temperature (C)	11.72	22.62	30.19	1.84
Surface DO (mg/L)	5.90	7.84	10.19	0.37
Bottom DO (mg/L)	4.19	6.58	8.86	0.46
Surface pH	7.79	7.96	8.20	0.03
Bottom pH	7.75	7.92	8.05	0.03
Surface Salinity (ppt)	18.90	23.61	28.00	0.87
Bottom Salinity (ppt)	24.30	27.92	30.30	0.58
Surface Phosphorus (µg/L)	11.25	16.44	24.20	1.20
Surface Nitrogen (µg/L)	152.62	201.00	251.12	8.07
Surface Chlorophyll (µg/L)	1.60	2.44	3.75	0.20

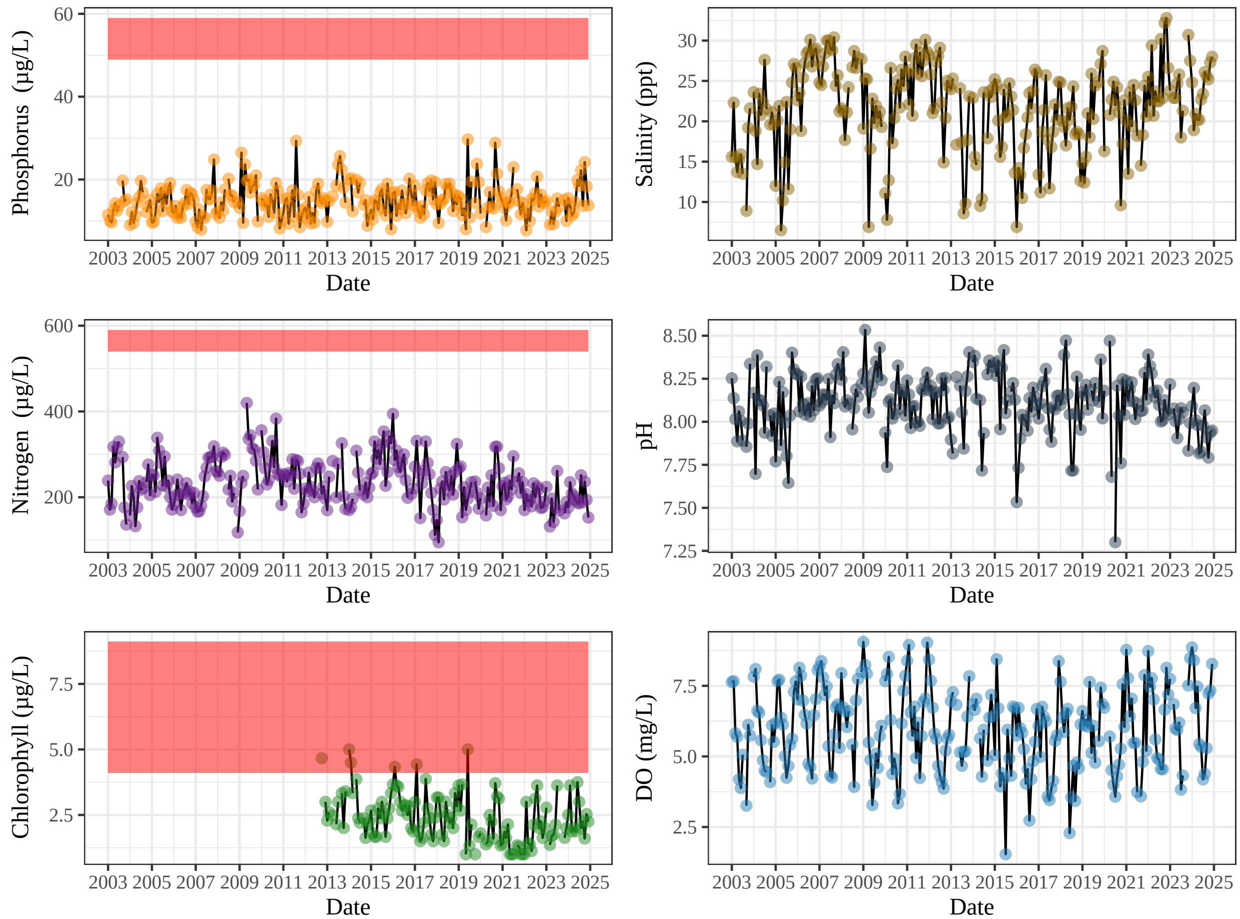

Figure 14: Timeseries of water chemistry variables in West Bay. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 17: Long-Term Water Chemistry values for West Bay

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	9.88	22.63	31.78	0.38	.
Bottom Temperature (C)	11.72	22.6	31.11	0.34	.
Surface DO (mg/L)	4.64	7.66	10.5	0.07	.
Bottom DO (mg/L)	1.53	5.97	9.05	0.09	Increasing
Surface pH	7.3	8.11	8.53	0.01	Decreasing
Bottom pH	7.24	8.03	8.56	0.01	.
Surface Salinity (ppt)	6.5	21.61	32.8	0.33	Increasing
Bottom Salinity (ppt)	16.3	27.95	34.8	0.18	.
Surface Phosphorus (µg/L)	7.75	14.88	29.67	0.24	.
Surface Nitrogen (µg/L)	95	234.93	420	3.36	Decreasing
Surface Chlorophyll (µg/L)	1	2.41	5	0.06	Decreasing

3.7 Lesser Regions

3.7.1 Lesser Region 1: LaGrange Bayou

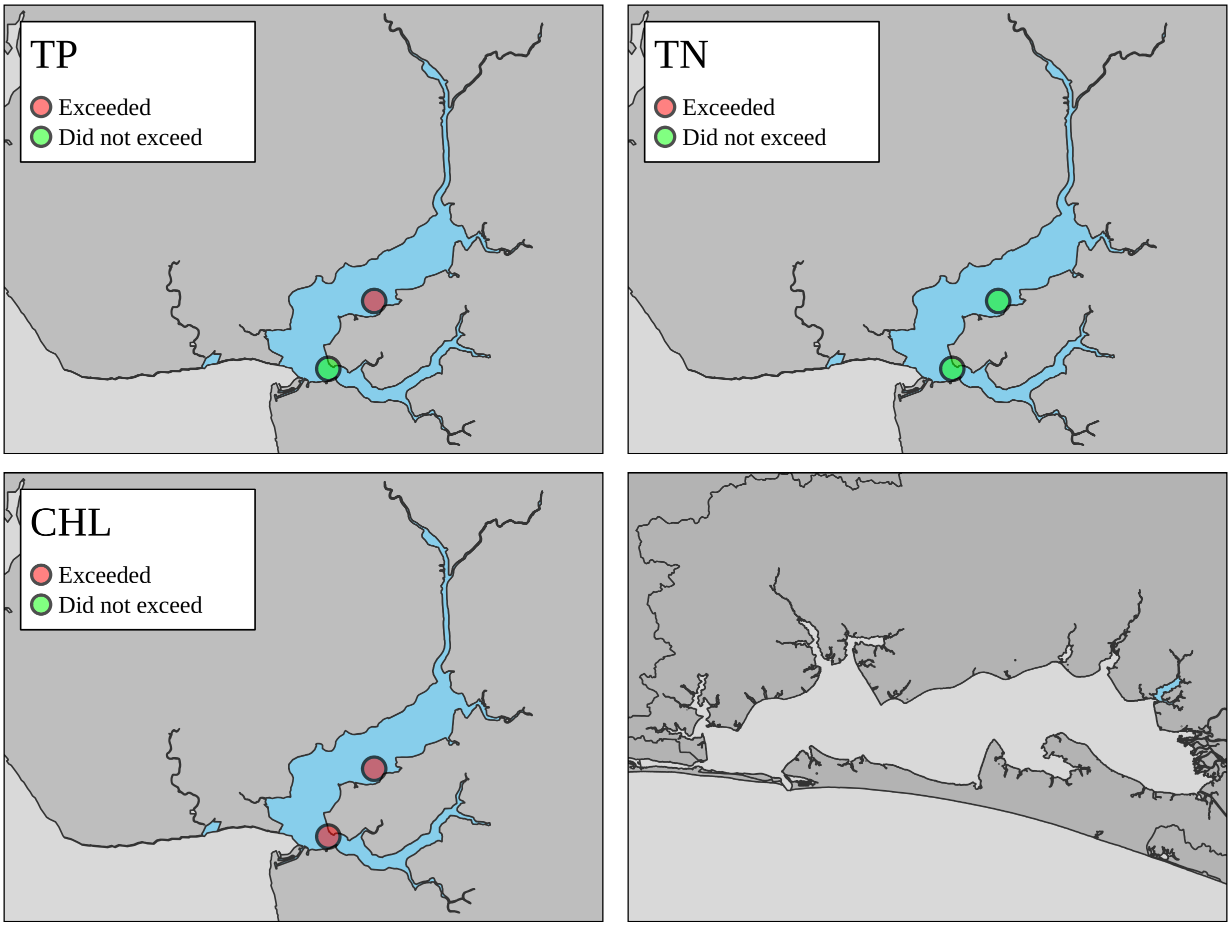

Figure 15: Choctawhatchee Bay Lesser Region 1: LaGrange Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.2 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in LaGrange Bayou exceeded the recommended threshold in 12 months out of the last 36 months (33%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in LaGrange Bayou exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in LaGrange Bayou exceeded the recommended threshold in 24 months out of the last 36 months (67%). Chlorophyll in this region has been stable over the last decade.

3.7.3 Trophic state index

For summer, 2024, total chlorophyll in the LaGrange Bayou region averaged 11.62, yielding a TSI classification of 54.66 and indicating that the region is currently eutrophic.

Table 18: 2024 Water Chemistry values for LaGrange Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	17.14	25.13	32.78	1.56
Bottom Temperature (C)	22.75	27.15	32.50	1.04
Surface DO (mg/L)	5.46	8.33	9.84	0.34
Bottom DO (mg/L)	4.58	7.27	8.71	0.51
Surface pH	6.90	7.74	8.20	0.11
Bottom pH	6.90	7.55	8.13	0.13
Surface Salinity (ppt)	4.80	12.57	22.30	1.82
Bottom Salinity (ppt)	5.90	10.99	19.00	1.56
Surface Phosphorus (µg/L)	16.66	27.88	42.00	2.08
Surface Nitrogen (µg/L)	210.00	344.81	435.00	22.41
Surface Chlorophyll (µg/L)	3.50	11.62	23.50	1.72

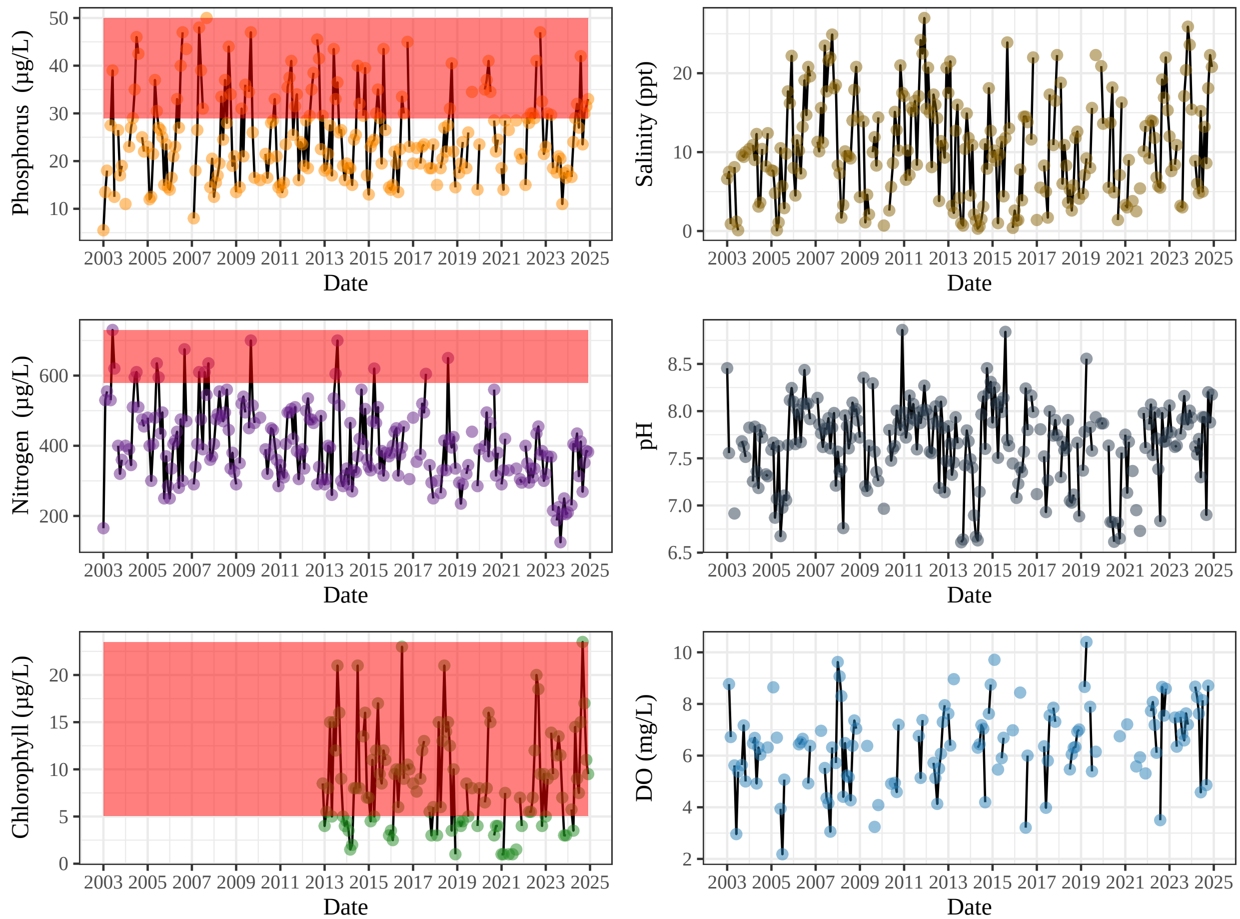

Figure 16: Timeseries of water chemistry variables in LaGrange Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 19: Long-Term Water Chemistry values for LaGrange Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	7.61	23.82	33.42	0.38	.
Bottom Temperature (C)	14.81	25.87	33.11	0.31	.
Surface DO (mg/L)	3.84	7.49	10.97	0.08	.
Bottom DO (mg/L)	2.18	6.4	10.4	0.1	.
Surface pH	6.61	7.66	8.86	0.03	.
Bottom pH	6.44	7.52	8.27	0.03	.
Surface Salinity (ppt)	0.1	10.67	27	0.4	Increasing
Bottom Salinity (ppt)	0.1	12.56	27	0.43	.
Surface Phosphorus (µg/L)	5.5	25.46	50	0.56	.
Surface Nitrogen (µg/L)	125	401.42	730	6.67	Decreasing
Surface Chlorophyll (µg/L)	1	8.76	23.5	0.32	.

3.7.4 Lesser Region 2: Alaqua Bayou

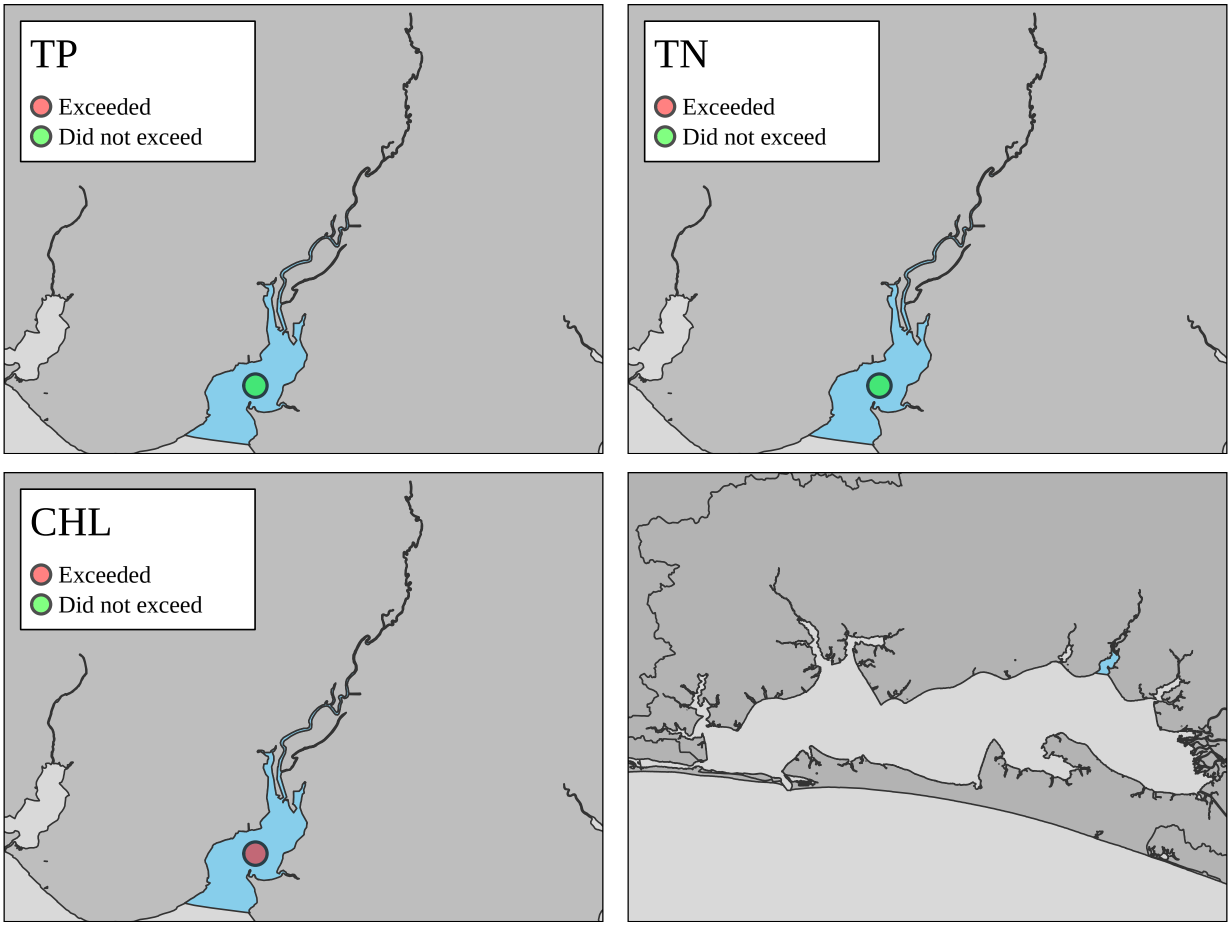

Figure 17: Choctawhatchee Bay Lesser Region 2: Alaqua Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.5 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Alaqua Bayou exceeded the recommended threshold in 7 months out of the last 36 months (19%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in Alaqua Bayou exceeded the recommended threshold in 4 months out of the last 36 months (11%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Alaqua Bayou exceeded the recommended threshold in 18 months out of the last 36 months (50%). Chlorophyll in this region has been stable over the last decade.

3.7.6 Trophic state index

For summer, 2024, total chlorophyll in the Alaqua Bayou region averaged 7.07, yielding a TSI classification of 49.79 and indicating that the region is currently mesotrophic.

Table 20: 2024 Water Chemistry values for Alaqua Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	16.11	24.12	29.83	1.44
Bottom Temperature (C)	15.39	25.16	31.06	1.33
Surface DO (mg/L)	4.92	7.43	9.52	0.42
Bottom DO (mg/L)	3.40	6.57	9.11	0.56
Surface pH	6.79	7.56	8.02	0.12
Bottom pH	6.67	7.50	7.90	0.12
Surface Salinity (ppt)	1.60	11.65	24.60	2.02
Bottom Salinity (ppt)	2.10	14.66	25.60	2.21
Surface Phosphorus (µg/L)	9.00	25.27	43.00	3.37
Surface Nitrogen (µg/L)	170.00	303.48	459.00	27.98
Surface Chlorophyll (µg/L)	1.00	7.07	15.00	1.40

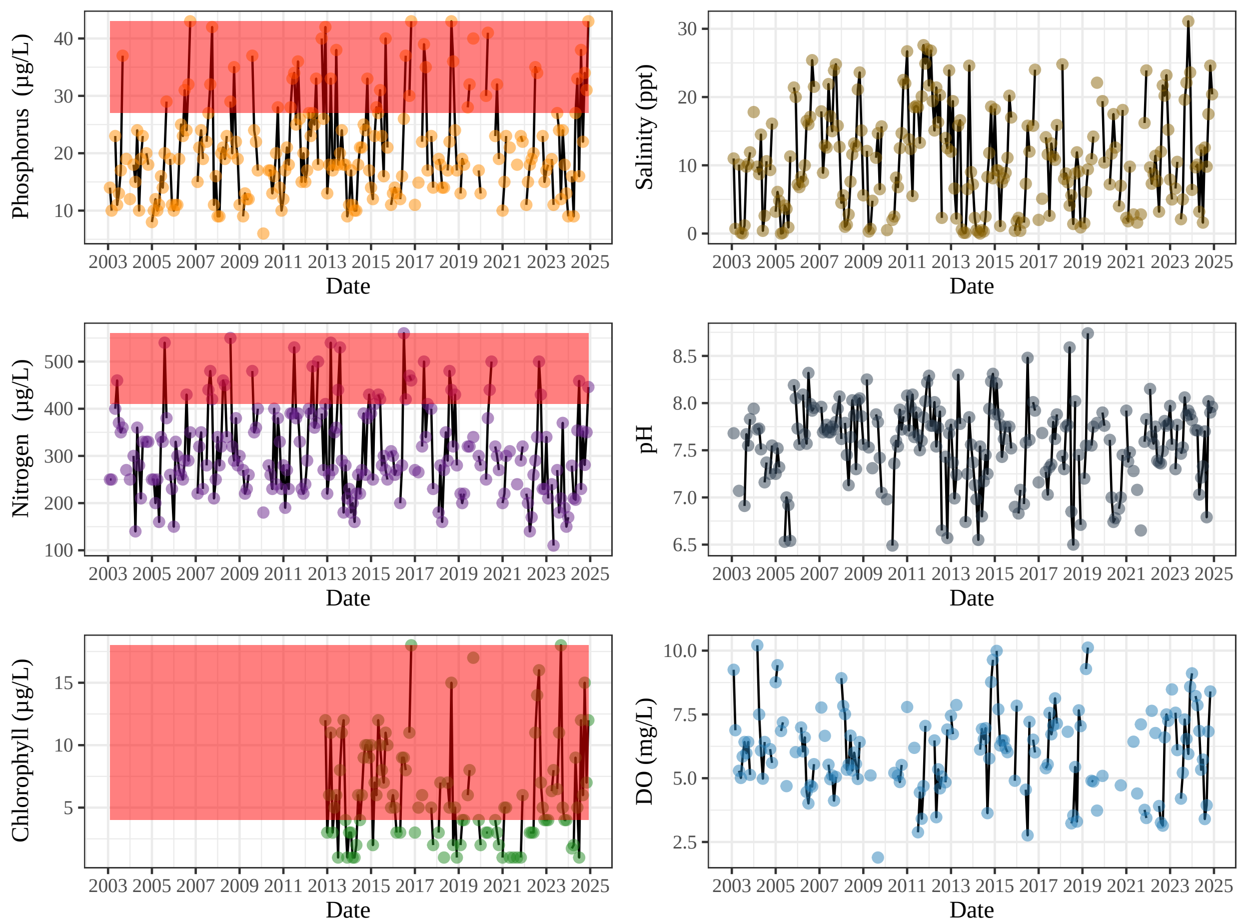

Figure 18: Timeseries of water chemistry variables in Alaqua Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 21: Long-Term Water Chemistry values for Alaqua Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	9.39	23.4	32.94	0.36	.
Bottom Temperature (C)	12.94	24.96	32.89	0.32	.
Surface DO (mg/L)	3.53	7.17	11.15	0.09	.
Bottom DO (mg/L)	1.89	6.09	10.21	0.1	.
Surface pH	6.49	7.57	8.74	0.03	.
Bottom pH	6.62	7.58	8.45	0.02	.
Surface Salinity (ppt)	0	10.91	31.1	0.46	.
Bottom Salinity (ppt)	0	14.93	31.6	0.5	Increasing
Surface Phosphorus (µg/L)	6	20.96	43	0.54	.
Surface Nitrogen (µg/L)	110	309.88	560	5.78	Decreasing
Surface Chlorophyll (µg/L)	1	6.1	18	0.25	.

3.7.7 Lesser Region 3: Basin Bayou

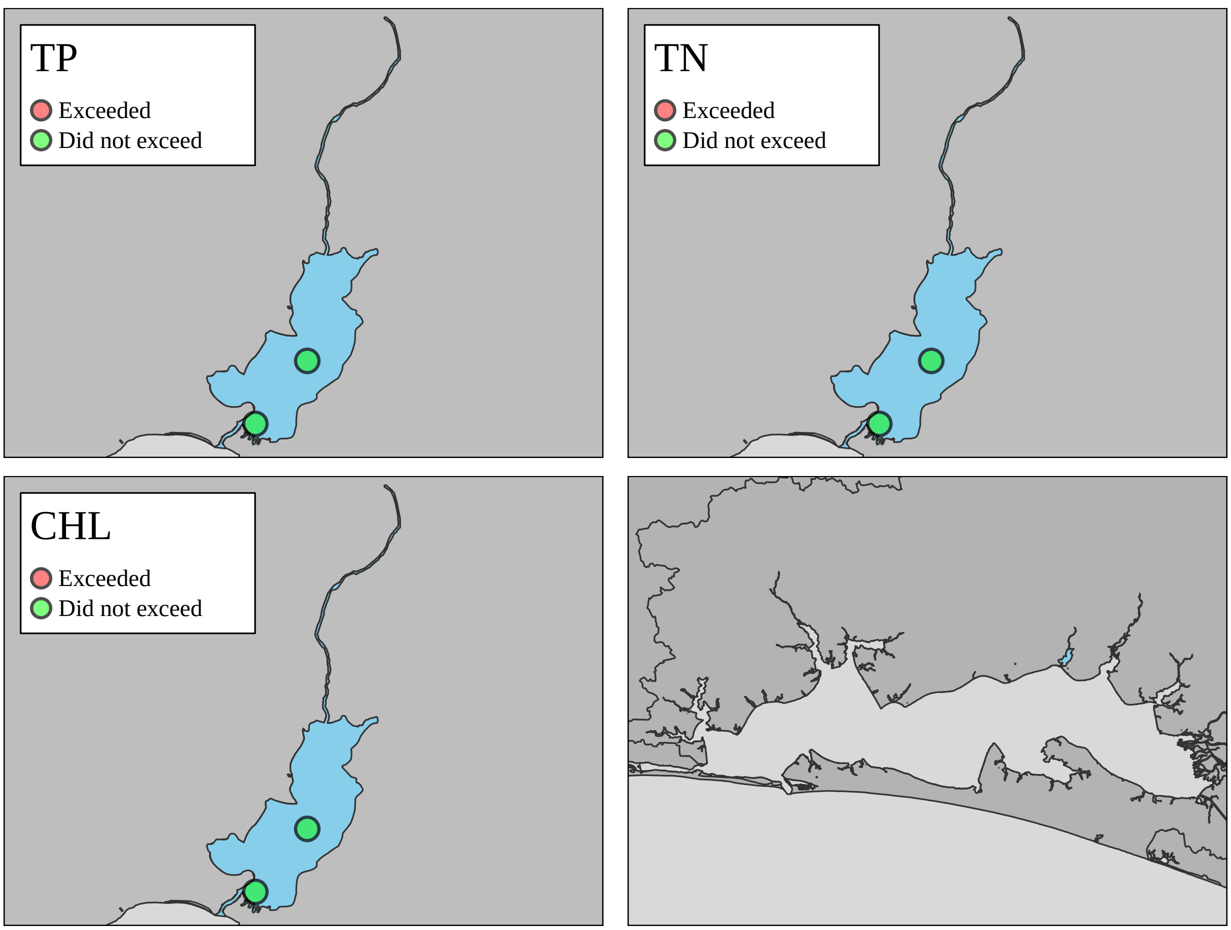

Figure 19: Choctawhatchee Bay Lesser Region 3: Basin Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.8 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Basin Bayou exceeded the recommended threshold in 3 months out of the last 36 months (8%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in Basin Bayou exceeded the recommended threshold in 1 months out of the last 36 months (3%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Basin Bayou exceeded the recommended threshold in 1 months out of the last 36 months (3%). Chlorophyll in this region has been stable over the last decade.

3.7.9 Trophic state index

For summer, 2024, total chlorophyll in the Basin Bayou region averaged 2.59, yielding a TSI classification of 39.94 and indicating that the region is currently oligotrophic.

Table 22: 2024 Water Chemistry values for Basin Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	8.78	21.29	30.58	2.06
Bottom Temperature (C)	7.86	21.97	32.19	2.13
Surface DO (mg/L)	6.41	8.19	11.38	0.42
Bottom DO (mg/L)	2.43	6.57	11.70	0.71
Surface pH	6.43	7.30	8.17	0.14
Bottom pH	6.26	7.22	8.09	0.14
Surface Salinity (ppt)	0.20	2.67	5.50	0.47
Bottom Salinity (ppt)	0.20	8.09	20.10	1.83
Surface Phosphorus (µg/L)	7.50	12.96	20.00	1.04
Surface Nitrogen (µg/L)	63.50	160.92	281.00	18.13
Surface Chlorophyll (µg/L)	1.00	2.59	3.50	0.23

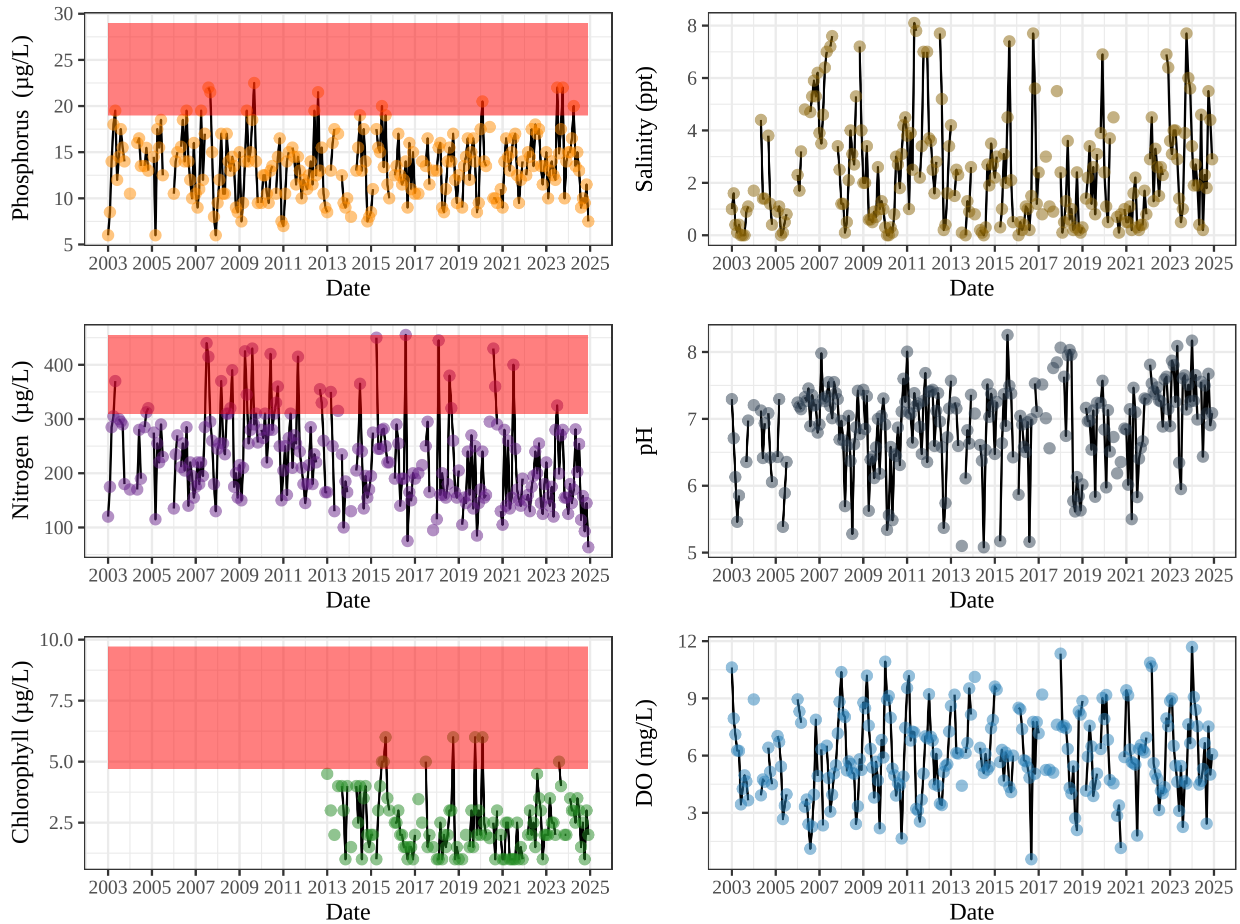

Figure 20: Timeseries of water chemistry variables in Basin Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 23: Long-Term Water Chemistry values for Basin Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	4.81	21.63	32.22	0.41	.
Bottom Temperature (C)	4.53	22.26	32.19	0.4	.
Surface DO (mg/L)	4.07	7.63	11.74	0.1	.
Bottom DO (mg/L)	0.56	6.01	11.7	0.13	.
Surface pH	5.08	6.88	8.25	0.04	Increasing
Bottom pH	5.02	6.84	8.09	0.04	Increasing
Surface Salinity (ppt)	0	2.36	8.1	0.13	Increasing
Bottom Salinity (ppt)	0	7.17	23.6	0.38	Increasing
Surface Phosphorus (µg/L)	6	13.45	22.5	0.21	.
Surface Nitrogen (µg/L)	63.5	227.07	455	5	Decreasing
Surface Chlorophyll (µg/L)	1	2.45	6	0.08	.

3.7.10 Lesser Region 5: Rocky Bayou

Figure 21: Choctawhatchee Bay Lesser Region 5: Rocky Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.11 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Rocky Bayou exceeded the recommended threshold in 4 months out of the last 36 months (11%). Phosphorus in this region has been increasing over the last decade.
- **Nitrogen**: On average, TN values in Rocky Bayou exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Rocky Bayou exceeded the recommended threshold in 2 months out of the last 36 months (6%). Chlorophyll in this region has been stable over the last decade.

3.7.12 Trophic state index

For summer, 2024, total chlorophyll in the Rocky Bayou region averaged 2.4, yielding a TSI classification of 39.19 and indicating that the region is currently oligotrophic.

Table 24: 2024 Water Chemistry values for Rocky Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	13.89	24.39	33.08	2.00
Bottom Temperature (C)	13.44	23.53	31.89	1.84
Surface DO (mg/L)	5.62	7.90	10.27	0.40
Bottom DO (mg/L)	0.35	4.87	8.90	0.90
Surface pH	7.72	7.97	8.24	0.05
Bottom pH	7.34	7.79	8.18	0.07
Surface Salinity (ppt)	12.10	17.51	25.20	1.54
Bottom Salinity (ppt)	21.00	26.18	29.00	0.75
Surface Phosphorus (µg/L)	9.50	13.21	18.50	0.80
Surface Nitrogen (µg/L)	200.00	250.25	295.50	8.38
Surface Chlorophyll (µg/L)	1.50	2.40	3.00	0.18

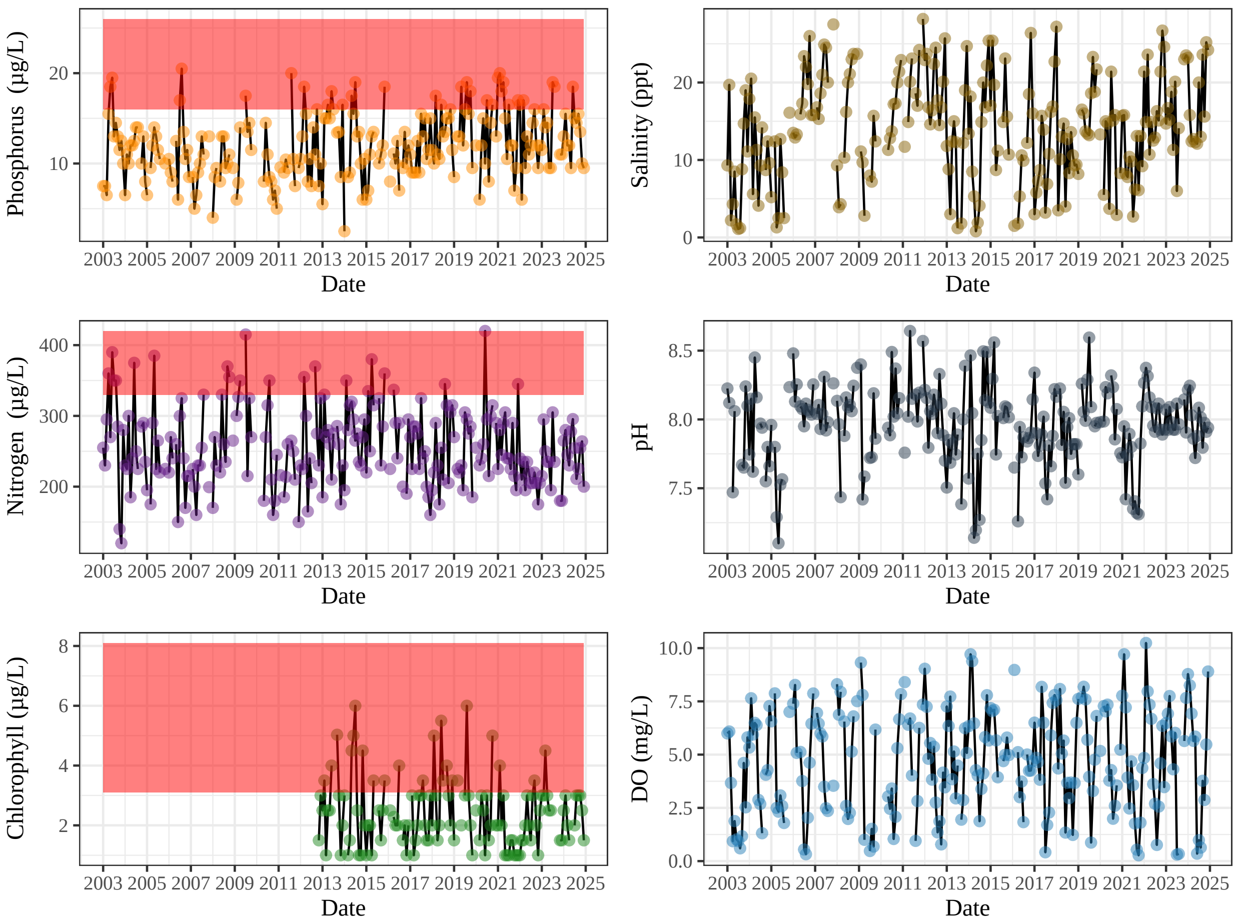

Figure 22: Timeseries of water chemistry variables in Rocky Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 25: Long-Term Water Chemistry values for Rocky Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	8.92	23.8	34.19	0.4	.
Bottom Temperature (C)	13.22	23.17	31.89	0.34	.
Surface DO (mg/L)	4.22	7.69	11.41	0.08	.
Bottom DO (mg/L)	0.28	4.74	10.24	0.15	.
Surface pH	7.1	7.96	8.64	0.02	.
Bottom pH	6.99	7.84	8.7	0.02	.
Surface Salinity (ppt)	0.8	14.09	28.2	0.42	Increasing
Bottom Salinity (ppt)	11.5	25.68	36.2	0.27	Increasing
Surface Phosphorus (µg/L)	2.5	12	20.5	0.22	Increasing
Surface Nitrogen (µg/L)	120	255.28	420	3.42	Decreasing
Surface Chlorophyll (µg/L)	1	2.43	6	0.07	.

3.7.13 Lesser Region 6: Boggy Bayou

Figure 23: Choctawhatchee Bay Lesser 6: Boggy Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.14 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Boggy Bayou exceeded the recommended threshold in 1 months out of the last 36 months (3%). Phosphorus in this region has been increasing over the last decade.
- **Nitrogen**: On average, TN values in Boggy Bayou exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been stable over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Boggy Bayou exceeded the recommended threshold in 5 months out of the last 36 months (14%). Chlorophyll in this region has been stable over the last decade.

3.7.15 Trophic state index

For summer, 2024, total chlorophyll in the Boggy Bayou region averaged 2.24, yielding a TSI classification of 38.51 and indicating that the region is currently oligotrophic.

Table 26: 2024 Water Chemistry values for Boggy Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	11.96	23.91	31.49	2.04
Bottom Temperature (C)	13.76	23.43	30.42	1.76
Surface DO (mg/L)	6.14	7.96	10.24	0.37
Bottom DO (mg/L)	0.62	4.04	7.09	0.66
Surface pH	7.58	7.94	8.39	0.07
Bottom pH	7.33	7.70	8.03	0.07
Surface Salinity (ppt)	7.70	15.53	28.70	2.10
Bottom Salinity (ppt)	20.60	27.30	32.50	1.01
Surface Phosphorus (µg/L)	9.25	11.56	17.00	0.65
Surface Nitrogen (µg/L)	122.33	194.80	272.50	13.29
Surface Chlorophyll (µg/L)	1.00	2.24	3.33	0.23

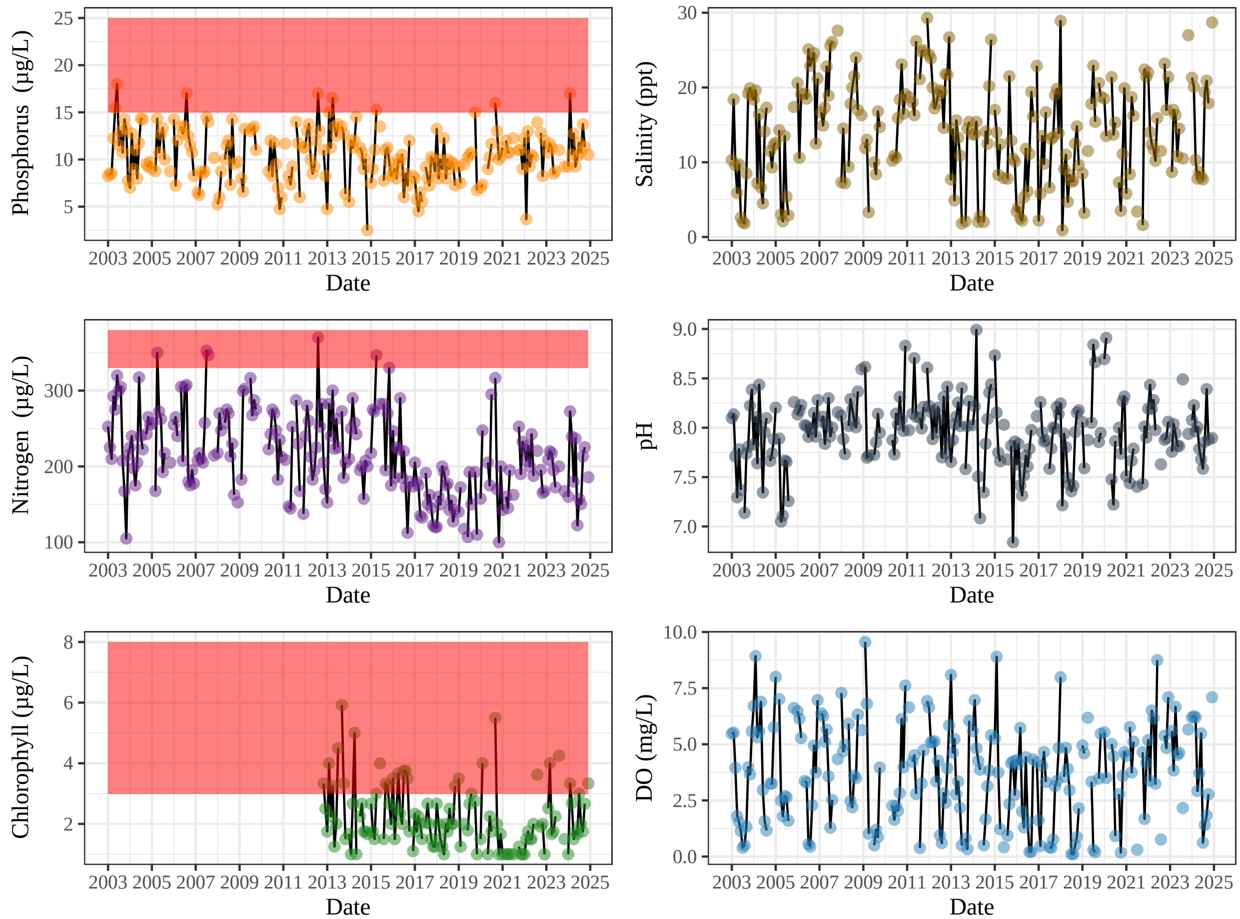

Figure 24: Timeseries of water chemistry variables in Boggy Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 27: Long-Term Water Chemistry values for Boggy Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	8.85	23.31	34.14	0.39	.
Bottom Temperature (C)	12.57	22.96	31.39	0.33	.
Surface DO (mg/L)	4.06	7.53	11.11	0.08	.
Bottom DO (mg/L)	0.1	3.75	9.55	0.13	Increasing
Surface pH	6.84	7.95	8.99	0.02	.
Bottom pH	6.91	7.76	8.77	0.02	.
Surface Salinity (ppt)	0.9	14.13	29.3	0.42	Increasing
Bottom Salinity (ppt)	15.8	27.46	35.1	0.21	.
Surface Phosphorus (µg/L)	2.5	10.38	18	0.17	Increasing
Surface Nitrogen (µg/L)	100	215.84	370	3.41	.
Surface Chlorophyll (µg/L)	1	2.22	5.92	0.06	.

3.7.16 Lesser Region 7: Garnier Bayou

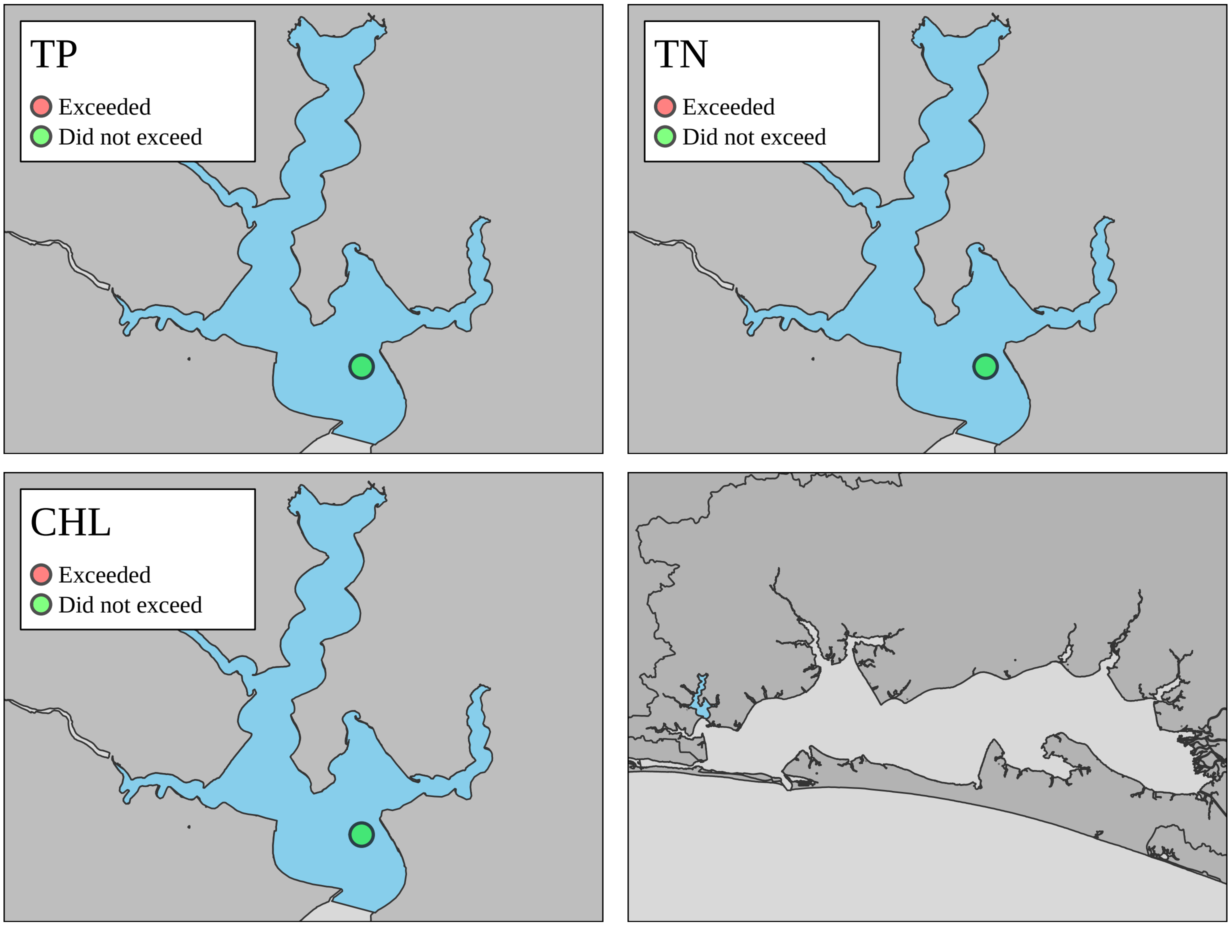

Figure 25: Choctawhatchee Bay Lesser Region 7: Garnier Bayou. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.17 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Garnier Bayou exceeded the recommended threshold in 1 months out of the last 36 months (3%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in Garnier Bayou exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Garnier Bayou exceeded the recommended threshold in 0 months out of the last 36 months (0%). Chlorophyll in this region has been decreasing over the last decade.

3.7.18 Trophic state index

For summer, 2024, total chlorophyll in the Garnier Bayou region averaged 2.45, yielding a TSI classification of 39.39 and indicating that the region is currently oligotrophic.

Table 28: 2024 Water Chemistry values for Garnier Bayou

	Min	Mean	Max	Std Error
Surface Temperature (C)	11.00	23.14	31.61	2.14
Bottom Temperature (C)	14.39	23.06	30.39	1.76
Surface DO (mg/L)	6.83	7.96	9.87	0.28
Bottom DO (mg/L)	1.36	4.83	7.55	0.62
Surface pH	7.82	7.96	8.10	0.02
Bottom pH	7.61	7.82	7.95	0.04
Surface Salinity (ppt)	16.60	21.10	27.90	1.03
Bottom Salinity (ppt)	30.40	32.37	33.60	0.28
Surface Phosphorus (µg/L)	8.00	11.85	18.00	0.85
Surface Nitrogen (µg/L)	114.00	212.59	294.00	16.91
Surface Chlorophyll (µg/L)	1.00	2.45	4.00	0.27

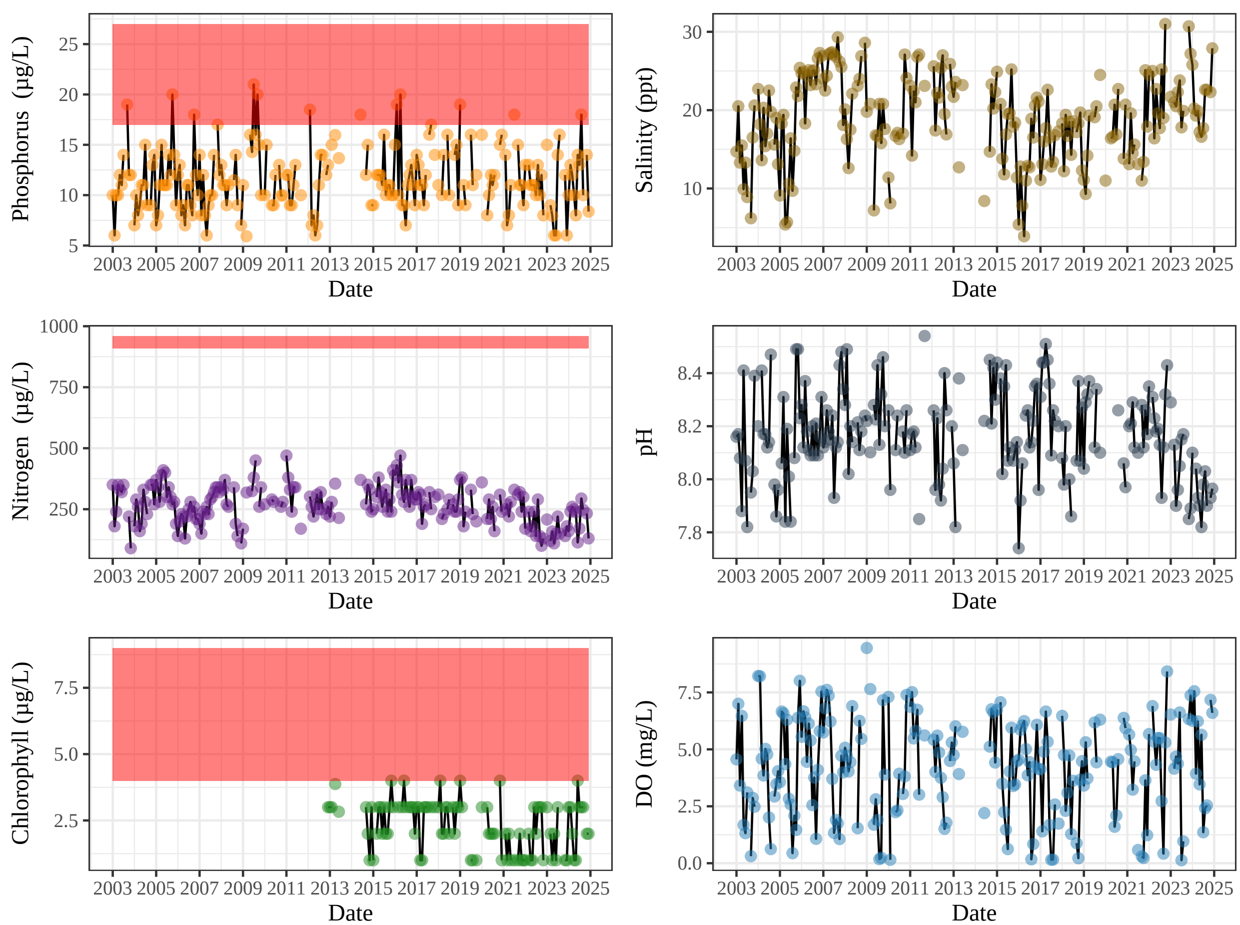

Figure 26: Timeseries of water chemistry variables in Garnier Bayou. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 29: Long-Term Water Chemistry values for Garnier Bayou

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	10.28	22.93	32.11	0.39	.
Bottom Temperature (C)	11.61	22.58	31.06	0.33	.
Surface DO (mg/L)	4.35	7.88	11.01	0.07	.
Bottom DO (mg/L)	0.13	4.21	9.45	0.13	.
Surface pH	7.74	8.17	8.54	0.01	Decreasing
Bottom pH	7.28	7.92	8.45	0.01	.
Surface Salinity (ppt)	3.9	18.93	31	0.34	Increasing
Bottom Salinity (ppt)	23.7	30.45	35	0.15	Increasing
Surface Phosphorus (µg/L)	5.92	11.67	21	0.19	.
Surface Nitrogen (µg/L)	90	267.11	470	4.64	Decreasing
Surface Chlorophyll (µg/L)	1	2.34	4	0.06	Decreasing

3.7.19 Lesser Region 8: Santa Rosa Sound

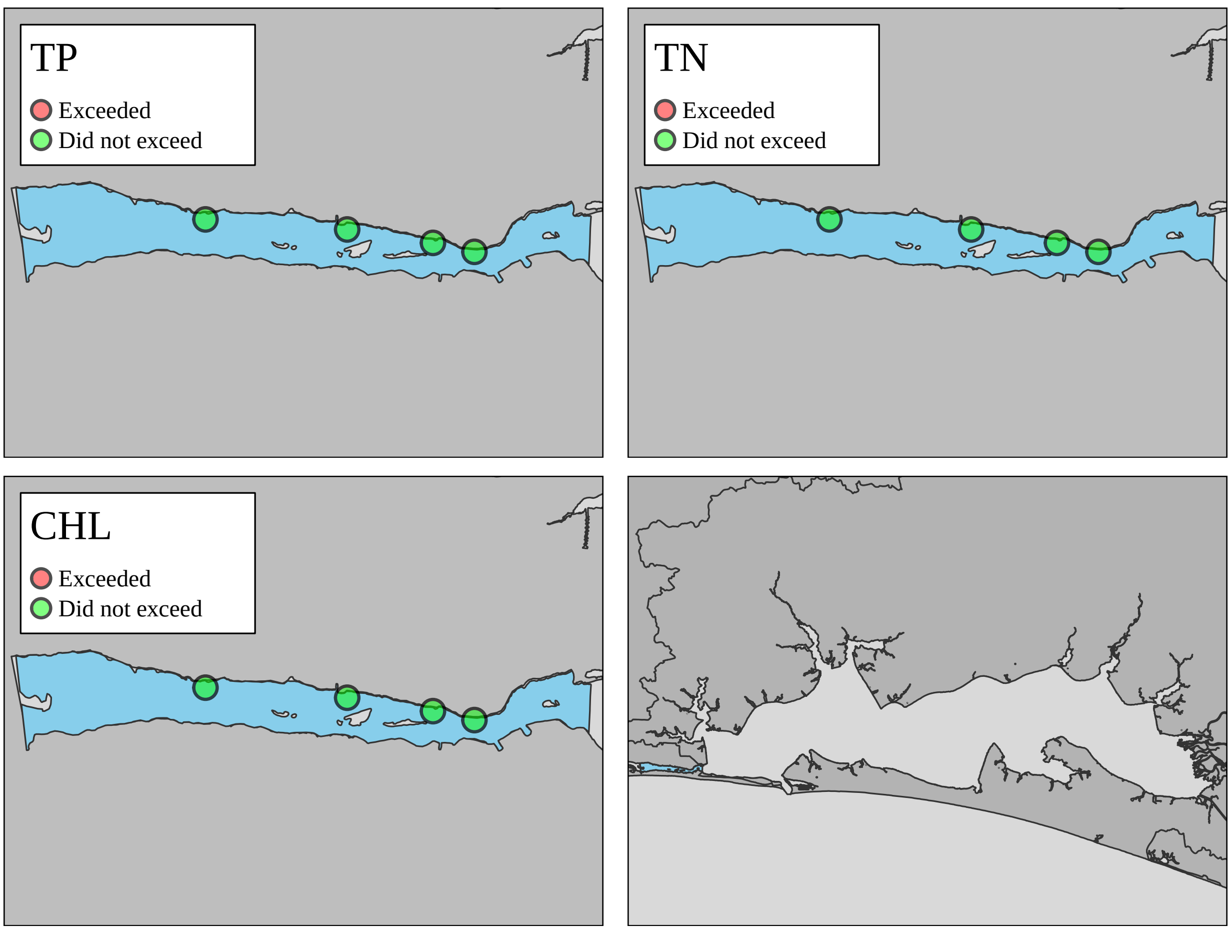

Figure 27: Choctawhatchee Bay Lesser Region 8: Santa Rosa Sound. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region.

3.7.20 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in Santa Rosa Sound exceeded the recommended threshold in 0 months out of the last 36 months (0%). Phosphorus in this region has been stable over the last decade.
- **Nitrogen**: On average, TN values in Santa Rosa Sound exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been decreasing over the last decade.
- **Chlorophyll**: On average, total chlorophyll values in Santa Rosa Sound exceeded the recommended threshold in 3 months out of the last 36 months (8%). Chlorophyll in this region has been decreasing over the last decade.

3.7.21 Trophic state index

For summer, 2024, total chlorophyll in the Santa Rosa Sound region averaged 2.11, yielding a TSI classification of 37.93 and indicating that the region is currently oligotrophic.

Table 30: 2024 Water Chemistry values for Santa Rosa Sound

	Min	Mean	Max	Std Error
Surface Temperature (C)	13.18	22.58	31.03	1.99
Bottom Temperature (C)	12.82	22.43	30.97	1.99
Surface DO (mg/L)	6.15	7.69	9.49	0.32
Bottom DO (mg/L)	6.16	7.64	9.43	0.33
Surface pH	7.76	7.94	8.20	0.04
Bottom pH	7.76	7.94	8.19	0.04
Surface Salinity (ppt)	17.00	21.77	27.00	0.97
Bottom Salinity (ppt)	17.20	22.24	27.10	0.91
Surface Phosphorus (µg/L)	8.00	11.39	17.00	0.74
Surface Nitrogen (µg/L)	81.00	186.22	243.03	15.25
Surface Chlorophyll (µg/L)	1.00	2.11	3.75	0.26

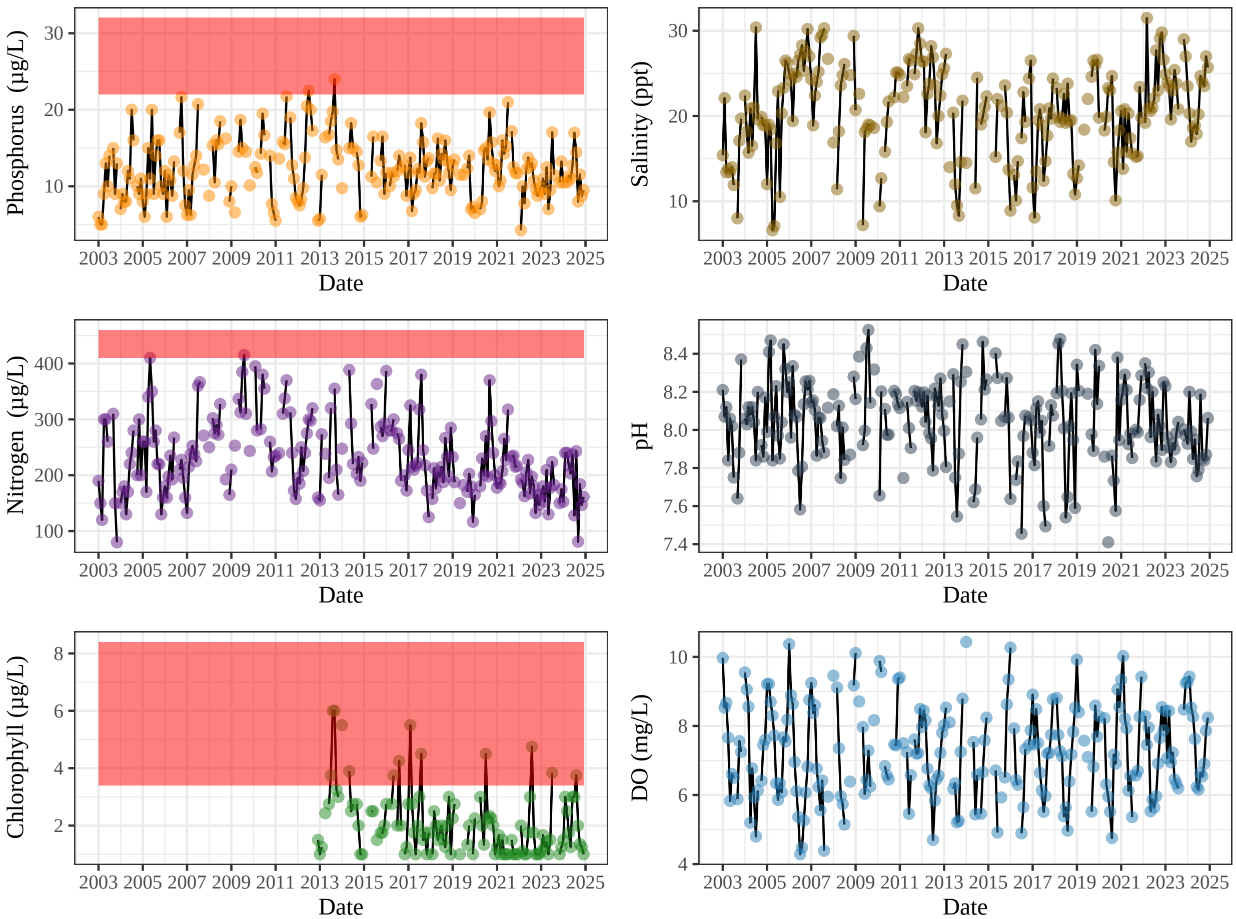

Figure 28: Timeseries of water chemistry variables in Santa Rosa Sound. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 31: Long-Term Water Chemistry values for Santa Rosa Sound

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	8.26	22.7	32.97	0.39	.
Bottom Temperature (C)	8.24	22.52	32.78	0.38	.
Surface DO (mg/L)	4.58	7.41	11.33	0.08	.
Bottom DO (mg/L)	4.28	7.28	10.43	0.08	.
Surface pH	7.41	8.04	8.53	0.01	.
Bottom pH	7.41	8.03	8.54	0.01	.
Surface Salinity (ppt)	6.6	20.51	31.5	0.33	Increasing
Bottom Salinity (ppt)	8	21.1	32.1	0.31	Increasing
Surface Phosphorus (µg/L)	4.25	12.23	24	0.24	.
Surface Nitrogen (µg/L)	80	231.76	415	4.14	Decreasing
Surface Chlorophyll (µg/L)	1	2.09	6	0.07	Decreasing

3.7.22 Lesser Region 9: Choctawhatchee River

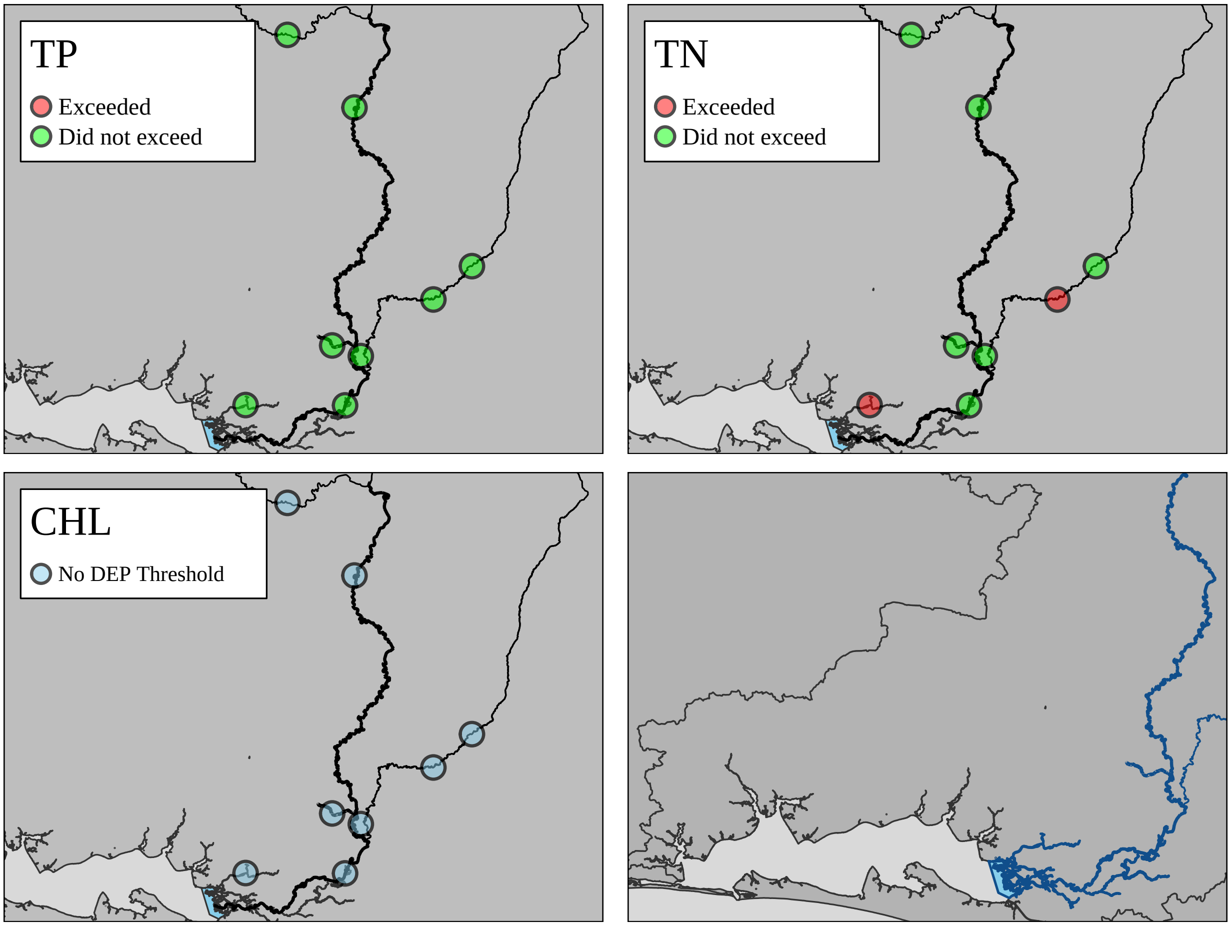

Figure 29: Choctawhatchee Bay Lesser Region 9: Choctawhatchee River. Coloration for each station is based on whether 2024 mean phosphorus, nitrogen, and chlorophyll values exceeded (red) or did not exceed (green) recommended DEP numeric nutrient criteria for the region for the present year. Figure in the bottom-right corner depicts the relative location and extent (blue) of the region. Note that FDEP Chlorophyll threshold values do not exist for this region, so numeric nutrient criteria cannot be evaluated. Bay sites included in the trends analysis for the Choctawhatchee River include Black Creek, Choctawhatchee River at Cowford Landing, Seven Runs Creek, Holmes Creek, Choctawhatchee River at Westville, and Pea River.

3.7.23 Numeric nutrient criteria

- **Phosphorus**: On average, TP values in River exceeded the recommended threshold in 0 months out of the last 36 months (0%). Phosphorus in this region has been increasing over the last decade.
- **Nitrogen**: On average, TN values in River exceeded the recommended threshold in 0 months out of the last 36 months (0%). Nitrogen in this region has been increasing over the last decade.
- **Chlorophyll**: FDEP Chlorophyll threshold values do not exist for this region, so numeric nutrient criteria cannot be evaluated.

3.7.24 Trophic state index

For summer, 2024, total chlorophyll in the River region averaged 2.98, yielding a TSI classification of 41.31 and indicating that the region is currently mesotrophic.

Table 32: 2024 Water Chemistry values for the Choctawhatchee River

	Min	Mean	Max	Std Error
Surface Temperature (C)	10.91	20.74	29.00	0.64
Bottom Temperature (C)	10.56	20.86	29.36	0.65
Surface DO (mg/L)	3.94	7.21	9.74	0.16
Bottom DO (mg/L)	2.85	6.69	9.31	0.18
Surface pH	5.28	6.77	7.68	0.07
Bottom pH	5.10	6.77	7.74	0.07
Surface Salinity (ppt)	0.02	0.07	0.38	0.01
Bottom Salinity (ppt)	0.02	0.22	2.55	0.06
Surface Phosphorus (µg/L)	9.00	27.65	62.33	1.27
Surface Nitrogen (µg/L)	265.00	527.17	830.00	14.27
Surface Chlorophyll (µg/L)	1.00	2.98	10.00	0.20

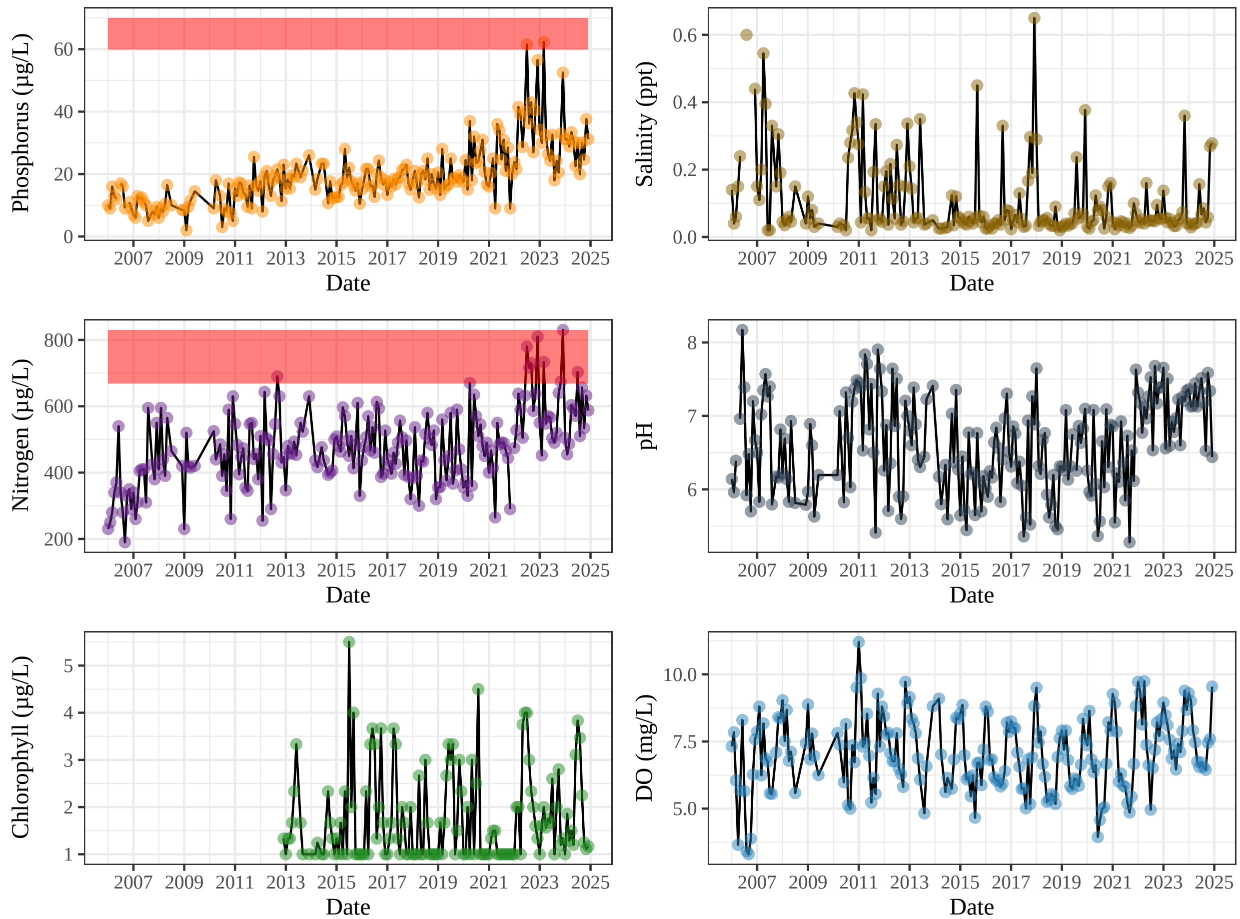

Figure 30: Timeseries of water chemistry variables in The Choctawhatchee River. CBA chlorophyll data were uncorrected for pheophytins until 2013. As a result, only chlorophyll data post-correction (i.e., 2013-present) are reported here. Red areas in the graphs denote exceedance of NNC thresholds where applicable.

Table 33: Long-Term Water Chemistry values for the Choctawhatchee River

	Min	Mean	Max	Std Error	10-Year Trend
Surface Temperature (C)	8.22	20.49	31.11	0.34	.
Bottom Temperature (C)	9.11	20.94	31.11	0.35	.
Surface DO (mg/L)	3.3	7.08	11.2	0.09	Increasing
Bottom DO (mg/L)	0.15	5.63	9.31	0.13	Increasing
Surface pH	5.28	6.61	8.17	0.04	Increasing
Bottom pH	5.06	6.51	7.83	0.04	Increasing
Surface Salinity (ppt)	0.02	0.11	0.65	0.01	.
Bottom Salinity (ppt)	0.02	0.73	10.4	0.12	.
Surface Phosphorus (µg/L)	2	19.59	62.33	0.6	Increasing
Surface Nitrogen (µg/L)	190	474.44	830	6.99	Increasing
Surface Chlorophyll (µg/L)	0.9	2.98	15.2	0.14	.

4 Citations

Blaylock, D. 1983. Choctawhatchee Bay: Analysis and interpretation of baseline environmental data. Technical Paper No. 29. Pensacola, FL: Institute for Statistical and Mathematical Modeling, University of West Florida.

FDEP. 2010. Overview of approaches for nutrient criteria development in marine waters.

Florida Natural Areas Inventory (FNAI). 2010. Guide to the natural communities of Florida: 2010 edition. Florida Natural Areas Inventory, Tallahassee, FL.

Frazer, T. K., Hoyer, M. V., Notestein, S. K., Hale, J. A., and Canfield Jr, D. E. (2001). Physical, chemical and vegetative characteristics of five Gulf coast rivers. Final Report. Southwest Florida Water Management District, Brooksville, Florida.

Hemming, J. M. and J. M. Brown. 2004. Sediment analysis in Choctawhatchee Bay. PublicationNo. PCFO-EC-04-01. Panama City, FL: U.S. Fish and Wildlife Service, Panama City Field Office

Hoyer, M. V., Terrell, J. B., and Canfield Jr, D. E. (2013). Water chemistry in Choctawhatchee Bay, Florida USA: spatial and temporal considerations based on volunteer collected data. Florida Scientist, 453-466.

Hyman, A. C., & Stephens, D. B. (2020). Effects of seawater exchange on water chemistry among coastal lakes with intermittent connections to the sea. Estuarine, Coastal and Shelf Science, 244, 106934.

Livingston, R. J. 2010. Choctawhatchee River-Bay system: A nutrient report for the Florida Department of Environmental Protection. FDEP, Tallahassee

McSweeney, S. L., Kennedy, D. M., Rutherfurd, I. D., and Stout, J. C. (2017). Intermittently Closed/Open Lakes and Lagoons: Their global distribution and boundary conditions. Geomorphology, 292, 142-152.

Northwest Florida Water Management District (NWFWMD). 1996. Choctawhatchee River and Bay system surface water improvement and management plan. Program Development Series 96-4, Havana, F

Pebesma, E. J. (2004). Multivariable geostatistics in S: the gstat package. Computers and geosciences, 30(7), 683-691.

Roy, P. S., Williams, R. J., Jones, A. R., Yassini, I., Gibbs, P. J., Coates, B., West, R.J., Scanes, P.R., Hudson, J.P., and Nichol, S. (2001). Structure and function of south-east Australian estuaries. Estuarine, Coastal and Shelf Science, 53(3), 351-384.

U.S. Census Bureau. (2024). QuickFacts: Walton County, Florida. https://www.census.gov/quickfacts/fact/table/waltoncountyflorida/PST045223