



Assessment of Estuarine Water Quality at Timucuan Ecological and Historic Preserve

2023 Data Summary



Looking east-northeast across the Nassau River on a calm July morning.
NPS / SECN

Assessment of estuarine water quality at Timucuan Ecological and Historic Preserve: 2023 data summary

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Abstract

In July 2023, the Southeast Coast Network assessed water-quality at Timucuan Ecological and Historic Preserve as part of the National Park Service Vital Signs Monitoring Program. Monitoring was conducted following methods developed by the Environmental Protection Agency (EPA) as part of the National Coastal Assessment Program (EPA 2014). Laboratory analysis measured chlorophyll *a* and total and dissolved concentrations of nitrogen and phosphorous. Field measurements included water temperature, pH, dissolved oxygen, and salinity. Water clarity, which requires a Secchi depth measurement, was calculated when possible. All measured parameters were rated as good, fair, or poor based on thresholds set by the EPA (2012).

The purpose of this document is to report the most recently collected data from the Preserve as part of an ongoing long-term water-quality monitoring program. This report was designed to provide water-quality monitoring data to managers as a concise summary in the context of applicable federal standards developed by the EPA. Previous synoptic assessments of water-quality conditions at Timucuan Ecological and Historic Preserve were conducted in July 2008, August 2013, and July 2018 as part of NPS Inventory and Monitoring efforts.

Based on the summary water-quality index rating, overall water-quality conditions at Timucuan Ecological and Historic Preserve during 2023 sampling were fair. The summary water-quality index rating for overall water-quality conditions is consistent with findings in 2008 and 2013, and an improvement from a poor rating in 2018.

Summary and Key Findings

In July 2023 the Southeast Coast Network assessed water-quality at Timucuan Ecological and Historic Preserve as part of the National Park Service Vital Signs Monitoring Program. Monitoring was conducted following methods developed by the Environmental Protection Agency (EPA) as part of the National Coastal Assessment Program (EPA 2014). Laboratory analysis measured chlorophyll *a* and total and dissolved concentrations of nitrogen and phosphorous. Field measurements included water temperature, pH, dissolved oxygen, and salinity. Water clarity, which requires a Secchi depth measurement, was calculated when possible. All measured parameters were rated as good, fair, or poor based on thresholds set by the EPA (2012).

- Water clarity was rated good at nine sites (30%), fair at ten sites (33%) and poor at eleven sites (37%).
- Chlorophyll *a* concentrations were rated good at five sites (17%), fair at twenty-two sites (73%) and poor at three sites (10%).
- Dissolved inorganic nitrogen (DIN) concentrations were good at all thirty sites (100%).
- Dissolved inorganic phosphorus (DIP) concentrations were good at four sites (13%), fair at twenty-three sites (77%) and poor at three sites (10%).
- Dissolved oxygen concentrations (bottom) were rated good at seventeen sites (57%) and fair at thirteen sites (43%).
- A water-quality condition summary index was calculated for each site sampled at Timucuan Ecological and Historic Preserve based on the categorical assessments of chlorophyll *a*, DIN and DIP concentrations, dissolved oxygen, and water clarity. This summary index indicated good water-quality conditions at two sites (7%), fair at twenty-four sites (80%), and poor at four sites (13%).
- See [supplemental materials](#) to compare the distribution of good, fair, and poor ratings for each parameter across the period of record.
- Based on the summary water-quality index rating, overall water-quality conditions at Timucuan Ecological and Historic Preserve during 2023 sampling were fair.
- The summary water-quality index rating for overall water-quality conditions at Timucuan Ecological and Historic Preserve is consistent with findings in 2008 and 2013, and an improvement from a poor rating in 2018.

Introduction

Overview

Due to the importance of water resources to park management from ecological, regulatory, and visitor experience perspectives, estuarine water and sediment quality in and around parks were selected to be monitored by the National Park Service (NPS) Inventory and Monitoring Division's Southeast Coast Network (SECN; DeVivo et al. 2008). Since 2005, the SECN has employed a multiscale approach to assess estuarine resources in seven park units located in North Carolina, Georgia, and Florida. Data collected as part of this effort are intended help resource managers: (1) better understand ecological processes and impacts caused by development, (2) make informed management decisions, and (3) form/maintain strategic partnerships to monitor and improve water-quality conditions in and around park units. In addition, given the diverse and dynamic nature of estuaries, this monitoring is intended to capture the spatial and temporal variability of these systems.

Monitoring at permanent fixed stations using continuous data loggers and discrete samples allow for evaluation of temporal patterns in core water quality parameters (dissolved oxygen, pH, salinity, temperature, and turbidity), nutrients (nitrogen and phosphorus) and chlorophyll *a*. While fixed-station monitoring provides fine resolution data to determine diel, monthly, and seasonal fluctuations in water quality, it lacks spatial extent. To fill this gap, spatial variability of water and sediment quality is determined with park-wide assessments every five years. These assessments include discrete sampling of nutrients, water quality parameters, and evaluation of sediment contaminants following methods developed by the Environmental Protection Agency-National Coastal Assessment Program. This monitoring approach leads to an understanding of the spatiotemporal status and variability of estuarine water quality and yields information useful to park management.

The SECN's monitoring approach is extensively documented in the Protocol for Monitoring Estuarine Water and Sediment Quality in Selected Southeast Coast Network Parks: Protocol Narrative (Gregory et al. 2013 and Starkey et al. 2023) and associated Standard Operating Procedures (SOPs). Version 1.0 of the protocol (Gregory et al. 2013) was implemented between 2007 and 2018. Version 2.0 of the protocol (Starkey et al. 2023) was implemented 2019 to present and was updated to align with new technology and techniques documented in revised Standard Operating Procedures. Monitoring objectives remain consistent across both versions of the protocol.

Monitoring Objectives

The Southeast Coast Network identified an overall goal of monitoring the status and trends in water and sediment quality in estuaries surrounding SECN parks. To achieve this goal, data are collected and analyzed to meet four specific monitoring objectives. These objectives remain consistent across both versions of the protocol (Gregory et al. 2013; Starkey et al. 2023) and are listed below.

1. Determine diel and seasonal water-quality patterns for five core parameters (dissolved oxygen, salinity, temperature, pH, and turbidity) at selected coastal areas near SECN parks using fixed-station continuous data loggers.

2. Determine monthly and seasonal patterns in nutrients (nitrogen and phosphorus) and chlorophyll *a* at selected coastal areas near SECN parks by collecting discrete water samples.
3. Determine status and spatial variability of water and nutrient conditions in estuarine waters every five years near SECN parks.
4. Determine status and spatial variability of benthic sediment quality (organic contaminants, carbon, and metal levels) every 10 years in estuarine waters near SECN parks.

This report summarizes water-quality monitoring data collected during a parkwide assessment to address objective 3 at Timucuan Ecological and Historic Preserve. Data were gathered from July 24–July 27, 2023. The purpose of this document is to report the most recently collected data from the Preserve as part of an ongoing long-term water-quality monitoring program. This report was designed to provide water-quality monitoring data to managers as a concise summary in the context of applicable federal standards developed by the Environmental Protection Agency (EPA). Previous synoptic assessments of water-quality conditions at Timucuan Ecological and Historic Preserve were conducted in July 2008, August 2013, and July 2018 as part of I&M monitoring efforts (Gregory et al. 2011; Wright et al. 2013; Starkey et al. 2019).

Study Area

Timucuan Ecological and Historic Preserve

Timucuan Ecological and Historic Preserve encompasses 18,600 hectares (46,000 acres) of salt marsh and coastal hammock habitat in addition to estuarine, marine, and brackish open waters (Figure 1). The park includes the seaward confluence of the Nassau and St. Johns Rivers and is along the northeastern coast of Florida in Duval County and entirely within the city limits of Jacksonville. Timucuan Ecological and Historic Preserve includes several rare and vulnerable natural communities including coastal strand, maritime hammock, scrub, and shell mound habitat. Other state and city parks in the area include Big and Little Talbot Island State Parks, Fort George Island Cultural State Park, Little Jetties Park, Huguenot Memorial Park, and the Sisters Creek Park and boat ramp (Anderson et al. 2005).

Water resources are an integral part of the park with approximately 75% of the protected area composed of wetlands and open water. These resources include numerous tidal creeks, portions of the Nassau and St. Johns Rivers, Sisters Creek/Intracoastal Waterway (ICWW), and the Fort George River. The park's estuarine setting serves as a vital ecological link between freshwater habitats and the ocean. The waters of Timucuan Ecological and Historic Preserve have been affected by land use in the surrounding watersheds. Examples of water-quality issues applicable to the park include nonpoint source pollution from urban and agricultural areas, elevated metal concentrations in the sediments of the St. Johns River, effects of several Superfund sites and landfills, and water pollution from malfunctioning septic systems within and adjacent to Timucuan Ecological and Historic Preserve (Anderson et al. 2005).

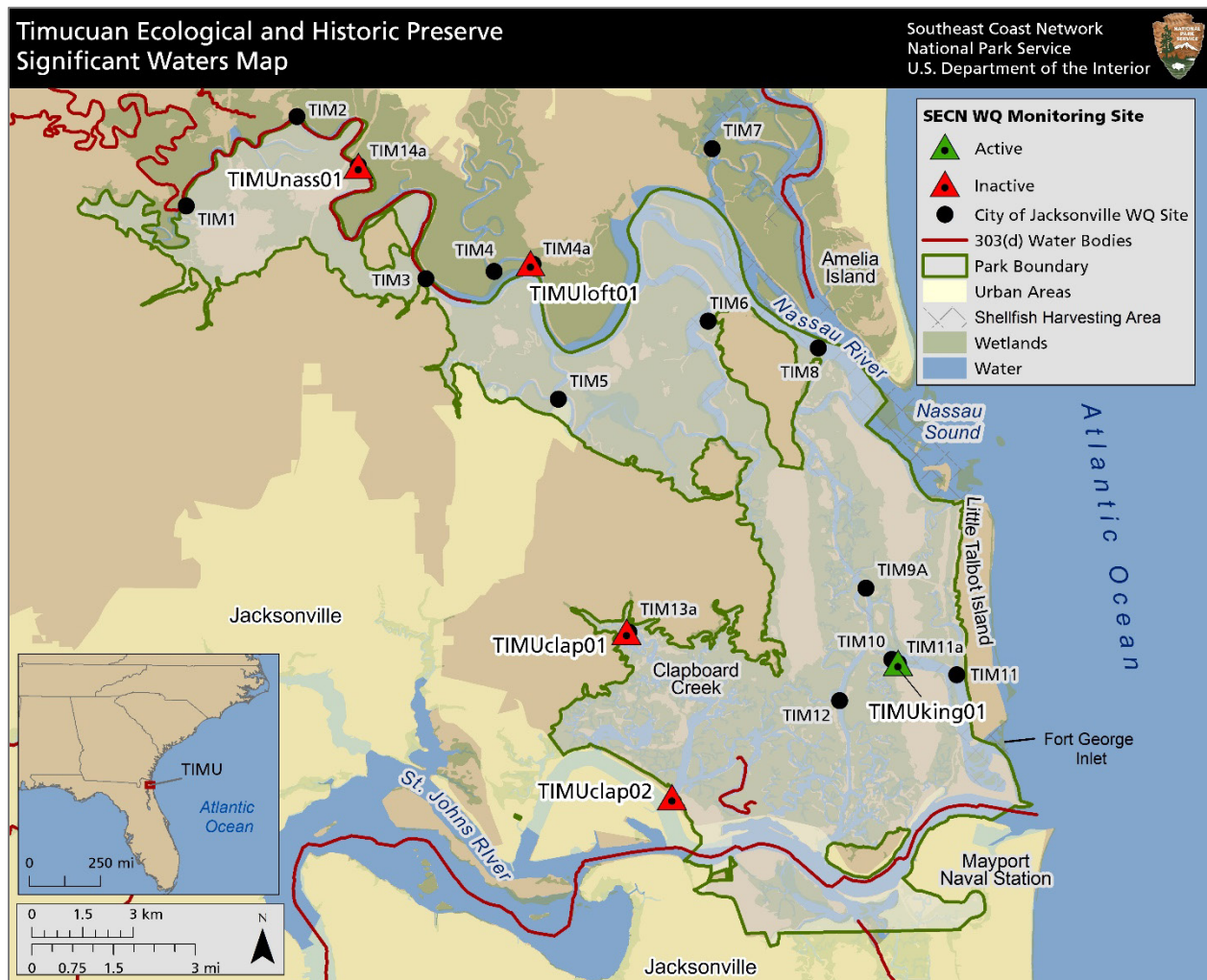


Figure 1. Southeast Coast Network and City of Jacksonville fixed-station monitoring sites and estuarine and marine water resources in the vicinity of Timucuan Ecological and Historic Preserve in Florida. Indicated are areas of wetlands (FWS 2024), urbanized area (USCB 2023), 303(d) listed water bodies (EPA 2022) and shellfish harvesting area (FDEP 2011). NPS / SECN

Methods

The water-quality assessment was conducted in estuarine waters in the vicinity of Timucuan Ecological and Historic Preserve, following the methods developed by the Environmental Protection Agency (EPA) National Coastal Assessment Program. Descriptions of the water-quality parameters and the assessment criteria are from the EPA National Coastal Assessment IV Report (EPA 2012). Methods used for these assessments were adapted and integrated into protocols tailored specifically to parks in the Southeast Coast Network (Starkey et al. 2023). Site selection and sampling methodology are briefly outlined in the following sections.

In 2023, thirty sites in estuarine waters near the preserve were randomly selected for monitoring following methods developed by the EPA (Table 1, Figure 2; Stevens 1997; Stevens and Olsen 1999; Stevens and Olsen 2004). This method of randomly selecting spatially balanced sites provides managers with a statistically valid estimate of the overall conditions of the assessed resource within or around the park.

Table 1. Site name (which includes site number 01, 02, ...etc.), waterbody name and location, depth, coordinates, and chemical and physical attributes of sampling sites at Timucuan Ecological and Historic Preserve, July 24–27, 2023. The table references site names used to present data in this report (Figure 2). All coordinates are in NAD83 Datum, in UTM zone 17. Salinity, pH, and water temperature measured at a depth of 0.5 meters unless water depth was too shallow in which case it was measured at 0.1 meters. [SAV—sub-aquatic vegetation; m—meters; °C—degrees Celsius; PSU—practical salinity units].

Site Name	Water Body	UTMX	UTMY	SAV	Debris	Site Depth (m)	Water Temp (°C)	pH	Salinity (PSU)
TIMU01_2023	Saint Johns River	454905	3361730	No	No	8.5	29.24	7.93	25.68
TIMU02_2023	Nassau River	454720	3377426	No	No	5.6	29.99	7.95	33.53
TIMU03_2023	Nassau River	450743	3381732	No	No	9.2	30.67	7.82	31.59
TIMU04_2023	Nassau River	442983	3381312	No	No	4.8	29.99	7.25	17.69
TIMU05_2023	Fort George River	459749	3366177	No	No	4.4	30.67	8.17	35.46
TIMU06_2023	Shad Creek	458053	3363045	No	No	6.0	30.66	8.04	26.62
TIMU07_2023	Nassau River	453462	3378552	No	No	6.3	30.45	7.82	31.70
TIMU08_2023	Pumpkin Hill Creek	450617	3379056	No	No	4.8	31.24	7.75	30.12
TIMU09_2023	Hannah Mills Creek	454502	3363436	No	No	2.0	31.72	7.98	22.08
TIMU10_2023	Clapboard Creek	450635	3368071	No	No	1.4	30.02	7.51	19.64
TIMU11_2023	Clapboard Creek	451720	3364957	No	No	1.5	31.65	8.01	19.52
TIMU12_2023	Back River	451552	3380141	No	No	3.1	30.33	7.62	29.39
TIMU13_2023	Cedar Point Creek	452729	3363547	No	No	0.6	30.23	7.60	21.62
TIMU14_2023	Pumpkin Hill Creek	453635	3371943	No	No	1.0	31.31	7.50	28.33
TIMU15_2023	Browns Creek	450477	3365887	No	No	1.1	31.16	7.94	21.64
TIMU16_2023	Nassau River	456721	3376588	No	No	5.9	30.03	7.96	33.64
TIMU17_2023	Fort George River	458612	3367669	No	No	0.6	31.43	8.04	32.58
TIMU18_2023	Nassau River	455709	3376863	No	No	3.4	29.90	7.96	33.63
TIMU19_2023	Nassau River	449246	3377300	No	No	4.1	30.09	7.55	28.05
TIMU20_2023	Unnamed Tributary to Nassau River	439332	3383119	No	No	1.5	28.96	6.85	5.92
TIMU21_2023	Mud River	457445	3369563	No	No	1.7	30.85	7.62	26.44

Table 1 (continued). Site name (which includes site number 01, 02, ...etc.), waterbody name and location, depth, coordinates, and chemical and physical attributes of sampling sites at Timucuan Ecological and Historic Preserve, July 24–27, 2023. The table references site names used to present data in this report (Figure 2). All coordinates are in NAD83 Datum, in UTM zone 17. Salinity, pH, and water temperature measured at a depth of 0.5 meters unless water depth was too shallow in which case it was measured at 0.1 meters. [SAV—sub-aquatic vegetation; m—meters; °C—degrees Celsius; PSU—practical salinity units].

Site Name	Water Body	UTMX	UTMY	SAV	Debris	Site Depth (m)	Water Temp (°C)	pH	Salinity (PSU)
TIMU22_2023	Hannah Mills Creek	455062	3363996	No	No	3.0	31.42	7.99	21.90
TIMU23_2023	Sawpit Creek	454752	3375095	No	No	6.5	30.75	7.79	29.94
TIMU24_2023	Nassau River	450496	3380944	No	No	1.3	30.15	7.56	28.99
TIMU25_2023	Cedar Point Creek	453375	3364609	No	No	0.5	30.16	7.78	21.88
TIMU26_2023	Cedar Point Creek	453776	3365674	No	No	0.5	31.15	7.83	21.75
TIMU27_2023	Saint John River	448986	3364934	No	No	10.4	30.41	7.94	20.67
TIMU28_2023	Nassau River	452912	3379592	No	No	0.1	30.22	7.81	31.87
TIMU29_2023	Clapboard Creek	451487	3364485	No	No	3.4	30.22	7.76	20.97
TIMU30_2023	Sawpit Creek	456212	3372925	No	No	0.6	30.74	7.55	28.36

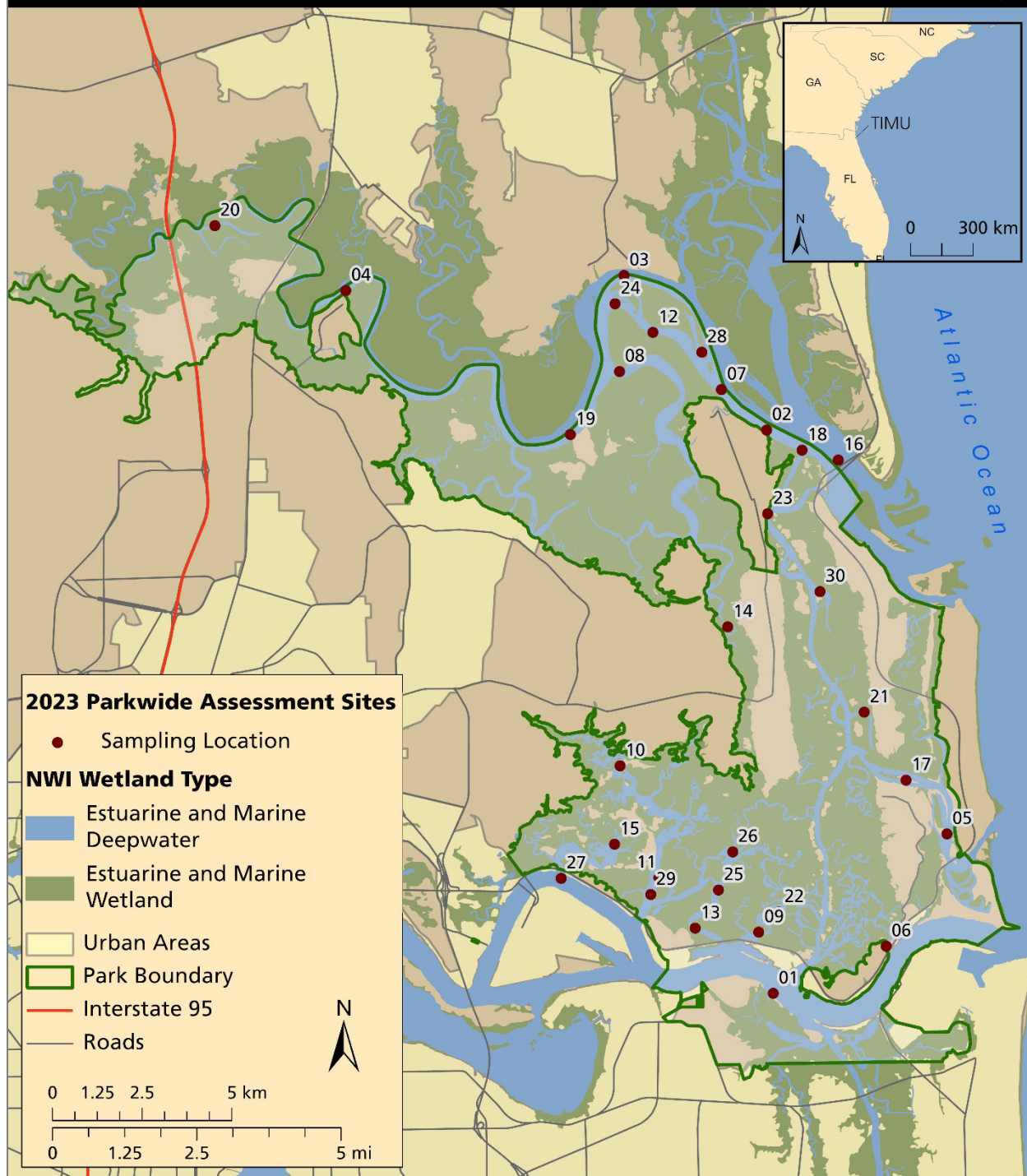


Figure 2. Map showing the location of parkwide assessment sites (site numbers from Table 1) sampled in July 2023 at Timucuan Ecological and Historic Preserve. NPS / SECN

Water-Quality Data Collection

The water-quality assessment conducted during this sampling period incorporated hydrographic profiles at 0.5–1.0 meter (1.6–3.3 feet) intervals at each site, to measure temperature, pH, dissolved oxygen, and salinity. Chlorophyll *a* and total dissolved nutrient samples were collected from 0.5 meters (1.6 feet) below the surface. Chlorophyll *a* samples were processed using known volumes of water samples that were filtered onto glass-fiber filters then refrigerated and submitted for laboratory analysis.

Water clarity was estimated at each site using a Secchi disk to determine light extinction depths, which were converted to light attenuation coefficients (*k*) using the equation: $k = c / \text{Secchi depth}$ (in meters) where “*c*” is a constant that corresponds to the water body’s naturally occurring clarity conditions (i.e., *c* = 1.0 for naturally turbid conditions, *c* = 1.4 for normal turbidity conditions, or *c* = 1.7 for waters supporting submerged aquatic vegetation (SAV) restoration [Smith et al. 2006; EPA 2016]). Timucuan Ecological and Historic Preserve uses a constant (*c*) of 1.4 because the area experiences “normal turbidity” conditions (EPA 2016). This method of estimating water-clarity condition is generally used when information on light transmission in the water column is missing. The Southeast Coast Network is reporting derived values to maintain data consistency across other network parks. Water clarity was not assessed at sites with excessive current or depths too shallow to ascertain an accurate Secchi depth measurement. When sites were too shallow to access by boat, or when they were in heavily trafficked channels where safety was a concern, alternate sites were used.

Water-Quality Assessment Criteria

The categorical assessments (e.g., good, fair, poor) use measurements of chlorophyll *a*, nutrient concentrations, bottom dissolved oxygen, and water clarity (Table 2) and are intended to characterize acutely degraded water-quality conditions at a site. The assessments do not consistently identify sites that experience occasional or infrequent hypoxia, nutrient enrichment, or decreased water clarity. Therefore, a rating of poor for the water-quality index means the site likely exhibited consistently poor conditions before or after the assessment period. If a site is designated fair or good, the site did not experience poor conditions on the date of sampling; however, the site could be characterized by poor conditions for short time periods.

Site assessments were also made using an index that combines the ratings for each parameter into a site-specific water-quality index rating. This index allows for general comparisons between sites in a park (Table 3) and can be used to summarize overall conditions in the waters around a park. This rating also allows general comparisons between parks and at the same park over time based on the percentage of sites that fall within the good, fair, or poor categories.

Table 2. Water-quality monitoring condition criteria for water-quality parameters collected by the Southeast Coast Network based on thresholds set by EPA (2012) [$\mu\text{g/L}$ —micrograms per liter; mg/L —milligrams per liter].

Rating	Water Clarity (k) ^A	Chlorophyll a ($\mu\text{g/L}$)	Dissolved Inorganic Nitrogen (DIN) (mg/L)	Dissolved Inorganic Phosphorus (DIP) (mg/L)	Dissolved Oxygen (mg/L)
Good	< 1.61	< 5	< 0.1	< 0.01	>5
Fair	1.61–2.30	5–20	0.1–0.5	0.01–0.05	2–5
Poor	> 2.30	> 20	> 0.5	> 0.05	<2

^A Light attenuation coefficients (k) were used to assess water-clarity conditions using criteria categories in Smith et al. (2006) which are comparable to the EPA (2012) criteria for the assessed water bodies.

Table 3. Condition criteria used for water-quality assessment summaries at individual sampling sites and parks.

Rating	Site Water-Quality Index Rating ^A	Park Water-Quality Index Rating ^A
Good	A maximum of one indicator is rated fair, and no indicators are rated poor.	Less than 10% of sites are in poor condition, and more than 50% of sites are in good condition.
Fair	One indicator is rated poor, or two or more indicators are rated fair.	10% to 20% of sites are in poor condition, or 50% or less of sites are in good condition.
Poor	Two or more of the five indicators are rated poor.	More than 20% of sites are in poor condition.
Missing	Two components of the indicator are missing, and the available indicators do not suggest a fair or poor rating.	NA

^A Park and site water-quality index ratings are adapted from ratings established by the EPA (2012).

Results

Parameter-Based Water Condition Assessments

Figures 3–7 illustrate the spatial distribution of sampling sites and the corresponding ratings for water clarity, chlorophyll *a*, dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), and bottom-reading dissolved oxygen (DO) based on each parameter’s corresponding condition category. Inset graphs on Figures 3–7 show the proportion of sites in the assessed area that were placed in each rating category. The map and graph in Figure 8 summarize Timucuan Ecological and Historic Preserve’s water-quality conditions during the assessment. Site-specific water-quality data for each parameter are also presented in Table 4. For comparison with past assessments, maps and condition rating summary graphs for sample years 2008–2023 can be found in the supplementary materials.

- Water clarity was rated good at nine sites (30%), fair at ten sites (33%) and poor at eleven sites (37%).
- Chlorophyll *a* concentrations were rated good at five sites (17%), fair at twenty-two sites (73%) and poor at three sites (10%).
- Dissolved inorganic nitrogen concentrations were good at all thirty sites (100%).
- Dissolved inorganic phosphorus concentrations were good at four sites (13%), fair at twenty-three sites (77%) and poor at three sites (10%).
- Dissolved oxygen concentrations (bottom) were rated good at seventeen sites (57%) and fair at thirteen sites (43%).
- A water-quality condition summary index was calculated for each site sampled at Timucuan Ecological and Historic Preserve based on the categorical assessments of chlorophyll *a*, DIN and DIP concentrations, dissolved oxygen, and water clarity. This summary index indicated good water-quality conditions at two sites (7%), fair at twenty-four sites (80%), and poor at four sites (13%).
- Site water-quality condition ratings indicate that overall water-quality was better during the 2023 assessment than in 2018 (reduction of poor sites by 10%). However, there were still more sites rated as poor in 2023 than seen in the 2013 and 2008 assessments, 7% and 3% respectively.
- Chlorophyll *a* concentrations improved relative to the 2018 assessment and were similar to ratings in 2013 and 2008.
- See [supplemental materials](#) to compare the distribution of good, fair, and poor ratings for each parameter across the period of record.
- Based on the summary water-quality index rating, overall water-quality conditions at Timucuan Ecological and Historic Preserve during 2023 sampling were fair.

- The EPA summary water-quality index rating for overall water-quality conditions at Timucuan Ecological and Historic Preserve is consistent with findings in 2008 and 2013, and an improvement from a poor rating in 2018.

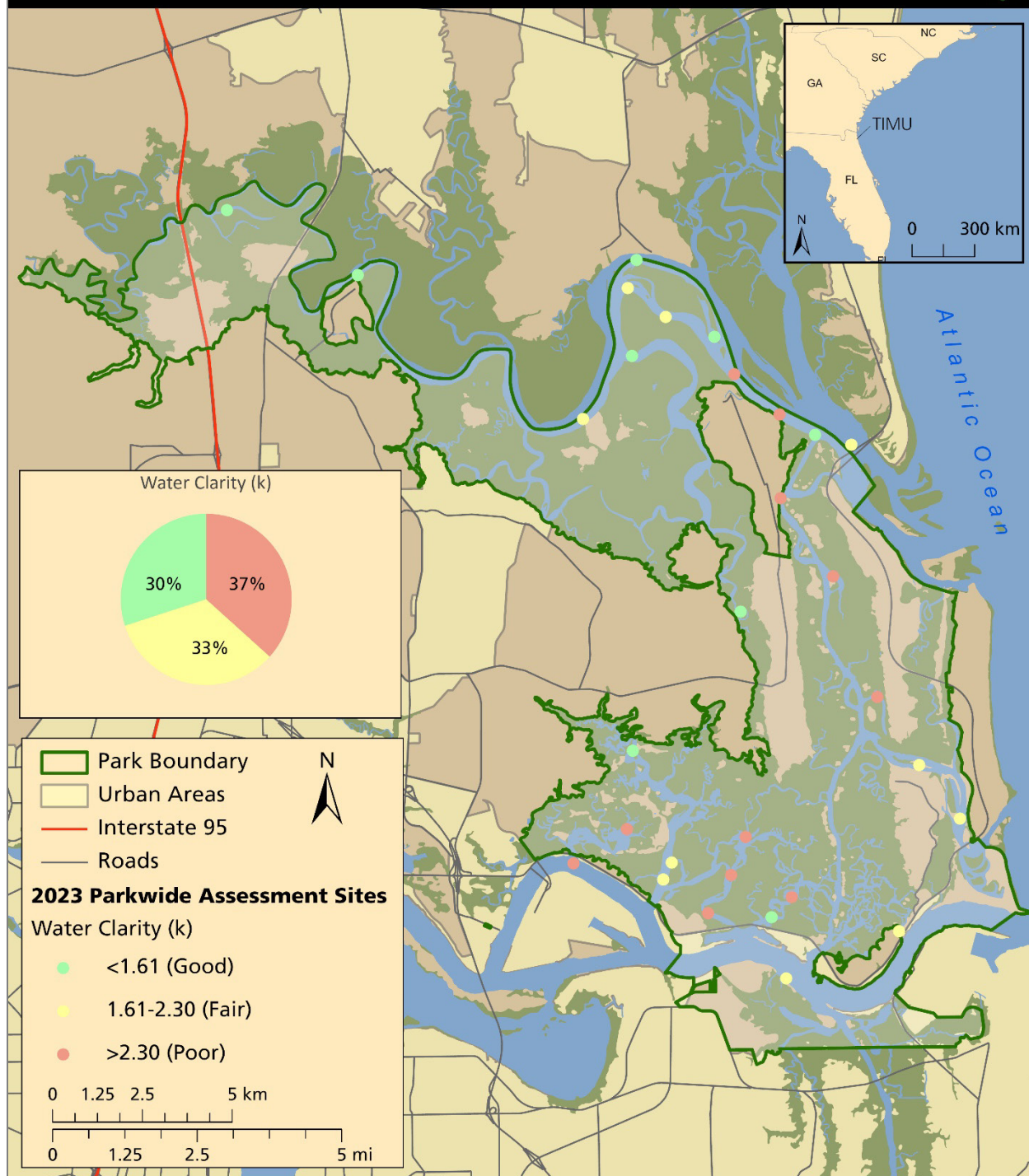


Figure 3. Water clarity ratings for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the percent of sites in each condition category [Green—good; yellow—fair; red—poor]. NPS / SECN

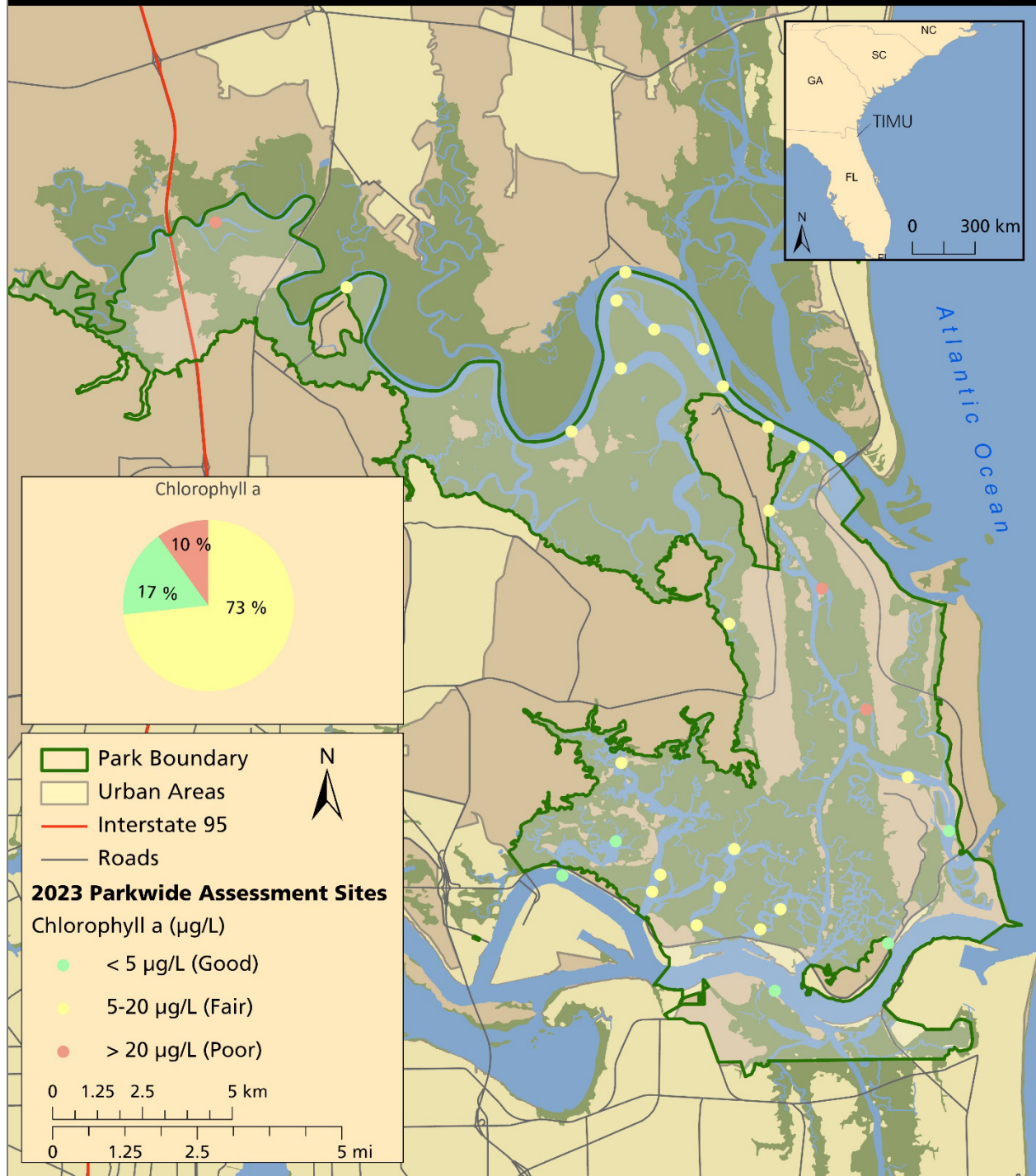


Figure 4. Chlorophyll a concentrations for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the percent of sites in each condition category [Green—good; yellow—fair; red—poor]. NPS / SECN

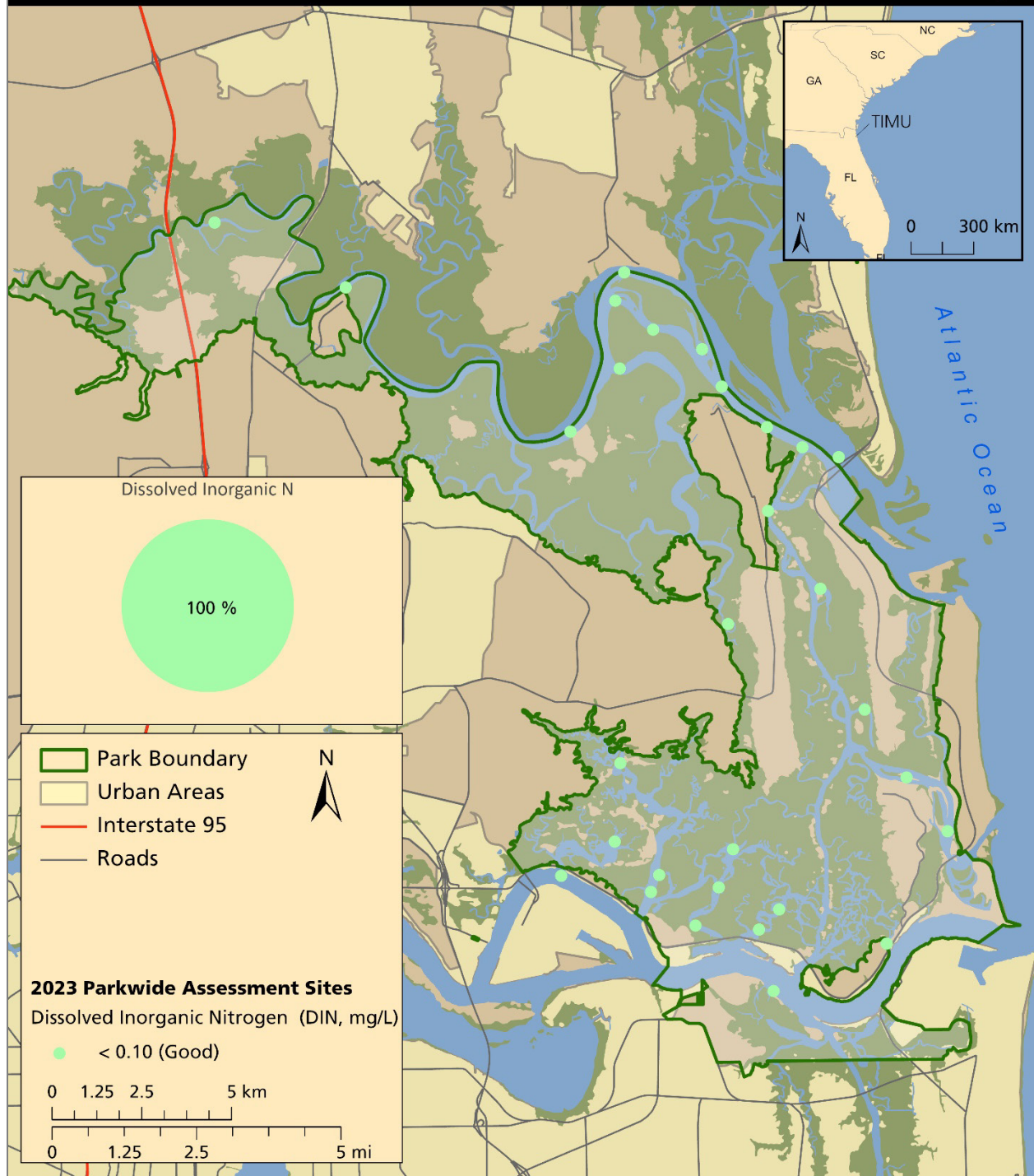


Figure 5. Dissolved inorganic nitrogen concentrations for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the percent of sites in each condition category [Green—good]. NPS / SECN

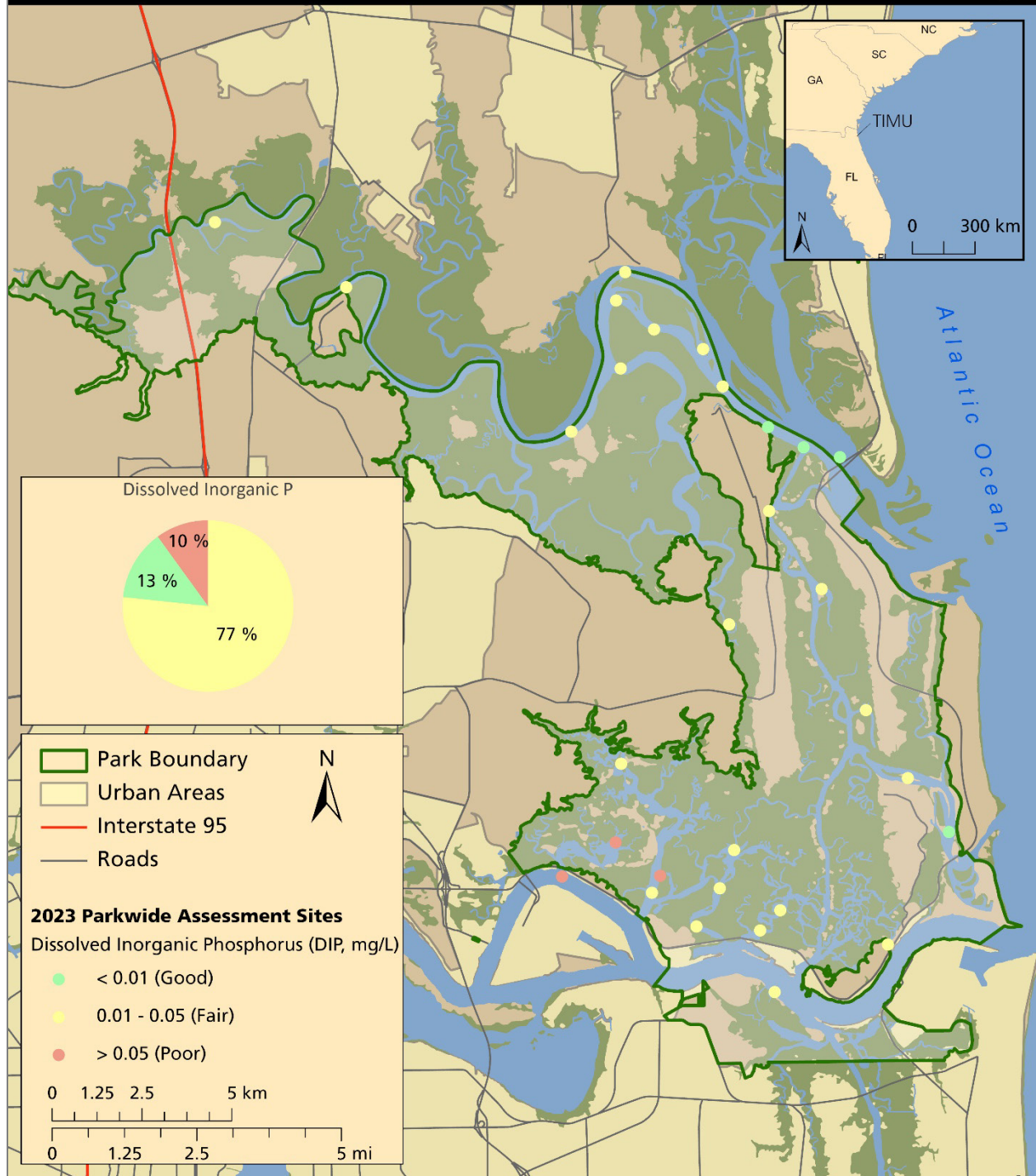


Figure 6. Dissolved inorganic phosphorus concentrations for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the percent of sites in each condition category [Green—good; yellow—fair; red—poor]. NPS / SECN

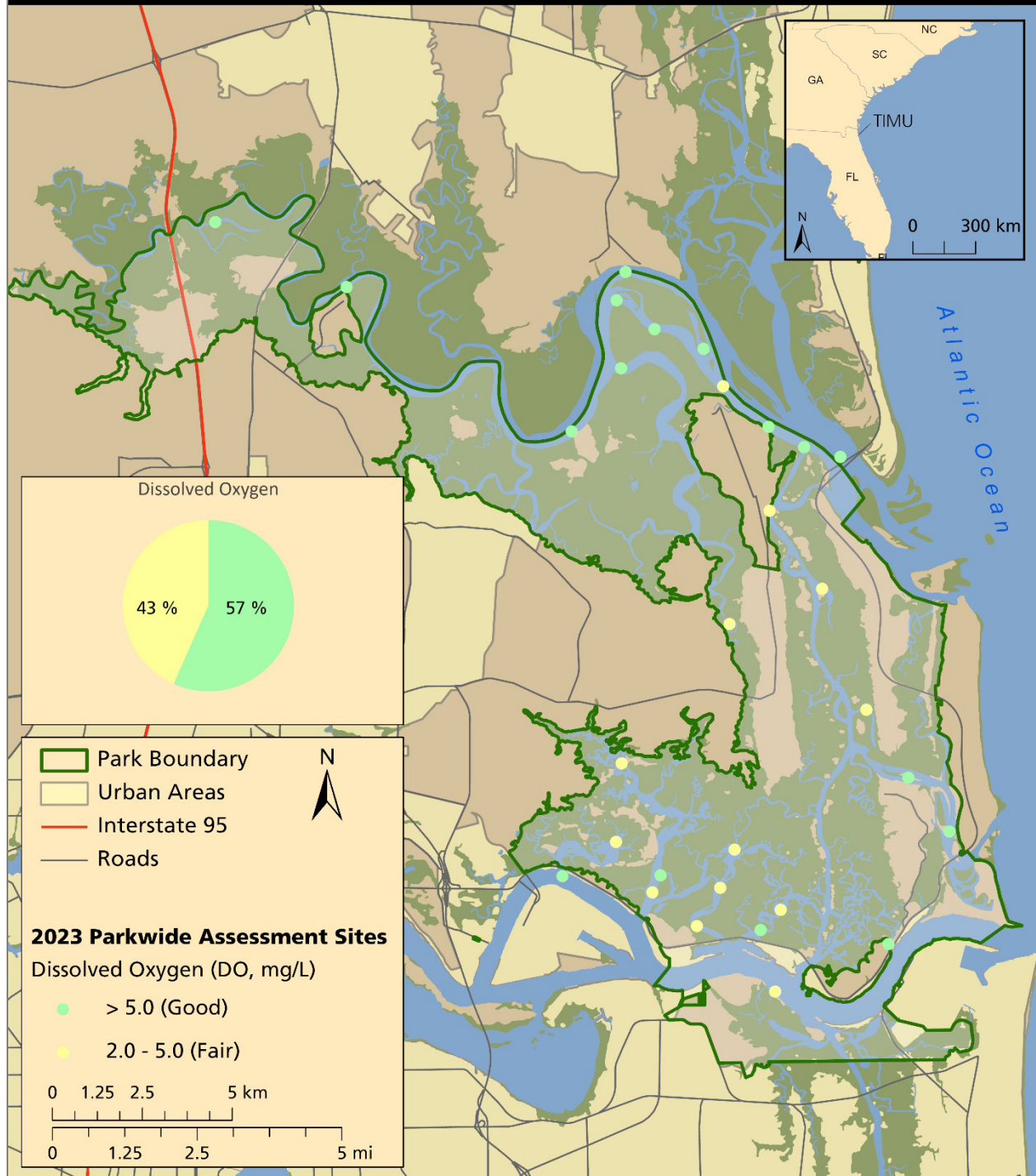


Figure 7. Dissolved oxygen concentrations for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the proportion of sites in each condition category [Green—good; yellow—fair]. NPS / SECN

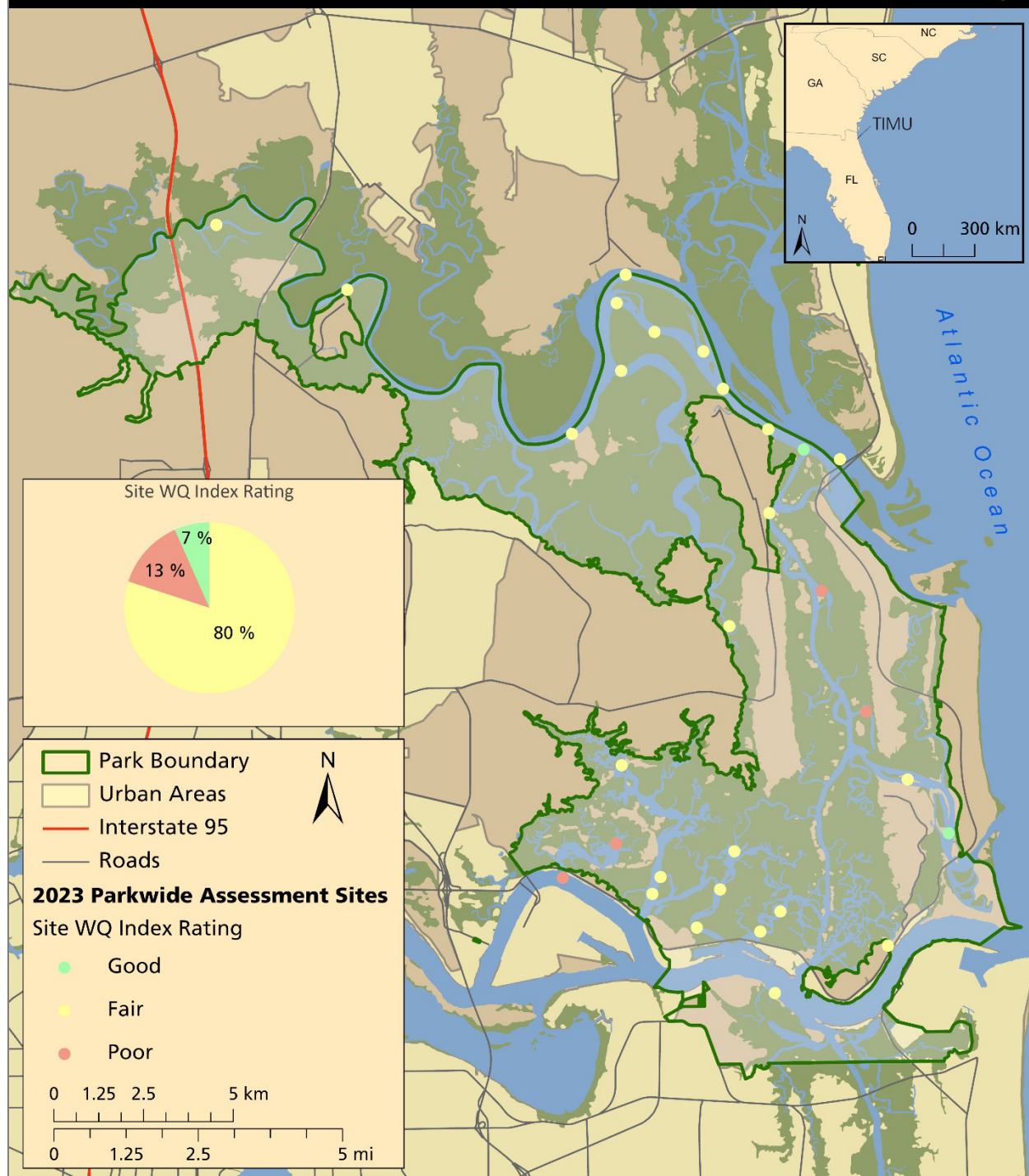


Figure 8. Water-quality index rating for sites sampled at Timucuan Ecological and Historic Preserve July 24–27, 2023. Inset graph shows the proportion of sites in each condition category [Green—good; yellow—fair; red—poor]. NPS / SECN

Table 4. Water-quality parameter values and assessment conditions for sampling sites in the vicinity of Timucuan Ecological and Historic Preserve July 24–27, 2023. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” conditions (Smith et al. 2006) and assessment categories that correspond to EPA (2012). Condition of other assessed parameters based on EPA (2012) [Green ^D —good; yellow ^E —fair; red ^F —poor; *result was less than or equal to the Method Detection Limit [MDL reported]; k— light attenuation coefficient; µg/L—micrograms per liter; N—Nitrogen; mg/L—milligrams per liter; P— Phosphorous; – — data not collected]. Dissolved oxygen concentrations are taken near the bottom (deepest reading).

Site	Water Clarity (k) ^A	Chlorophyll a (µg/L) ^B	Dissolved Oxygen (DO, mg/L) ^B	Dissolved Inorganic Nitrogen (DIN, mg/L) ^B	Dissolved Inorganic Phosphorous (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
TIMU01_2023	1.8 ^E	3.04 ^D	4.8 ^E	0.0827 ^D	0.0382 ^E	0.06	0.0564	Fair ^E
TIMU02_2023	7.0 ^F	6.51 ^E	5.3 ^D	0.0175 ^D	0.0089 ^D	0.05	0.0326	Fair ^E
TIMU03_2023	1.4 ^D	14.53 ^E	6.3 ^D	0.0176 ^D	0.0141 ^E	0.05	0.0326	Fair ^E
TIMU04_2023	1.4 ^D	11.77 ^E	5.7 ^D	0.0350 ^D	0.0338 ^E	0.58	0.0526	Fair ^E
TIMU05_2023	1.8 ^E	1.65 ^D	6.0 ^D	0.0132 ^D	0.0056 ^D	0.05	0.0250	Good ^D
TIMU06_2023	2.0 ^E	3.49 ^D	5.4 ^D	0.0557 ^D	0.0337 ^E	0.05	0.0488	Fair ^E
TIMU07_2023	4.7 ^F	7.57 ^E	4.4 ^E	0.0213 ^D	0.0142 ^E	0.05	0.0326	Fair ^E
TIMU08_2023	0.7 ^D	15.31 ^E	6.8 ^D	0.0207 ^D	0.0166 ^E	0.05	0.0325	Fair ^E
TIMU09_2023	1.1 ^D	7.24 ^E	5.7 ^D	0.0688 ^D	0.0458 ^E	0.06	0.0593	Fair ^E
TIMU10_2023	1.1 ^D	12.00 ^E	4.9 ^E	0.0595 ^D	0.0435 ^E	0.51	0.0622	Fair ^E
TIMU11_2023	1.8 ^E	5.87 ^E	5.4 ^D	0.0694 ^D	0.0512 ^F	0.50	0.0678	Fair ^E

^A Light attenuation coefficients (k) were used to assess water-clarity conditions using criteria categories in Smith et al. (2006) which are comparable to the EPA (2012) criteria for the assessed water bodies.

^B Where µg/L = micrograms per liter, N = Nitrogen; mg/L = milligrams per liter; P = Phosphorous.

^C There are no EPA condition criteria for TDN and TDP.

^D Conditions are assessed as good using parameters from the EPA (2012) (also with a green background).

^E Conditions are assessed as fair using parameters from the EPA (2012) (also with a yellow background).

^F Conditions are assessed as poor using parameters from the EPA (2012) (also with a red background)

Table 4 (continued). Water-quality parameter values and assessment conditions for sampling sites in the vicinity of Timucuan Ecological and Historic Preserve July 24–27, 2023. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” conditions (Smith et al. 2006) and assessment categories that correspond to EPA (2012). Condition of other assessed parameters based on EPA (2012) [Green ^D —good; yellow ^E —fair; red ^F —poor; *result was less than or equal to the Method Detection Limit [MDL reported]; k— light attenuation coefficient; µg/L—micrograms per liter; N—Nitrogen; mg/L—milligrams per liter; P— Phosphorous; — — data not collected]. Dissolved oxygen concentrations are taken near the bottom (deepest reading).

Site	Water Clarity (k) ^A	Chlorophyll a (µg/L) ^B	Dissolved Oxygen (DO, mg/L) ^B	Dissolved Inorganic Nitrogen (DIN, mg/L) ^B	Dissolved Inorganic Phosphorous (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
TIMU12_2023	2.0 ^E	12.73 ^E	5.7 ^D	0.0419 ^D	0.0215 ^E	0.05	0.0517	Fair ^E
TIMU13_2023	2.8 ^F	19.11 ^E	3.8 ^E	0.0398 ^D	0.0494 ^E	0.07	0.0695	Fair ^E
TIMU14_2023	1.4 ^D	18.64 ^E	4.4 ^E	0.0207 ^D	0.0152 ^E	0.05	0.0458	Fair ^E
TIMU15_2023	2.8 ^F	4.96 ^D	4.6 ^E	0.0794 ^D	0.0517 ^F	0.07	0.0709	Poor ^F
TIMU16_2023	1.8 ^E	7.66 ^E	5.4 ^D	0.0135 ^D	0.0077 ^D	0.05	0.0232	Fair ^E
TIMU17_2023	1.8 ^E	6.03 ^E	5.7 ^D	0.0145 ^D	0.0130 ^E	0.05	0.0356	Fair ^E
TIMU18_2023	1.1 ^D	6.34 ^E	5.8 ^D	0.0174 ^D	0.0087 ^D	0.05	0.0254	Good ^D
TIMU19_2023	1.8 ^E	12.07 ^E	6.5 ^D	0.0304 ^D	0.0201 ^E	0.05	0.0403	Fair ^E
TIMU20_2023	1.2 ^D	35.73 ^F	5.6 ^D	0.0116 ^D	0.0420 ^E	0.75	0.0633	Fair ^E
TIMU21_2023	2.8 ^F	23.30 ^F	4.3 ^E	0.0294 ^D	0.0271 ^E	0.05	0.0532	Poor ^F
TIMU22_2023	4.7 ^F	5.02 ^E	4.4 ^E	0.0787 ^D	0.0472 ^E	0.06	0.0645	Fair ^E

^A Light attenuation coefficients (k) were used to assess water-clarity conditions using criteria categories in Smith et al. (2006) which are comparable to the EPA (2012) criteria for the assessed water bodies.

^B Where µg/L = micrograms per liter, N = Nitrogen; mg/L = milligrams per liter; P = Phosphorous.

^C There are no EPA condition criteria for TDN and TDP.

^D Conditions are assessed as good using parameters from the EPA (2012) (also with a green background).

^E Conditions are assessed as fair using parameters from the EPA (2012) (also with a yellow background).

^F Conditions are assessed as poor using parameters from the EPA (2012) (also with a red background)

Table 4 (continued). Water-quality parameter values and assessment conditions for sampling sites in the vicinity of Timucuan Ecological and Historic Preserve July 24–27, 2023. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” conditions (Smith et al. 2006) and assessment categories that correspond to EPA (2012). Condition of other assessed parameters based on EPA (2012) [Green ^D —good; yellow ^E —fair; red ^F —poor; *result was less than or equal to the Method Detection Limit [MDL reported]; k— light attenuation coefficient; µg/L—micrograms per liter; N—Nitrogen; mg/L—milligrams per liter; P— Phosphorous; — — data not collected]. Dissolved oxygen concentrations are taken near the bottom (deepest reading).

Site	Water Clarity (k) ^A	Chlorophyll a (µg/L) ^B	Dissolved Oxygen (DO, mg/L) ^B	Dissolved Inorganic Nitrogen (DIN, mg/L) ^B	Dissolved Inorganic Phosphorous (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
TIMU23_2023	2.8 ^F	7.63 ^E	3.3 ^E	0.0174 ^D	0.0169 ^E	0.05	0.0368	Fair ^E
TIMU24_2023	1.8 ^E	11.51 ^E	5.7 ^D	0.0455 ^D	0.0257 ^E	0.06	0.0627	Fair ^E
TIMU25_2023	2.3 ^F	5.74 ^E	4.2 ^E	0.0726 ^D	0.0439 ^E	0.06	0.0618	Fair ^E
TIMU26_2023	2.8 ^F	6.91 ^E	5.0 ^E	0.0541 ^D	0.0427 ^E	0.06	0.0624	Fair ^E
TIMU27_2023	2.8 ^F	2.83 ^D	5.5 ^D	0.0943 ^D	0.0553 ^F	0.07	0.0680	Poor ^F
TIMU28_2023	1.4 ^D	14.41 ^E	5.2 ^D	0.0222 ^D	0.0141 ^E	0.05	0.0308	Fair ^E
TIMU29_2023	2.0 ^E	5.25 ^E	4.6 ^E	0.0708 ^D	0.0453 ^E	0.06	0.0638	Fair ^E
TIMU30_2023	4.7 ^F	26.48 ^F	3.6 ^E	0.0179 ^D	0.0225 ^E	0.05	0.0467	Poor ^F

^A Light attenuation coefficients (k) were used to assess water-clarity conditions using criteria categories in Smith et al. (2006) which are comparable to the EPA (2012) criteria for the assessed water bodies.

^B Where µg/L = micrograms per liter, N = Nitrogen; mg/L = milligrams per liter; P = Phosphorous.

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Literature Cited

- Anderson, S. M., C. Katin, and W. R. Wise. 2005. Assessment of coastal water resources and watershed conditions at Timucuan Ecological and Historic Preserve. NPS/NRWRD/NRTR—2005/340, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/659893> (last accessed January 2025).
- DeVivo, J. C., C. J. Wright, M. Byrne, E. M. DiDonato, and T. Curtis. 2008. Vital signs monitoring in the Southeast Coast Inventory and Monitoring Network. NPS/SECN/NRR—2008/061, National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/DownloadFile/153409> (last accessed January 2025).
- Florida Department of Environmental Protection. 2011. Surface Water Class Boundaries. GIS coverage of shellfish areas. Available at: <https://geodata.dep.state.fl.us/> (last accessed January 2025).
- Gregory, M. B., J.C. DeVivo, P. H. Flournoy, and K. A. Smith. 2011. Assessment of estuarine water and sediment quality at Timucuan Ecological and Historic Preserve, 2008. Natural Resource Data Series NPS/SECN/NRDS—2011/134. National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/DownloadFile/427391> (last accessed January 2025).
- Gregory, M. B., J. C. DeVivo, E. M. DiDonato, C. J. Wright, and E. Thompson. 2013. Protocol for monitoring estuarine water and sediment quality in selected Southeast Coast Network parks. NPS/SECN/NRR—2013/644, National Park Service, Fort Collins, Colorado. Available at: [DataStore - Protocol for monitoring estuarine water and sediment quality in selected Southeast Coast Network parks](#) (last accessed January 2025).
- National Oceanic and Atmospheric Administration (NOAA). 2023. Marine Protected Areas. GIS coverage Available at: <https://coast.noaa.gov/digitalcoast/tools/mpaviewer.html> (last accessed January 2025).
- Smith, L. M., V. D. Engle, and J. K. Summers. 2006. Assessing water clarity as a component of water quality in Gulf of Mexico estuaries. *Environmental Monitoring & Assessment* 115:291–305.
- Starkey, E. N., M. B. Gregory, W. K. Wright, J. C. DeVivo, E. M. DiDonato, C. J. Wright, and E. Thompson. 2023. Protocol for monitoring estuarine water and sediment quality in selected Southeast Coast Network parks: Protocol narrative—version 2.0. Natural Resource Report NPS/SECN/NRR—2023/2528. National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2299077> (last accessed January 2025).

- Starkey, E. N., W. Wright, and C. S. Cooper. 2019. Assessment of estuarine water and sediment quality at Timucuan Ecological and Historic Preserve: 2018 data summary. Natural Resource Data Series NPS/SECN/NRDS—2019/1236. National Park Service, Fort Collins, Colorado. Available at: [DataStore - Assessment of Estuarine Water and Sediment Quality at Timucuan Ecological and Historic Preserve: 2018 data summary](#) (last accessed January 2025).
- Stevens, D., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association* 99:16.
- Stevens, D. L., Jr. 1997. Variable density grid-based samplings designs for continuous spatial populations. *Environmetrics* 8:167–195.
- Stevens, L., and A. R. Olsen. 1999. Spatially restricted surveys over time for aquatic resources. *Journal of Agricultural, Biological, and Environmental Statistics*:415.
- United States Census Bureau (USCB). 2023. Census 2000 Gateway website. Available at: [Decennial Census of Population and Housing by Decades](#) (last accessed January 2025).
- United States Environmental Protection Agency (EPA). 2012. National Coastal Condition Report IV. EPA-842-R-10–003, Washington D.C. 20460.
- United States Environmental Protection Agency (EPA). 2014. National Coastal Condition Assessment: Field Operations Manual. EPA-841-R-14–007. U.S. Environmental Protection Agency, Washington, D.C. 165 p.
- United States Environmental Protection Agency (EPA). 2016. National Coastal Condition Assessment (NCCA) 2010 Technical Report. Washington, D.C.
- United States Environmental Protection Agency (EPA). 2022. 303(d) listed water bodies (GIS Coverage) US EPA Office of Water. Available at: [How's My Waterway - Community](#) (last accessed January 2025).
- U.S. Fish and Wildlife Service (FWS). 2024. National Wetlands Inventory website. Available at: <http://www.fws.gov/wetlands/> (last accessed January 2025).
- Wright, W., M. B. Gregory, and J. Asper. 2013. Assessment of estuarine water quality at Timucuan Ecological and Historic Preserve, 2013. Natural Resource Data Series NPS/SECN/NRDS—2013/598. National Park Service, Fort Collins, Colorado. Available at: [DataStore - Assessment of estuarine water quality at Timucuan Ecological and Historic Preserve, 2013](#) (last accessed January 2025).

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