



Assessment of Estuarine Water Quality at Fort Matanzas National Monument

2022 Data Summary



Looking north in the Matanzas River from site FOMA-28.

NPS / SECN

Assessment of estuarine water quality at Fort Matanzas National Monument: 2022 data summary

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Contents

	Page
Figures.....	iv
Tables.....	iv
Abstract.....	v
Summary and Key Findings.....	vi
Introduction.....	1
Overview	1
Monitoring Objectives.....	1
Study Area	3
Fort Matanzas National Monument.....	3
Methods.....	6
Water-Quality Data Collection.....	10
Water-Quality Assessment Criteria	10
Results.....	12
Parameter-Based Water Condition Assessments.....	12
Literature Cited	23

Figures

	Page
Figure 1. Fixed station monitoring sites and estuarine and marine water resources in the vicinity of Fort Matanzas National Monument in Florida.	4
Figure 2. Map showing the location of parkwide assessment sites (site numbers from Table 1) sampled in July 2022 at Fort Matanzas National Monument.	9
Figure 3. Water clarity ratings for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	14
Figure 4. Chlorophyll <i>a</i> concentration for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	15
Figure 5. Dissolved inorganic nitrogen concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	16
Figure 6. Dissolved inorganic phosphorus concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	17
Figure 7. Dissolved oxygen concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	18
Figure 8. Water-quality index rating for sites sampled at Fort Matanzas National Monument July 18–21, 2022.	19

Tables

	Page
Table 1. Site name, waterbody name and location, depth, coordinates, and chemical and physical attributes of sampling sites at Fort Matanzas National Monument, July 18–21, 2022.	7
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].	10
Table 3. Condition criteria used for water-quality assessment summaries at individual sampling sites and parks.	11
Table 4. Water-quality parameter values and assessment conditions for sampling sites in the vicinity of Fort Matanzas National Monument July 18–21, 2022.	20

Abstract

In July 2022 the Southeast Coast Network assessed water-quality in the vicinity of Fort Matanzas National Monument 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 monument 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 Fort Matanzas National Monument were conducted in July 2012 and August 2017 as part of NPS Inventory and Monitoring efforts.

Based on the EPA summary water-quality index rating, overall water-quality conditions near Fort Matanzas National Monument during 2022 sampling were fair. The summary water-quality index rating for overall water-quality conditions is consistent with findings from 2012–2017.

Summary and Key Findings

In July 2022 the Southeast Coast Network assessed water-quality in the vicinity of Fort Matanzas National Monument 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 2009). 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 four sites (13%), fair at fifteen sites (50%) and poor at eleven sites (37%).
- Chlorophyll *a* concentration was good at thirteen sites (43%) and fair at seventeen sites (57%).
- Dissolved inorganic nitrogen (DIN) concentration was good at 28 sites (93%) and fair at two sites (7%).
- Dissolved inorganic phosphorus (DIP) concentration was good at one site (3%), fair at twenty-six sites (87%), and poor at three sites (10%).
- Dissolved oxygen concentration (bottom) was rated good at fifteen sites (50%) and fair at fifteen sites (50%).
- A water-quality condition summary index was calculated for each site sampled at Fort Matanzas National Monument 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 three sites (10%), fair water quality conditions at twenty-four sites (80%) and poor water-quality conditions at three sites (10%).
- 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 near Fort Matanzas National Monument during 2022 sampling were fair.
- The summary water-quality index rating is consistent with findings from 2012–2017.

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 network 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 improve water quality. 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 allows for evaluation of temporal patterns in core water quality parameters (dissolved oxygen, pH, salinity, temperature, and turbidity) and 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 meet this goal, data are collected and analyzed for four specific monitoring objectives. These objectives remain consistent across both versions of the protocol (Gregory et al. 2013, Starkey et al. 2023).

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 chemistry 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 Fort Matanzas National Monument. Data were gathered from July 18–July 21, 2022. The purpose of this document is to report the most recently collected data from the monument 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 Fort Matanzas National Monument were conducted in July 2012 and August 2017 as part of I&M monitoring efforts (Wright et al. 2013; Wright et al. 2019).

Study Area

Fort Matanzas National Monument

Fort Matanzas National Monument (FOMA) is 14 miles (22.5 kilometers) south of St. Augustine on the northeast Atlantic coast of Florida. Fort Matanzas encompasses a total of 298 acres (120.6 hectares) divided between the southern tip of Anastasia Island (108 acres or 43.7 hectares) and the northern end of Rattlesnake Island (190 acres or 76.9 hectares) by the Matanzas River Inlet (Figure 1). The visitors center is on a barrier island separated from the Florida mainland by the Matanzas River and the Intracoastal Waterway and consists of stabilized beach dunes rising as much as 25 feet (7.6 meters) above sea level. The main habitats in this portion of the park include beaches along both the Matanzas River and the Atlantic shore, stabilized sand dunes supporting maritime forest, secondary dunes further inland, and salt marsh.

The main attraction of Fort Matanzas National Monument is the 18th century coquina limestone fort on scenic Rattlesnake Island. The island is less than 5 feet (1.5 meters) above sea level, though it rises to 15 feet (4.6 meters) at one point on its northern end. Much of the northern portion of Rattlesnake Island consists of sandy fill pumped in from dredging operations that maintain the boat channels in the Intracoastal Waterway. In addition to the habitats found on Anastasia Island, Rattlesnake Island supports slash pine and red bay woodlands, oyster shell beaches, and developing hardwood forests typified by wax myrtle, cedar, and cabbage palm. Shoals along the river currently allow fishermen on Rattlesnake Island to wade into the middle of the Matanzas River west of the inlet bridge, while shallow bars outside break Atlantic waves before they can roll into the mouth of the Matanzas River. At the Matanzas Inlet, many fish are caught from the bridge, which has a separate protected lane for fishermen, as well as around the inside and outside of the inlet. During the seasonal mullet run, castnetters may take hundreds of pounds. Sharks and tarpon weighing over 100 pounds (45.4 kilograms) have been caught by fishermen standing on the shores of the inlet (SJRWMD 2009).

River water quality at the monument is heavily influenced by the daily tides and flows from upstream portions of the Matanzas River. Water-quality is potentially affected by nearby urban and residential development which mostly occurs immediately adjacent to the eastern side of the river both north and south of the Matanzas River Inlet. For the 2022 reporting cycle, the Matanzas River near the monument (assessment unit FL2363F) was listed by the U. S. Environmental Protection Agency (EPA) as impaired [303(d) listed], due to elevated mercury, iron, and fecal coliform bacteria (EPA 2022). Matanzas River south of the park, near Flagler Beach (water body IDFL2363D), is listed as impaired for chlorophyll *a*, iron, and mercury (EPA 2022).

Fort Matanzas National Monument Significant Waters Map

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Figure 1. Fixed station monitoring sites and estuarine and marine water resources in the vicinity of Fort Matanzas National Monument in Florida. Indicated are areas of salt marsh (FWS 2024), and areas designated as having special uses or restrictions (NOAA 2008). NPS / SECN

The St Johns River Water Management District (SJRWMD) is currently monitoring water quality monthly in the Matanzas River at County Road 312 approximately 15 miles (24.1 kilometers) north of the park as part of their ongoing water-quality assessment program (SJRWMD 2023). Even with the level of development in the watershed, the Matanzas River is one of the most natural areas within the St. Johns River Water Management District's 18-county region along Florida's central east coast and was nominated as an Outstanding Florida Waters (OFW) by the St. Johns River Water Management District (2009).

Methods

The water-quality assessment was conducted in estuarine waters in the vicinity of Fort Matanzas National Seashore, following the methods developed by the Environmental Protection Agency (EPA) National Coastal Assessment Program (EPA 2010). 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 partially 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 2022, thirty sites in estuarine waters near the monument 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, waterbody name and location, depth, coordinates, and chemical and physical attributes of sampling sites at Fort Matanzas National Monument, July 18–21, 2022. 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 (0.3 feet). [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)
FOMA01_2022	Long Creek	479282	3276752	No	No	0.9	28.69	7.59	21.61
FOMA02_2022	Matanzas River	473975	3295131	No	No	1.0	28.78	7.80	34.75
FOMA03_2022	Matanzas River	472873	3297862	No	No	1.0	30.06	7.85	34.08
FOMA04_2022	Pellicer Creek	477452	3281326	No	No	0.6	27.36	7.73	20.70
FOMA05_2022	Matanzas River	479760	3277007	No	No	1.6	29.05	7.78	27.26
FOMA06_2022	Matanzas River	475910	3289335	No	No	3.5	29.09	8.03	35.21
FOMA07_2022	Matanzas River	472550	3297181	No	No	0.9	29.64	7.80	33.98
FOMA08_2022	Matanzas River	474516	3293010	No	No	1.5	30.69	7.94	34.42
FOMA09_2022	Matanzas River	476849	3286405	No	No	4.5	29.47	7.85	30.06
FOMA10_2022	Pellicer Creek	474726	3282133	No	No	1.5	28.46	7.17	3.39
FOMA11_2022	Pellicer Creek	474761	3282169	No	No	1.0	28.46	7.14	2.63
FOMA12_2022	Pellicer Creek	477068	3281194	No	No	0.4	28.82	7.63	24.37
FOMA13_2022	Pellicer Creek	477576	3281601	No	No	0.6	28.14	7.66	23.66
FOMA14_2022	Matanzas River	473267	3294331	No	No	1.1	30.46	7.92	34.61
FOMA15_2022	Matanzas River	475057	3292048	No	No	0.9	31.06	7.91	35.45
FOMA16_2022	Matanzas River	477382	3285675	No	No	1.6	29.24	7.82	29.60
FOMA17_2022	Matanzas River	473776	3294203	No	No	0.9	28.23	7.83	35.11
FOMA18_2022	Matanzas River	479701	3277305	No	No	1.6	28.99	7.76	26.31
FOMA19_2022	Matanzas River	472843	3297987	No	No	1.1	30.29	7.85	34.20
FOMA20_2022	Matanzas River	476788	3287490	No	No	2.1	28.32	8.02	35.79
FOMA21_2022	Matanzas River	473715	3295897	No	No	0.6	28.84	7.81	34.81

Table 1 (continued). Site name, waterbody name and location, depth, coordinates, and chemical and physical attributes of sampling sites at Fort Matanzas National Monument, July 18–21, 2022. 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)
FOMA22_2022	Pellicer Creek	478610	3281030	No	No	1.6	28.55	7.73	24.83
FOMA23_2022	Pellicer Creek	476522	3281106	No	No	0.7	28.53	7.53	13.78
FOMA24_2022	Matanzas River	473398	3296587	No	No	5.8	28.76	7.86	35.14
FOMA25_2022	Matanzas River	474131	3293665	No	No	1.0	29.72	7.91	34.66
FOMA26_2022	Matanzas River	476581	3287632	No	No	1.5	28.67	8.03	35.83
FOMA27_2022	Matanzas River	473781	3294588	No	No	0.8	29.74	7.90	34.64
FOMA28_2022	Matanzas River	478913	3281739	No	No	2.1	28.89	7.75	26.78
FOMA29_2022	Matanzas River	475112	3291970	No	No	1.0	30.40	7.93	35.43
FOMA30_2022	Matanzas River	471593	3298148	No	No	4.5	29.00	7.81	34.82

Fort Matanzas National Monument 2022 Parkwide Assessment Sampling Sites

Southeast Coast Network
National Park Service
U.S. Department of the Interior



Figure 2. Map showing the location of parkwide assessment sites (site numbers from Table 1) sampled in July 2022 at Fort Matanzas National Monument. 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 [ft]) 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 ft) 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]). Fort Matanzas National Monument 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 when they were 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, alternate sites were used.

Water-Quality Assessment Criteria

The categorical assessments (e.g., good, fair, poor) use measurements of chlorophyll *a*, nutrients, bottom dissolved oxygen, and water clarity (Table 2) and are intended to characterize acutely degraded water-quality conditions. 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.

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 <i>a</i> ($\mu\text{g/L}$)	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.

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 based on the percentage of sites that fall within the good, fair, or poor categories.

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 Fort Matanzas National Monument’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 2012–2022 can be found in the supplementary materials.

- Water clarity was rated good at four sites (13%), fair at fifteen sites (50%) and poor at eleven sites (37%).
- Chlorophyll *a* concentration was rated good at thirteen sites (43%) and fair at seventeen sites (57%).
- Dissolved inorganic nitrogen concentration was good at 28 sites (93%) and fair at two sites (7%).
- Dissolved inorganic phosphorus concentration was good at one site (3%), fair at twenty-six sites (87%), and poor at three sites (10%).
- Dissolved oxygen concentration (bottom) was rated good at fifteen sites (50%) and fair at fifteen sites (50%).
- Notably, there were no sites (0%) rated as poor for chlorophyll *a* in 2022, whereas 16% and 7% of sites were rated as poor in 2012 and 2017. While this may be indicative of improving water quality in the southern portion of the surveyed area, site ratings of poor for dissolved inorganic phosphorus (DIP) increased from 0% in 2012 and 2017 to 10% in 2022. Future surveys may further elucidate patterns in DIP. Other parameters have remained relatively consistent over the period of record and suggest stable water-quality.
- A water-quality condition summary index was calculated for each site sampled at Fort Matanzas National Monument 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 three sites (10%), fair water quality conditions at twenty-four sites (80%) and poor water-quality conditions at three sites (10%).
- The site water-quality index ratings are similar to findings in 2012 and 2017 which had 65% and 80% of sites rated as fair respectively.
- 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 near Fort Matanzas National Monument during 2022 sampling were fair.

Fort Matanzas National Monument
2022 Water Clarity (k)

Southeast Coast Network
National Park Service
U.S. Department of the Interior

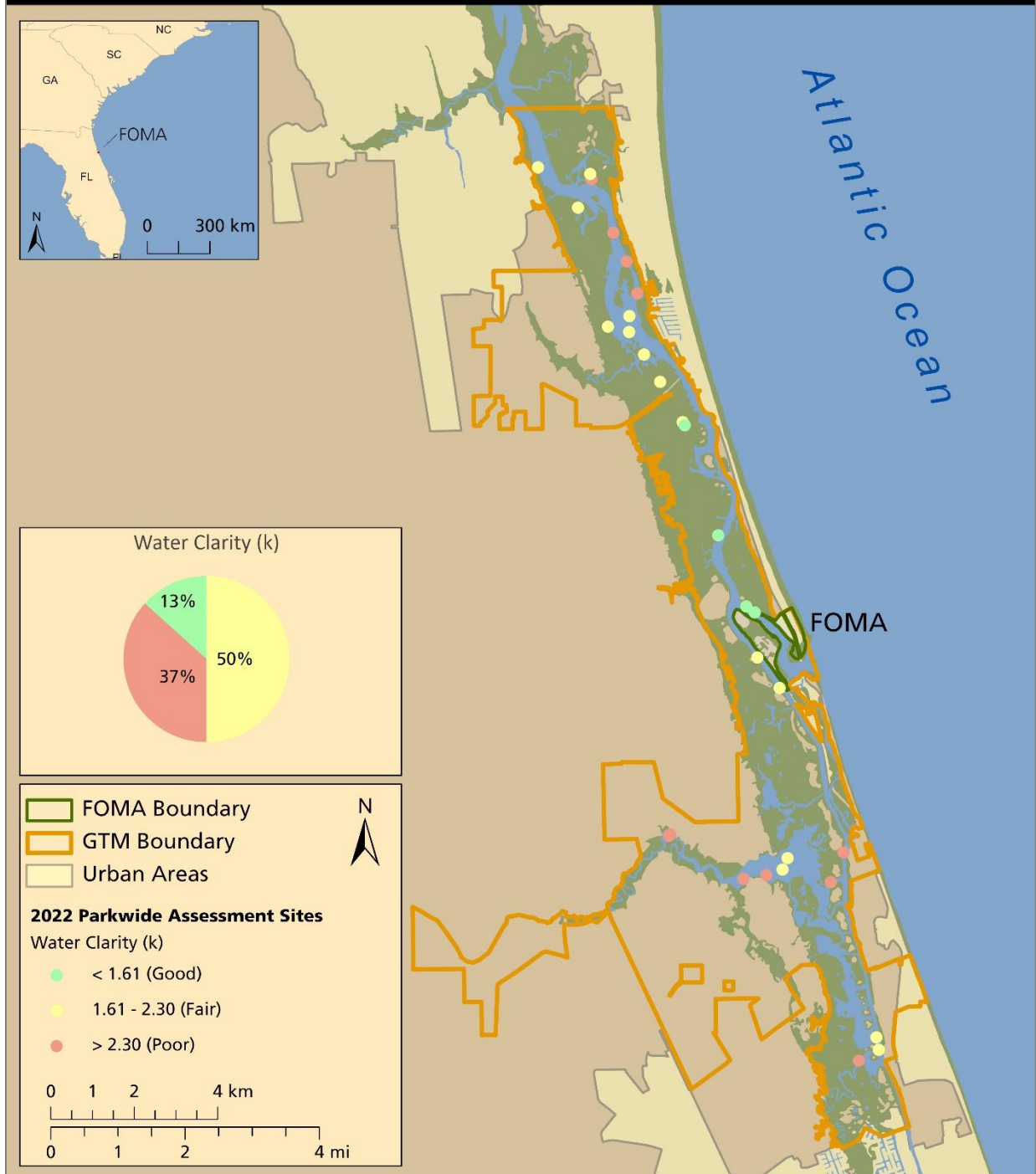


Figure 3. Water clarity ratings for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the percent of sites in each condition category [green—good; yellow—fair; red—poor]. NPS / SECN

Fort Matanzas National Monument
2022 Chlorophyll a

Southeast Coast Network
National Park Service
U.S. Department of the Interior

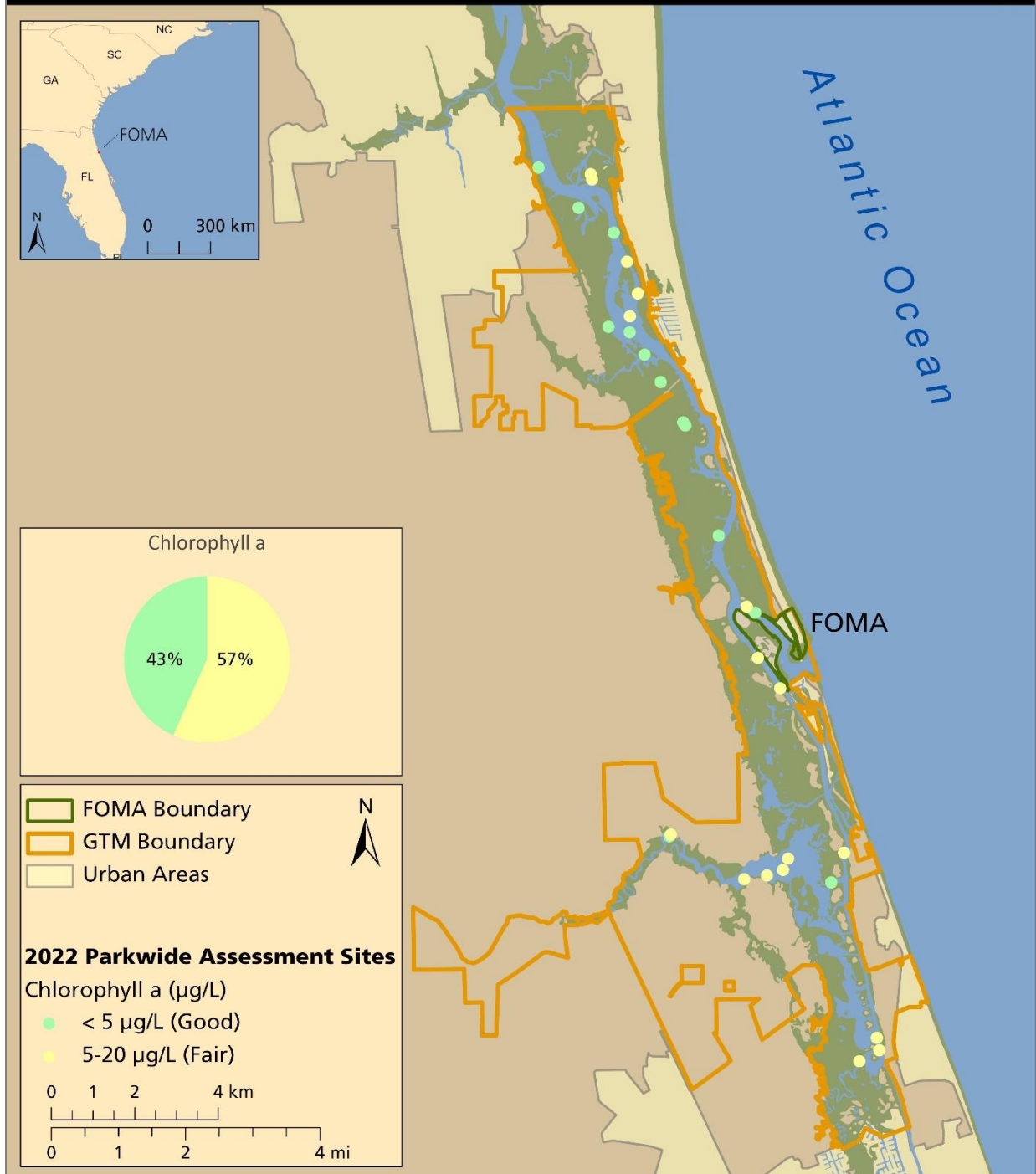


Figure 4. Chlorophyll a concentration for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the percent of sites in each condition category [green—good; yellow—fair].
NPS / SECN

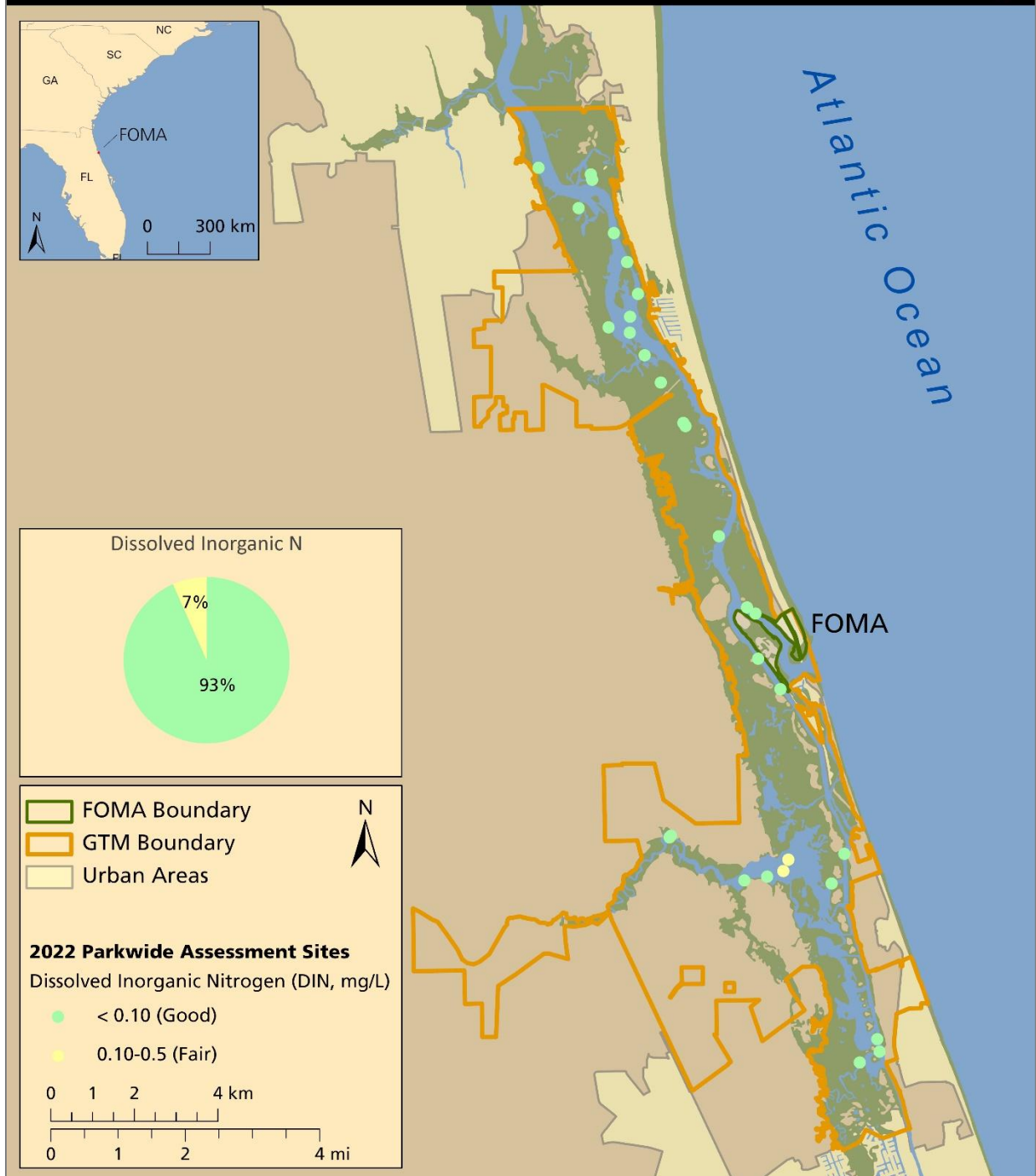


Figure 5. Dissolved inorganic nitrogen concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the percent of sites in each condition category [green—good; yellow—fair]. NPS / SECN

Fort Matanzas National Monument 2022 Dissolved Inorganic Phosphorus

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U.S. Department of the Interior

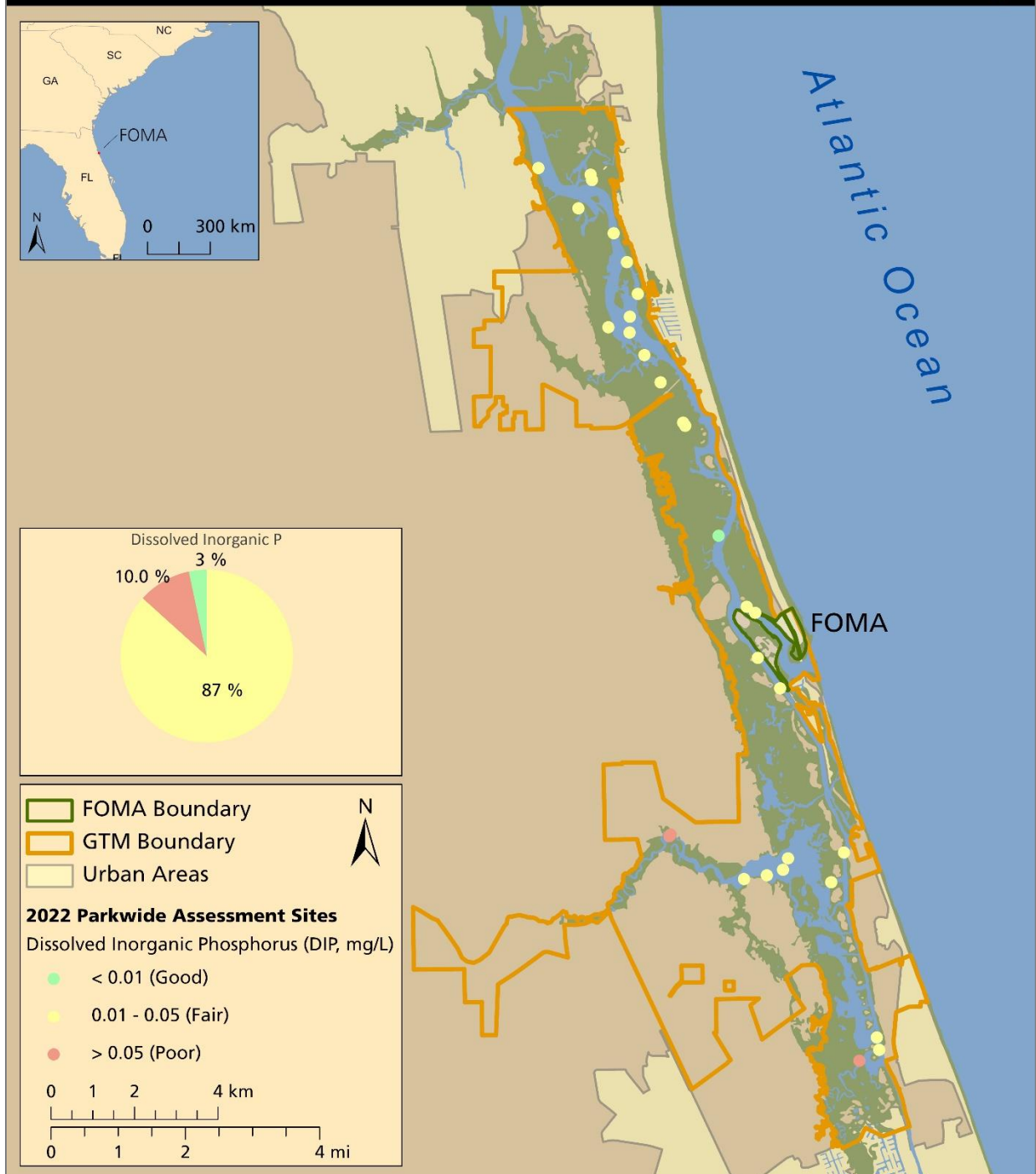


Figure 6. Dissolved inorganic phosphorus concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the percent of sites in each condition category [green—good; yellow—fair; red—poor]. NPS / SECN

Fort Matanzas National Monument 2022 Dissolved Oxygen

Southeast Coast Network
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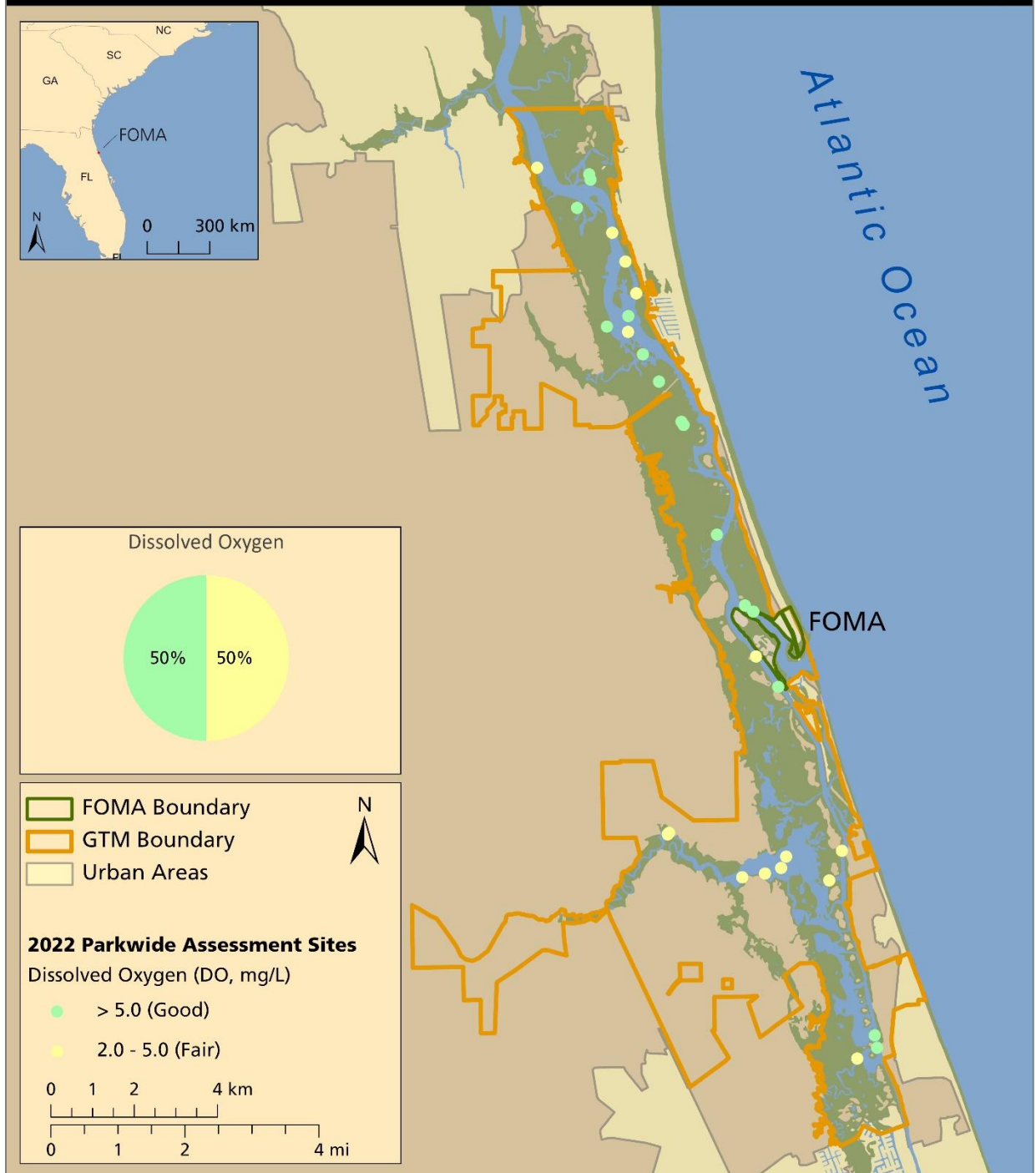


Figure 7. Dissolved oxygen concentrations for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the proportion of sites in each condition category [green—good; yellow—fair]. NPS / SECN

Fort Matanzas National Monument 2022 Site Water Quality Rating

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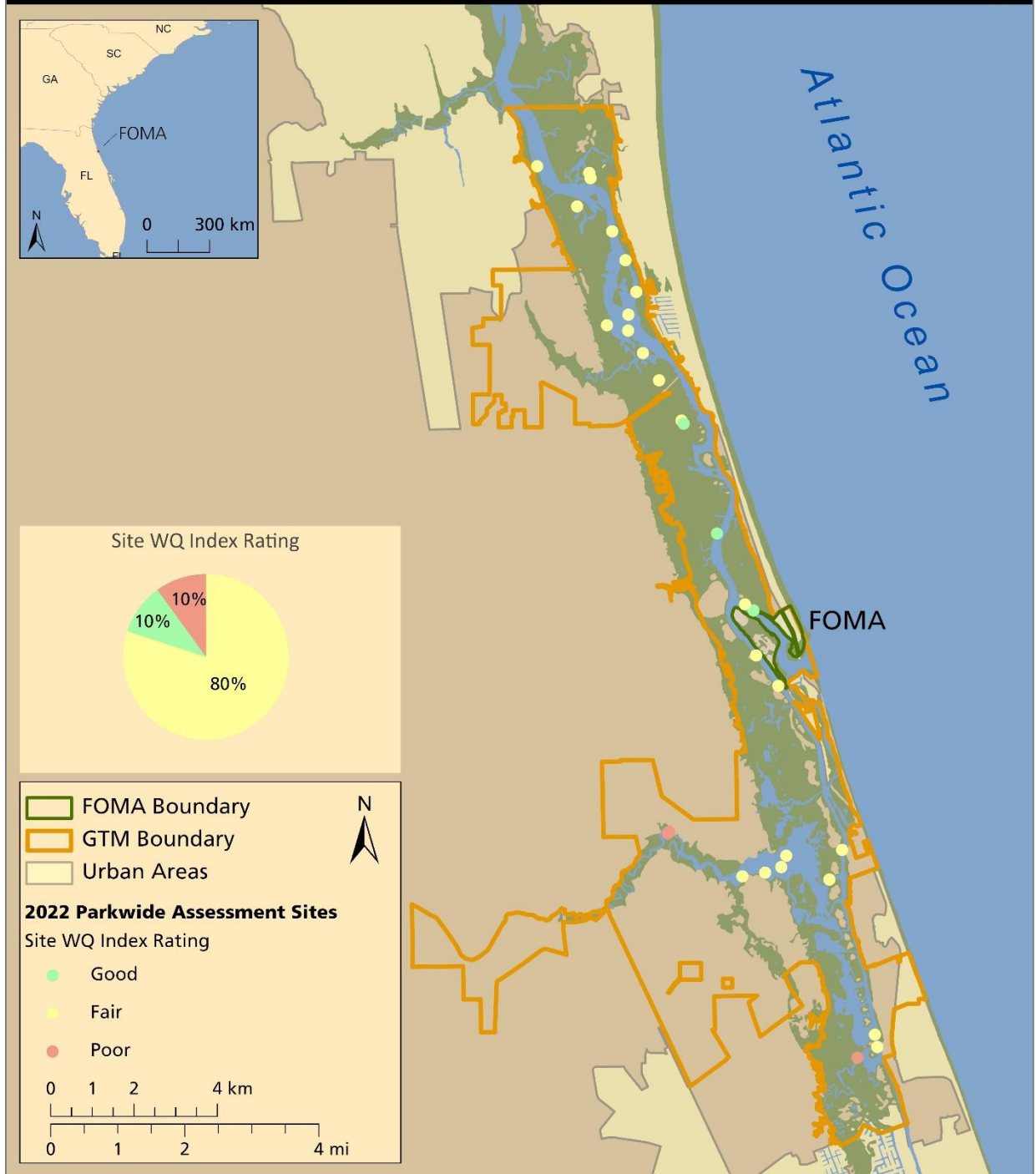


Figure 8. Water-quality index rating for sites sampled at Fort Matanzas National Monument July 18–21, 2022. Inset graph shows the proportion of sites in each condition category [green—good; yellow—fair; red—poor]. NPS / SECN

Table 4. Water-quality parameter values and assessment conditions for sampling sites in the vicinity of Fort Matanzas National Monument July 18–21, 2022. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” (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 Phosphorus (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
FOMA01_2022	2.8 ^F	7.11 ^E	4.4 ^E	0.0746 ^D	0.0587 ^F	0.49	0.084	Poor ^F
FOMA02_2022	2.8 ^F	5.35 ^E	4.7 ^E	0.0516 ^D	0.0285 ^E	0.29	0.052	Fair ^E
FOMA03_2022	2.8 ^F	5.72 ^E	5.7 ^D	0.0407 ^D	0.0259 ^E	0.28	0.049	Fair ^E
FOMA04_2022	2.3 ^E	7.05 ^E	4.8 ^E	0.1083 ^E	0.0456 ^E	0.49	0.067	Fair ^E
FOMA05_2022	2.0 ^E	7.48 ^E	5.1 ^D	0.0418 ^D	0.0343 ^E	0.36	0.053	Fair ^E
FOMA06_2022	1.4 ^D	4.27 ^D	6.2 ^D	0.0177 ^D	0.0084 ^D	0.17	0.025	Good ^D
FOMA07_2022	2.0 ^E	3.93 ^D	5.3 ^D	0.0231 ^D	0.0236 ^E	0.25	0.047	Fair ^E
FOMA08_2022	1.8 ^E	4.56 ^D	6.0 ^D	0.0471 ^D	0.0230 ^E	0.29	0.061	Fair ^E
FOMA09_2022	1.8 ^E	6.23 ^E	5.0 ^E	0.0291 ^D	0.0244 ^E	0.37	0.053	Fair ^E
FOMA10_2022	3.5 ^F	4.63 ^D	4.3 ^E	0.0774 ^D	0.0530 ^F	0.60	0.077	Poor ^F
FOMA11_2022	3.5 ^F	5.24 ^E	4.8 ^E	0.0676 ^D	0.0534 ^F	0.57	0.072	Poor ^F
FOMA12_2022	3.5 ^F	6.88 ^E	3.5 ^E	0.0959 ^D	0.0423 ^E	0.49	0.070	Fair ^E
FOMA13_2022	2.0 ^E	6.33 ^E	3.6 ^E	0.1034 ^E	0.0427 ^E	0.49	0.066	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 Fort Matanzas National Monument July 18–21, 2022. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” (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 Phosphorus (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
FOMA14_2022	2.0 ^E	4.65 ^D	6.4 ^D	0.0398 ^D	0.0222 ^E	0.24	0.041	Fair ^E
FOMA15_2022	2.0 ^E	4.00 ^D	6.4 ^D	0.0233 ^D	0.0140 ^E	0.21	0.035	Fair ^E
FOMA16_2022	2.3 ^E	6.92 ^E	5.1 ^D	0.0317 ^D	0.0271 ^E	0.39	0.063	Fair ^E
FOMA17_2022	2.3 ^E	2.85 ^D	4.6 ^E	0.0509 ^D	0.0254 ^E	0.28	0.046	Fair ^E
FOMA18_2022	2.3 ^E	7.49 ^E	5.1 ^D	0.0486 ^D	0.0326 ^E	0.44	0.075	Fair ^E
FOMA19_2022	2.3 ^E	6.56 ^E	5.8 ^D	0.0341 ^D	0.0235 ^E	0.25	0.046	Fair ^E
FOMA20_2022	1.4 ^D	4.64 ^D	5.7 ^D	0.0247 ^D	0.0105 ^E	0.18	0.029	Good ^D
FOMA21_2022	2.8 ^F	5.06 ^E	4.9 ^E	0.0362 ^D	0.0250 ^E	0.27	0.045	Fair ^E
FOMA22_2022	2.8 ^F	4.83 ^D	4.7 ^E	0.0847 ^D	0.0374 ^E	0.46	0.063	Fair ^E
FOMA23_2022	2.8 ^F	10.85 ^E	5.0 ^E	0.0870 ^D	0.0478 ^E	0.48	0.067	Fair ^E
FOMA24_2022	2.8 ^F	3.18 ^D	4.8 ^E	0.0401 ^D	0.0214 ^E	0.29	0.044	Fair ^E
FOMA25_2022	1.8 ^E	5.00 ^E	6.0 ^D	0.0477 ^D	0.0237 ^E	0.31	0.045	Fair ^E
FOMA26_2022	1.2 ^D	5.83 ^E	6.5 ^D	0.0215 ^D	0.0110 ^E	0.20	0.038	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 Fort Matanzas National Monument July 18–21, 2022. Water clarity was assessed using light attenuation values (k) using a constant (1.4) for estuarine waters that experience “normal turbidity” (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 Phosphorus (DIP, mg/L) ^B	Total Dissolved Nitrogen (mg/L) ^{B,C}	Total Dissolved Phosphorus (mg/L) ^{B,C}	Site WQ Index Rating
FOMA27_2022	2.3 ^E	5.08 ^E	6.0 ^D	0.0492 ^D	0.0232 ^E	0.27	0.048	Fair ^E
FOMA28_2022	2.8 ^F	6.33 ^E	4.8 ^E	0.0632 ^D	0.0336 ^E	0.44	0.056	Fair ^E
FOMA29_2022	1.4 ^D	3.63 ^D	6.3 ^D	0.0272 ^D	0.0159 ^E	0.21	0.039	Good ^D
FOMA30_2022	2.0 ^E	3.65 ^D	4.8 ^E	0.0392 ^D	0.0250 ^E	0.33	0.074	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).

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