

Chapter 8C: St. Lucie River Watershed Protection Plan Annual Progress Report

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St. Lucie Estuary Roosevelt Bridge (US1)



St. Lucie Inlet Submerged Aquatic Vegetation Monitoring Site

INTRODUCTION

The Northern Everglades and Estuaries Protection Program (NEEPP) promotes a comprehensive approach to protect the St. Lucie River Watershed (SLRW). Using a combination of research, monitoring, source controls and construction projects, the NEEPP will restore and protect surface water resources by addressing water quality and storage in the natural system. The following highlights document the key accomplishments and successes during the Water Year 2023 (WY2023; May 1, 2022 – April 30, 2023) reporting period.

The authors acknowledge staff from the Applied Sciences Bureau and the Everglades and Estuaries Protection Bureau for providing valuable review for this document. Appreciation also is extended to Laci Ursu, Erika Moylan, Christopher Barkley, Nicole Miller, and Allison Lamb for providing geographic information system (GIS) support.

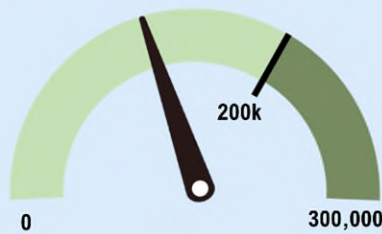
St. Lucie River Watershed Protection Plan Highlights

Progress Towards Future Storage Goals

Sixteen (16) projects were operational in WY2023 and provided approximately:

- 128,011 acre-feet (ac-ft) of water storage
- 41 metric tons (t) total phosphorus (TP) retention
- 266 t total nitrogen (TN) retention

Watershed Storage Goal



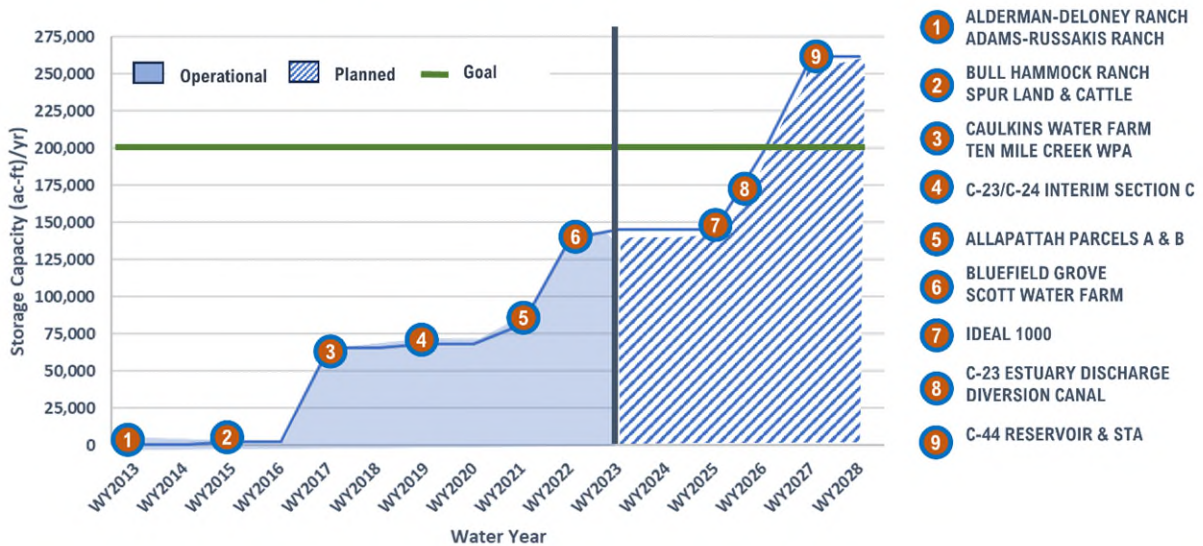
GOAL ≥ 200,000 Acre Feet
WY2023 = 128,011 Acre Feet



Project Highlight: Scott Water Farm

Scott Water Farm is a public-private partnership that retains stormwater on 7,549 acres, thus reducing overall loading to the C-25 Basin. During the first full year of operation (WY2023), the project removed 11.6 t/yr TP and 69.8 t/yr TN.

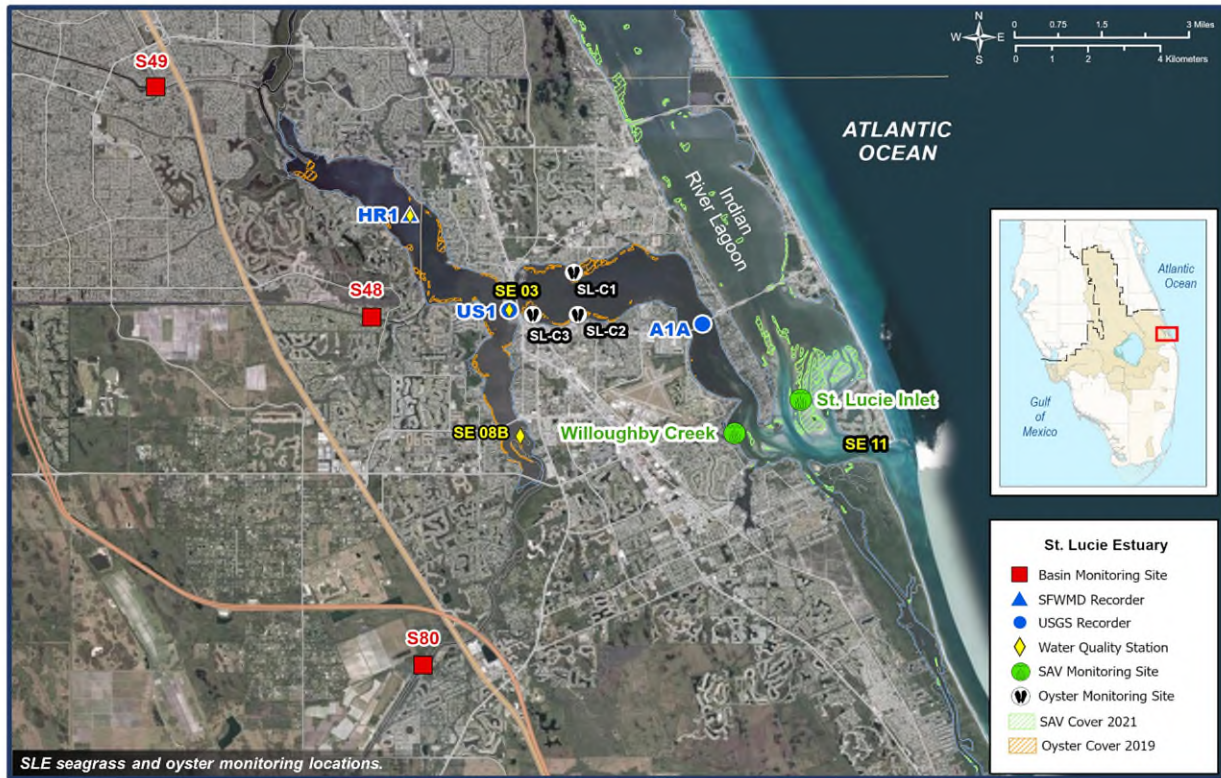
Increasing Project Storage Capacity in the St. Lucie River Watershed



- 1 ALDERMAN-DELONEY RANCH
- 2 ADAMS-RUSSAKIS RANCH
- 3 BULL HAMMOCK RANCH
- 4 SPUR LAND & CATTLE
- 5 CAULKINS WATER FARM
- 6 TEN MILE CREEK WPA
- 7 C-23/C-24 INTERIM SECTION C
- 8 ALLAPATTAH PARCELS A & B
- 9 BLUEFIELD GROVE
- 10 SCOTT WATER FARM
- 11 IDEAL 1000
- 12 C-23 ESTUARY DISCHARGE
- 13 DIVERSION CANAL
- 14 C-44 RESERVOIR & STA

St. Lucie River Watershed Protection Plan Highlights

Research & Monitoring Results



WY2023 Results – St. Lucie Estuary

Hydrologic Conditions	WY2023 Results	Change from WY2019-WY2023	Ecological Conditions	WY2023 Results	Change from WY2019-WY2023
Rainfall (inches)	51	↓ 6%	Submerged Aquatic Vegetation Wet Season Percent Cover Dry Season Percent Cover	8.4%	↓ 18%
Lake Discharges (ac-ft)	47,600	↓ 57%		6.8%	↓ 8%
Total Discharges (ac-ft)	681,000	↑ 12%	Live Oyster Densities (oysters per square meter) Wet Season Dry Season	315	↓ 22%
Total Phosphorus Loading (t)	195	↓ 1%		268	↓ 28%
Total Nitrogen Loading (t)	1,157	↑ 1%	% of the year in optimum salinity range for oysters	87%	↑ 20%



St. Lucie River Watershed Protection Plan Highlights

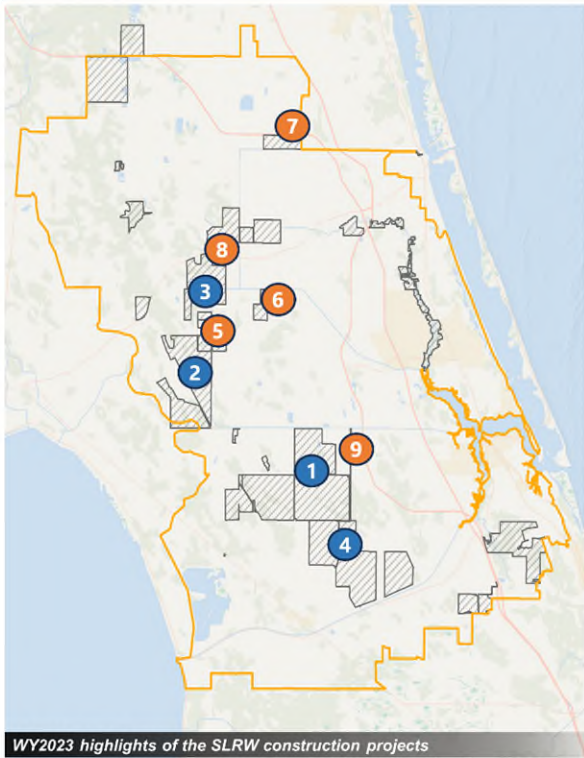
Advancing Watershed Construction Projects

Highlighted Operational Projects

- 1. Allapattah Flats Parcels A and B**
 - Restores 6,621 acres of wetlands
 - C-23 Basin
 - Operational since FY2021
- 2. Bluefield Grove Water Farm**
 - 6,104-acre above ground impoundment (AGI)
 - C-23 Basin
 - Operational since FY2022
- 3. C-23/24 Interim Storage Section C**
 - Retains rainfall and excess water pumped from the C-23 Canal on 297 acres
 - C-24 Basin
 - Operational since FY2019
- 4. C-44 Reservoir & STA**
 - Captures rainfall on 3,400-acre reservoir and 6,300-acre STA
 - C-44 Basin
 - Operational Testing and Monitoring Period since FY2022

Highlighted Future Projects

- 5. C-23/C-24 District Lands Hydrologic Enhancements**
 - Study evaluating the current site condition benefits with the intention of future hydrologic enhancements
 - C-24 Basin
 - Status: Planning
- 6. Ideal 1000**
 - Improvements to previous water farming pilot project
 - C-24 Basin
 - Status: Planning
- 7. C-25 Reservoir & STA**
 - Capture water from the C-25 Canal on 1,276 acres
 - C-25 Basin
 - Status: Design
- 8. C-23/C-24 North and South Reservoirs & STA**
 - Capture rainfall on 7,110-acre reservoirs and 2,568-acre STA
 - C-24 and C-23 Basins
 - Status: STA-Construction, Reservoirs-Design
- 9. C-23/C-44 Estuary Discharge Diversion Canal**
 - Directs excess water from the C-23 Canal through the C-44 Reservoir & STA and into the C-44
 - C-23 and C-44 Basins
 - Status: Construction



INTRODUCTION

As required by Subsection 373.4595(6), Florida Statutes (F.S.), this chapter, in conjunction with Chapters 8A, 8B, and 8D of this volume, fulfills the specific reporting requirements outlined in the Northern Everglades and Estuaries Protection Program (NEEPP) for the annual progress report. The chapter provides an annual review for the St. Lucie River Watershed Protection Plan (SLRWPP), which was initiated by the South Florida Water Management District (SFWMD) in 2021 and is critical to maintaining transparency and accountability in the state’s basin management action plan (BMAP) process and for collectively moving towards the achievement of total maximum daily loads (TMDLs).

Specifically, Chapter 8C is organized into three parts and supplemental information is appended as follows:

- Part I – Research and Water Quality Monitoring Program: St. Lucie River Watershed
- Part II – Research and Water Quality Monitoring Program: St. Lucie River Estuary
- Part III – St. Lucie River Watershed Construction Project
- Appendix 8C-1 – Water Year 2023 St. Lucie River Watershed Upstream Monitoring
- Appendix 8C-2 – Estuarine Water Quality Modeling: Zero-Dimension Theory and Its Application in a Shallow Subtropical Estuary in Florida
- Appendix 8C-3 – Phytoplankton in the C-44 Canal and St. Lucie Estuary: Relationships to Water Quality
- Appendix 8C-4 – Acoustic Telemetry to Determine Response of Large-Bodied Fishes to Freshwater Inflows in the St. Lucie River Estuary

For this reporting period, data for the research and water quality monitoring for the St. Lucie River Estuary and its watershed are reported through Water Year 2023 (WY2023; May 1, 2022–April 30, 2023), while project-related information is provided for Fiscal Year 2023 (FY2023; October 1, 2022–September 30, 2023).¹

In each PDF document, the outline for the complete *Table of Contents* can be accessed by selecting *Bookmarks* tab on the far left of the page; each section can be viewed by clicking on the bookmark link, which will navigate directly to the start of that section in the main document.

BACKGROUND

The St. Lucie River Watershed (SLRW) and St. Lucie Estuary (SLE) are in southeastern Florida, primarily in Martin and St. Lucie counties, and are tributaries to the southern Indian River Lagoon (IRL). The SLRW is comprised of ten basins that drain to major canals, such as the C-23, C-24, and C-44, which eventually flow into the SLE (**Table 8C-1** and **Figure 8C-1**). Based on the review of measured data at the G-81 structure, the C-25 Basin runoff flows directly to the IRL with less than 1% of flow routed to the SLE (**Figure 8C-1**). Therefore, limited information is presented for the C-25.

To calculate inputs of fresh water and nutrients to the system, the SLRW was divided into three primary contributing areas (**Table 8C-1**): Lake Okeechobee, the St. Lucie Basins, and the Tidal Basins. The St. Lucie Basins are comprised of the C-44, C-23, C-24, and Ten Mile Creek (TMC) basins. The Tidal Basins are comprised of the North Fork; South Fork; North Mid-Estuary; South Mid-Estuary; Basin 4, 5, and 6;

¹Results reported in Chapter 8C include a mixture of International System of Units (SI) and non-SI units. Non-SI units used in this chapter include surface area as acres (ac), flow rate as cubic feet per second (cfs), water volume as acre-feet (ac-ft), and mass as metric tons (t). Conversion factors to express these values in SI units are as follows: 1 ac = 0.40469 hectare or 4,046.9 square meters; 1 cfs = 0.02832 cubic meters per second; 1 ac-ft = 1,233.5 cubic meters; and 1 t = 1,000 kilograms.

and South Coastal basins. The SLE receives water from contributing areas in the SLRW via the North and South Forks and runoff from the contributing Tidal Basins (**Figure 8C-1**). The Tidal Basin discharges directly into the estuary and flows and loads from this basin are estimated using the Watershed (WaSh) model (Wan and Konyha 2015).

The C-44 Canal (St. Lucie Canal) was completed in 1924 and is the main connection between Lake Okeechobee and the South Fork of the SLE. The C-44 Canal begins at the S-308 structure in Port Mayaca on the east side of Lake Okeechobee and continues east to the S-80 structure in Stuart where the South Fork of the SLE begins. In addition to regulatory releases from Lake Okeechobee, the C-44 Canal also transports local basin runoff from the C-44 Basin, the largest of the St. Lucie basins. Additional inputs into the SLE include the Gordy Road Structure at TMC, conveying flows to the headwaters of the North Fork of the SLE; the further downstream C-24 Canal, which connects to the North Fork through the S-49 structure; and the C-23 Canal, which enters at the downstream reaches of the North Fork through the S-48 weir (USACE and SFWMD 2004; **Figure 8C-1**).

Table 8C-1. Major contributing areas of the SLRW.

Contributing Areas	Basins	Basin Acreage (% of Watershed Area)	Source of Flows and Loads	Sampling Method and Frequency
Lake Okeechobee	Not applicable	Not applicable	Measured ^a	S80 (Autosampler) ^b S308 (Weekly Grab)
St. Lucie Basins	C-44	132,705 (25%)	Measured	S80 (Autosampler) ^b S308 (Weekly Grab)
	C-23	110,872 (21%)	Measured	S-48 (Autosampler) ^b
	C-24	83,359 (16%)	Measured	S-49 (Autosampler) ^b
	TMC	40,327 (7%)	Measured ^c	Gordy Road (Autosampler) ^b
Tidal Basins	North Fork	91,529 (17%)	Modeled ^d	29 Tributaries (Bi-Weekly Grab) ^d
	North Mid-Estuary	4,196 (< 1%)	Modeled ^d	
	Basin 4,5,6	15,935 (3%)	Modeled ^d	
	South Fork	48,792 (9%)	Modeled ^d	
	South Mid-Estuary	2,080 (< 1%)	Modeled ^d	
	South Coastal	7,991 (1%)	Modeled ^d	

a. Lake Okeechobee releases to the SLE and C-44 Basin runoff are calculated via the measured flows and loads observed at the S-80 and S-308 water control structures.

b. Samples are collected weekly via autosampler at each structure and are analyzed for parameters including total nitrogen and total phosphorus by the SFWMD laboratory.

c. TMC flow data were estimated from October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing from October 21–26 and November 2–17, 2020, at the Gordy Road structure.

d. The Tidal Basins inflow and nutrient loads are calculated based on simulated flows using the SLE WaSh model (Wan and Konyha 2015), and measured water quality concentrations collected only during flow conditions at 29 upstream monitoring sites within the Tidal Basins.

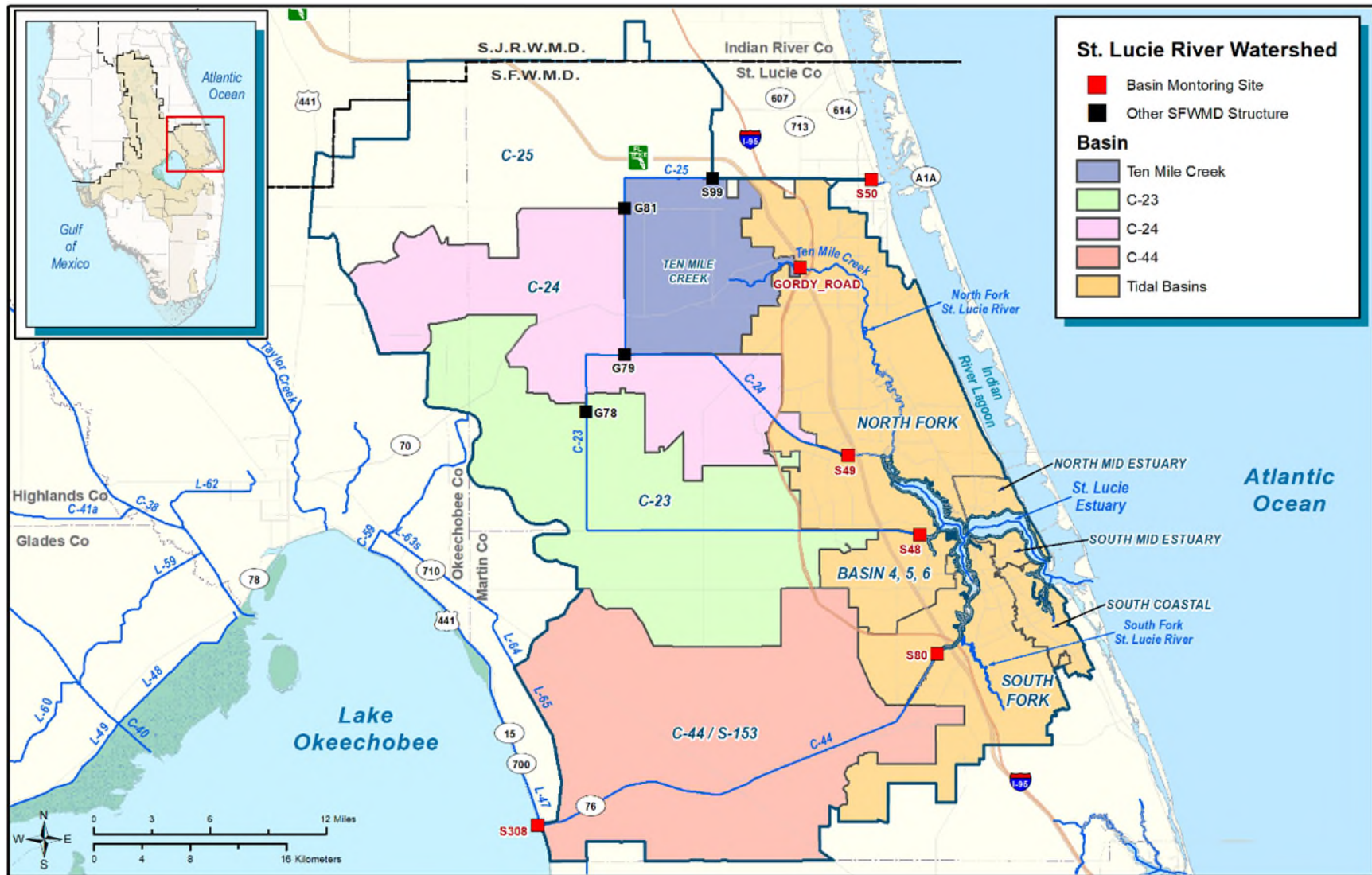


Figure 8C-1. The St. Lucie River Watershed (SLRW) with basins, corresponding basin structure monitoring sites, and other SFWMD water control structures.

The SLE is located adjacent to the St. Lucie Inlet, transects the Southern IRL, and is divided into the North and South Forks, middle estuary, and lower estuary. Historically, SLE was not an estuary, but a freshwater system exposed to the ocean only through ephemeral passes that intermittently cut through the barrier islands. The St. Lucie Inlet was constructed in 1892 thereafter providing a permanent connection to the Atlantic Ocean (SFWMD et al. 2009). SLE is now a partially mixed, micro-tidal estuary with an average depth of 7.87 feet (ft; 2.4 meters or m) and semi-diurnal tides averaging 1.25 ft (0.38 m) in amplitude (Buzzelli et al. 2013b) and is one of the largest brackish water systems on the southeast coast of Florida (Sime 2005). Estuarine flushing rates vary seasonally as net flushing and associated stratification are greatly influenced by freshwater inflows (Ji et al. 2007, Wan et al. 2012). Through tidal exchange only, and in the absence of freshwater inflow, the SLE flushing rate is approximately 15 to 20 days (Sun 2009). Total surface area of the estuary is 11.2 square miles (7,168 acres [ac] or 2,901 hectares [ha]), though it receives drainage from a comparatively large watershed of 840.2 square miles (537,700 ac or 217,599 ha), excluding the C-25 Basin (99,730 ac or 40,359 ha).

Fresh water entering the tributaries and estuary is affected by modifications to the natural system from anthropogenic impacts of land use changes in the watershed, coastal development, hydrological alterations through water management, hardened shorelines, and channelization (Doering 1996). Volume and source of freshwater inflow to the tributaries and estuary directly affect water quality conditions such as salinity, light attenuation, and nutrient concentrations. Changes in freshwater inflows and resultant changes to the habitat have been shown to affect the distribution and dynamics of many estuarine taxa and communities including phytoplankton, benthic microalgae (Mortazavi et al. 2000, Millie et al. 2004, Lapointe et al. 2012, Philips et al. 2012), seagrass (Doering and Chamberlain 2000, Doering et al. 2002, Buzzelli et al. 2012, Kahn et al. 2013), and oysters (Parker et al. 2013, Parker 2015, Parker and Radigan 2020).

The Florida Department of Environmental Protection (FDEP) has identified the SLE as an impaired water body and established a TMDL that sets concentration targets of 0.72 milligrams per liter (mg/L) of total nitrogen (TN) and 0.081 mg/L of total phosphorus (TP) as measured at the Roosevelt Bridge compliance point (SE 03) in the SLE (Parmer et al. 2008). The TMDL does not specify a compliance calculation; however, the *St. Lucie River and Estuary Basin Management Action Plan* (FDEP 2020) calculates compliance using a 5-year rolling average (the latest 5 water years) of TN and TP concentration data from the Roosevelt Bridge (SE 03). NEEPP mandates the SLRW Protection Program to address phosphorus and nitrogen to the estuary from both internal and external sources, and that the FDEP-adopted BMAP shall be the component of the program that achieves load reductions for the SLE (see Chapter 8A of this volume for more information).

In support of the BMAPs, NEEPP legislation directs SFWMD, in cooperation with the other two Coordinating Agencies (FDEP and Florida Department of Agriculture and Consumer Services [FDACS]) and local entities, to complete a watershed protection plan (WPP) for each of the three watersheds within NEEPP: Lake Okeechobee Watershed, SLRW, and Caloosahatchee River Watershed. WPPs are unique to each watershed and receiving water body and are coordinated in recognition of the connectivity of these watersheds. WPPs are science-driven plans that include two components: (1) the Research and Water Quality Monitoring Program (RWQMP) and (2) the Watershed Construction Project (WCP). The RWQMP builds upon existing research and monitoring to inform decisions, develop future efforts, and assess and modify existing plans such as the BMAPs. In this chapter, the RWQMP is presented in two parts: Part I: SLRW, in which watershed characteristics are described with a focus on loading from SLRW basins; and Part II: SLE, in which estuarine water quality, salinity, and benthic habitat are indicators of ecosystem health. The final section of this chapter, *Part III: St. Lucie River Watershed Construction Project*, provides a comprehensive strategy consisting of constructed facilities and programs implemented for improving water quality, quantity, timing, and distribution of surface water in the Northern Everglades ecosystem. The WCP also summarizes the current and future water quality improvement projects and programs designed to assist in achieving the SLE TMDL. Further information on the WPPs for the Northern Everglades watersheds is available on SFWMD's website at www.sfwmd.gov/wpps.

PART I: RESEARCH AND WATER QUALITY MONITORING PROGRAM – ST. LUCIE RIVER WATERSHED

The St. Lucie River Watershed (SLRW) is approximately 537,700 ac (excluding the C-25 Basin, which is 99,730 ac) divided into ten basins as indicated in **Table 8C-1** in the *Background* subsection. The SLRW includes areas that drain local runoff to major canals such as the C-23, C-24, and C-44 canals, which discharge into either the North Fork or South Fork of the St. Lucie River and ultimately to the St. Lucie Estuary (SLE). In addition to the drainage from local runoff, the C-44 Canal also serves as a flood control conveyance for Lake Okeechobee, transporting water from the lake into the estuary. Six of the basins (North Fork; Basin 4, 5, and 6; North Mid-Estuary; South Mid-Estuary; South Fork; and South Coastal) are served by numerous tributaries that discharge to the SLE and, unlike the other basins, do not have water control structures.

As part of the Research and Water Quality Monitoring Program (RWQMP), SFWMD maintains a long-term water quality monitoring network within the SLRW. SFWMD's current monitoring network consists of stations at two hydrologic levels within the SLRW: (1) basin level, and (2) subbasin level (**Figure 8C-2**). Flow and nutrient (TP and TN) concentrations are monitored, and nutrient loads are calculated at the basin loading stations. The upstream stations typically only monitor nutrient concentration data. Stations in the network are continuously reviewed by the Coordinating Agencies—SFWMD, FDACS, and FDEP—for efficiency and to ensure all data collection objectives associated with legislatively-mandated and permit-required monitoring are being met. Data collected as part of the RWQMP, along with data collected by other local entities, allow FDEP to evaluate water body conditions, measure progress toward the TMDLs, and ensure that the appropriate projects and programs are being designated and incorporated into the BMAPs (FDEP 2020). SFWMD coordinates monitoring efforts with FDEP, FDACS, and the United States Geological Survey (USGS) to leverage existing monitoring sites and reduce duplication of efforts.

Freshwater inflow and water quality concentrations entering the SLE are measured at the S-308 (Lake Okeechobee), S-80 (C-44 Basin and Lake Okeechobee), S-48 (C-23 Basin), S-49 (C-24 Basin), and Gordy Road (TMC Basin) water control structures. The contributions from Lake Okeechobee inflows to the SLE were calculated based on the measured flow and water quality concentrations at the S-308 and S-80 structures. The Tidal Basins inflow and nutrient loads were calculated based on simulated flows using the SLE Watershed (WaSh) model (Wan and Konyha 2015), and measured water quality concentrations collected at 29 upstream monitoring sites within the Tidal Basins (**Figure 8C-2**). Additional water quality samples were collected at 44 upstream monitoring sites within the SLRW (**Figure 8C-2**) and results from this monitoring effort are summarized in Appendix 8C-1.

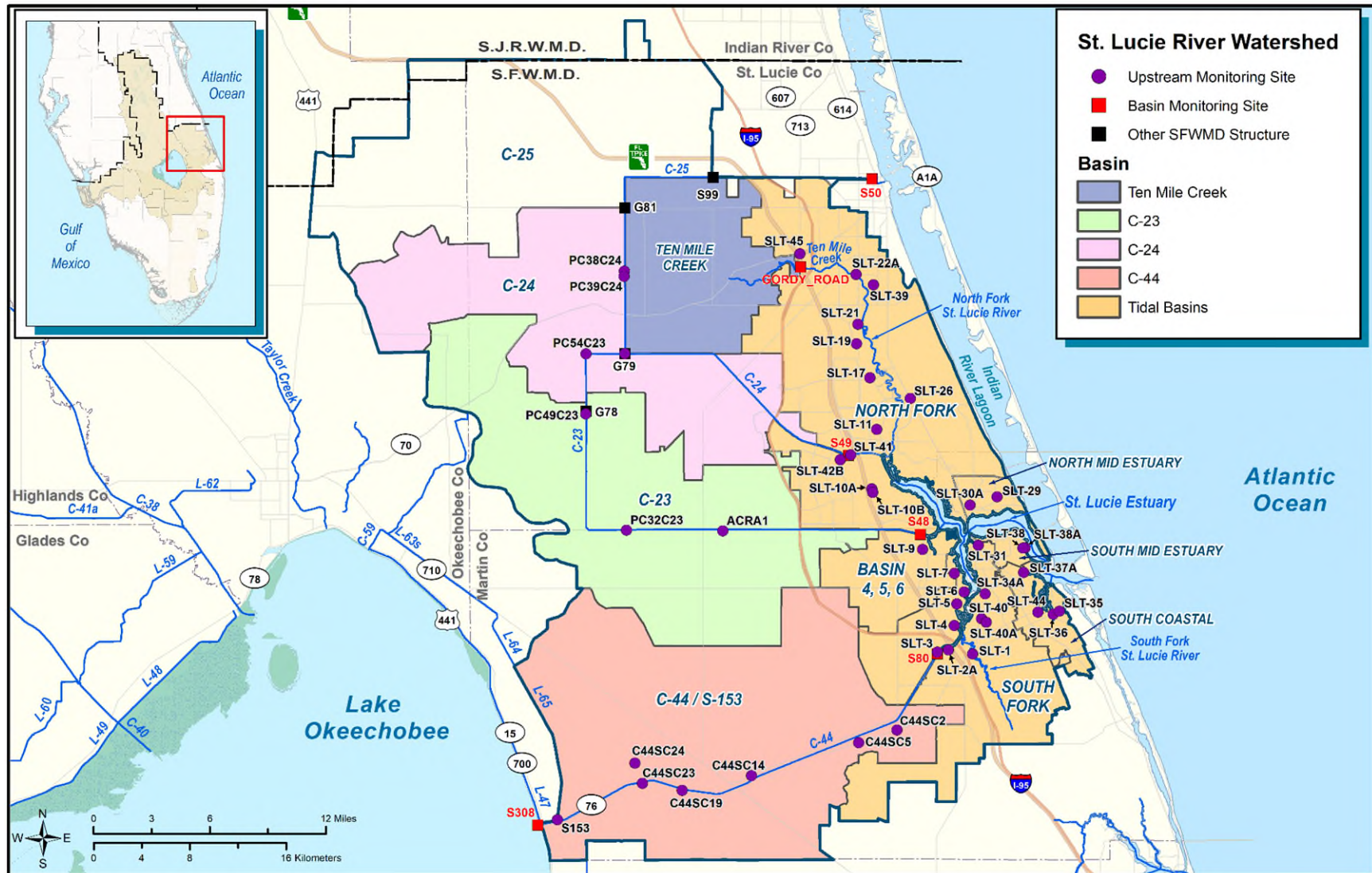


Figure 8C-2. The St. Lucie River Watershed with basin monitoring (red squares) and upstream monitoring (purple circles) locations.

HYDROLOGY

Precipitation

Daily Next Generation Radar (NEXRAD) rainfall data from the long-term period of record (POR; WY1997–WY2023) for each SLRW basin were downloaded from the SFWMD environmental database, DBHYDRO, accessible at <https://apps.sfwmd.gov/nexrad2/nrdmain.action>. The cumulative amount of rainfall across the watershed was computed using area weighting, which accounts for the different sizes of the basins within the SLRW.

Total rainfall in the SLRW in WY2023 was 50.5 inches (128 centimeters or cm) and was like the long-term POR average. In WY2023, 68% of the annual rainfall occurred during the wet season (May 1–October 31) and 32% in the dry season (November 1–April 30; **Figure 8C-3**). This resulted in a drier-than-normal wet season and a wetter-than-normal dry season. Spatial distribution patterns of rainfall across the watershed in WY2023 were like those observed in the long-term POR average (**Figure 8C-4**) with most rainfall occurring in the Tidal Basins (52.4 inches) and TMC Basin (52.2 inches).

During WY2023, it rained 257 days (70%) in the SLRW with six days having rainfall > 1.0 inch (2.5 cm; **Figure 8C-5**). Days with rainfall over 1 inch were largely associated with major tropical storms. In early June, Tropical Storm Alex (NHC 2022) passed over Florida in a northeast trajectory moving from the west to the east coast, resulting in over an inch of rainfall in the SLRW. Hurricane Ian (NHC 2023a) devastated the western coast of Florida in late September as it moved across the state in a northeast trajectory, changing from a category 4 hurricane at landfall to a tropical storm as it moved over the east coast. The SLRW received greater than 2 inches of total rainfall for two consecutive days resulting in the highest daily rainfall totals recorded in WY2023. Hurricane Nicole (NHC 2023b) affected Florida just a few weeks after Hurricane Ian, also bringing heavy rainfall to the SLRW.

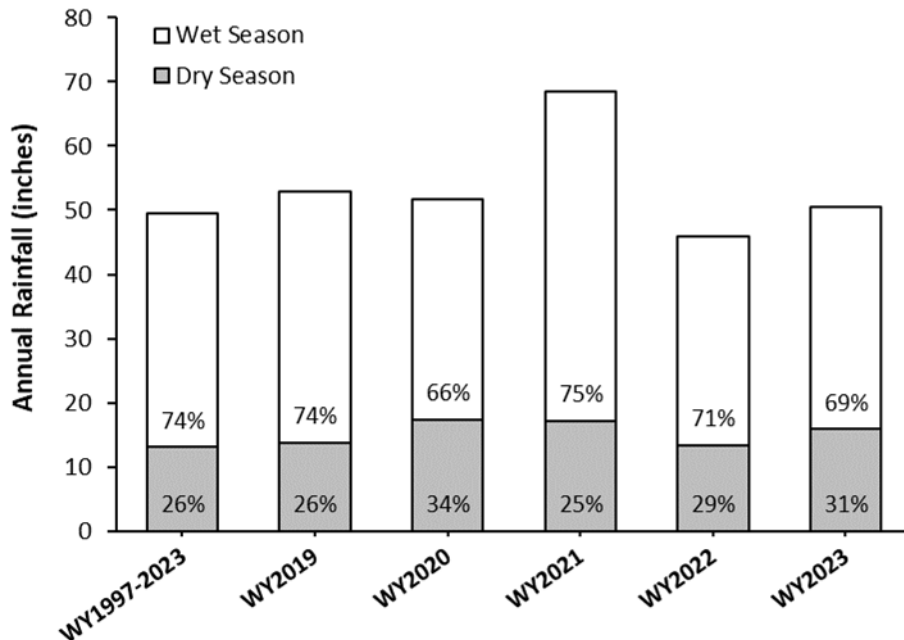


Figure 8C-3. Total annual rainfall for the SLRW by water year for the most recent 5-year period (WY2019–WY2023) and the long-term average for the POR (WY1997–WY2023) with percent contributed by season.

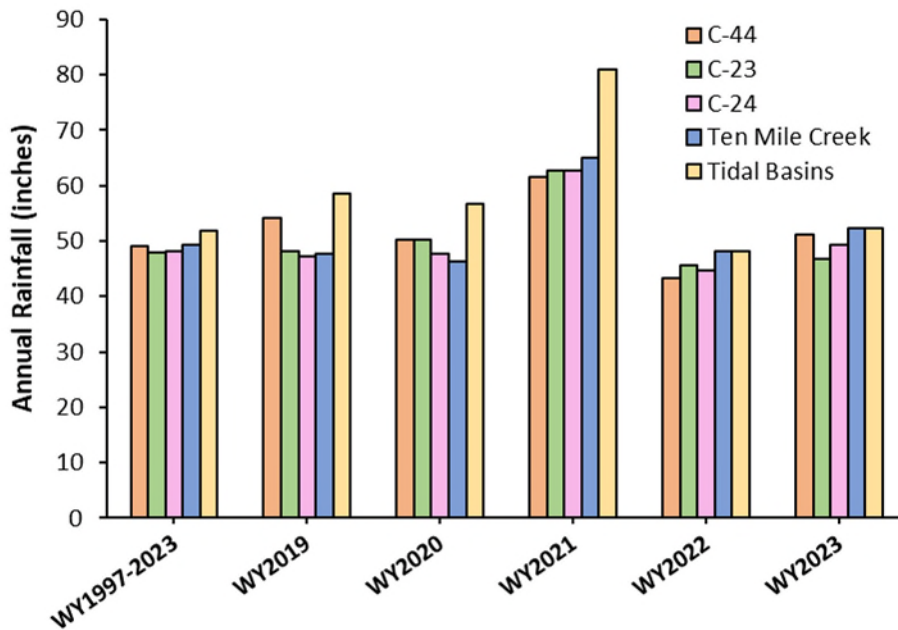


Figure 8C-4. Total annual rainfall by basin in the SLRW by water year for the most recent 5-year period (WY2019–WY2023) and the long-term average for the POR (WY1997–WY2023). See **Figure 8C-1** for basin locations.

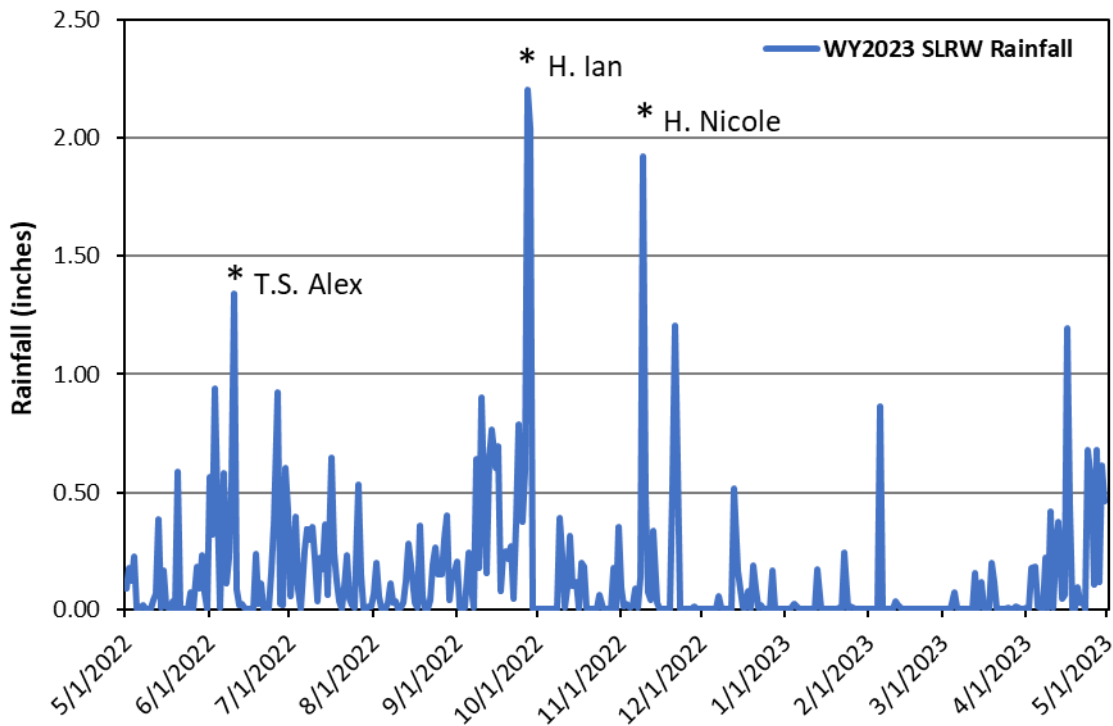


Figure 8C-5. Daily rainfall in inches for the SLRW in WY2023. Note: An * indicates a major storm occurred.

Freshwater Inflow

The timing, duration, and volume of fresh water entering the estuary is the primary factor affecting water quality within the estuary. Freshwater inflow and tidal fluctuations are the main drivers affecting the salinity gradient within the estuary. Large freshwater inflows can reduce estuarine salinities and potentially alter habitat availability for benthic sessile organisms such as seagrass and oysters (Lirman and Cropper 2003, La Peyre et al. 2003, Buzzelli et al. 2012, 2013c, Wilson et al. 2005, Borja and Tunberg 2011, Parker et al. 2013, McKeon et al. 2015). Freshwater inflow to the estuary is comprised of both surface and groundwater flow from the contributing watershed, and managed flow releases from Lake Okeechobee. Fresh water coming from the watershed and Lake Okeechobee also transports nutrients and suspended sediments, which can affect water quality within the estuary by altering light and nutrient availability (Paczkowska et al. 2020).

Freshwater inflow to the SLE was estimated from three main contributing areas in the SLRW: Lake Okeechobee, the St. Lucie Basins (represents 69% of the watershed area), and the Tidal Basins (represents 31% of the watershed area; see **Figure 8C-1** and **Table 8C-1** in the *Background* subsection). Freshwater inflow was measured at the S-308 (Lake Okeechobee), S-80 (C-44 Basin), S-48 (C-23 Basin), S-49 (C-24 Basin), and Gordy Road structures (TMC Basin). Inflows from the Tidal Basins were simulated using the SLE WaSh model and data collected from nearby basins (Wan and Konyha 2015). Flow data for the Gordy Road structure was unavailable for half of WY2023 (November 8, 2022–April 30, 2023) so flows were estimated using the WaSh model. Total daily inflows for WY1997–WY2023 from Lake Okeechobee, the St. Lucie Basins, and the Tidal Basins were used to quantify total inflow annually and seasonally to evaluate intra- and interannual variations and relative contributions by basin.

Total freshwater inflow to the SLE in WY2023 (681.3×10^3 acre-feet or ac-ft) was 29% lower than the average for the POR (964.5×10^3 ac-ft) and 12% higher than WY2022 (598×10^3 ac-ft; **Figure 8C-6** and **Table 8C-2** in the *St. Lucie River Watershed Basin Loading* subsection). In WY2023, there was some flow from Lake Okeechobee (47.6×10^3 ac-ft) whereas there was no flow to the SLE from Lake Okeechobee in WY2022. The Tidal Basins were the largest contributor of flow to the SLE (50%; 338.8×10^3 ac-ft) followed by the St. Lucie Basins contributing 43% (294.8×10^3 ac-ft) in WY2023. Looking at each of the St. Lucie Basins separately, the C-24 Basin (15%) had the most flow, followed by the C-23 Basin (10%) and TMC Basin (10%), and lastly the C-44 Basin (8%) (**Figure 8C-7**). Contributions to total inflows from the Tidal Basins and C-24 Basin were higher in WY2023 relative to the long-term POR average due to lower contributions from Lake Okeechobee.

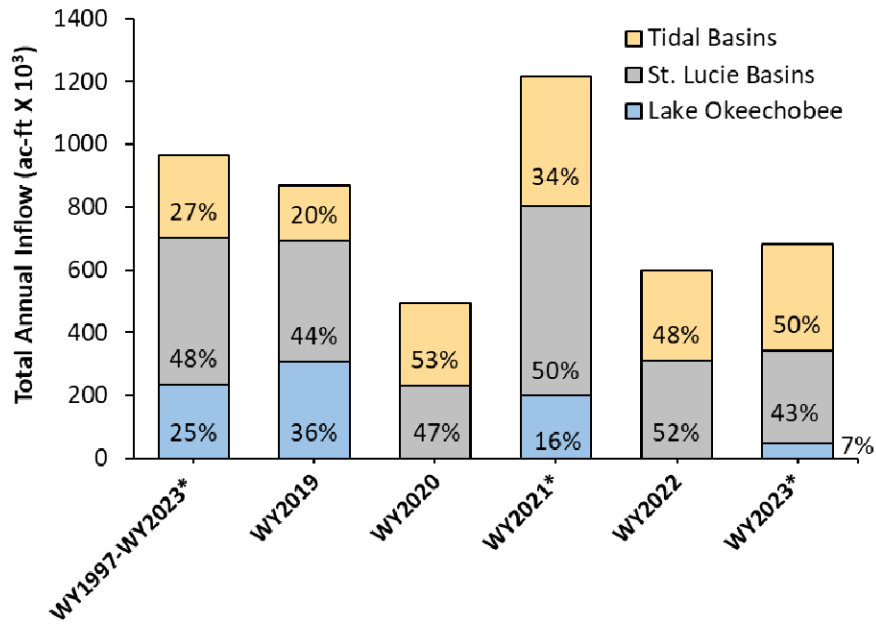


Figure 8C-6. Total annual freshwater inflow to the estuary for each contributing area by water year for the most recent 5-year period (WY2019–WY2023) and the long-term average for the POR (WY1997–WY2023) with relative percent contribution to total. (*TMC flow data were estimated from October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing from October 21–26 and November 2–17, 2020.)

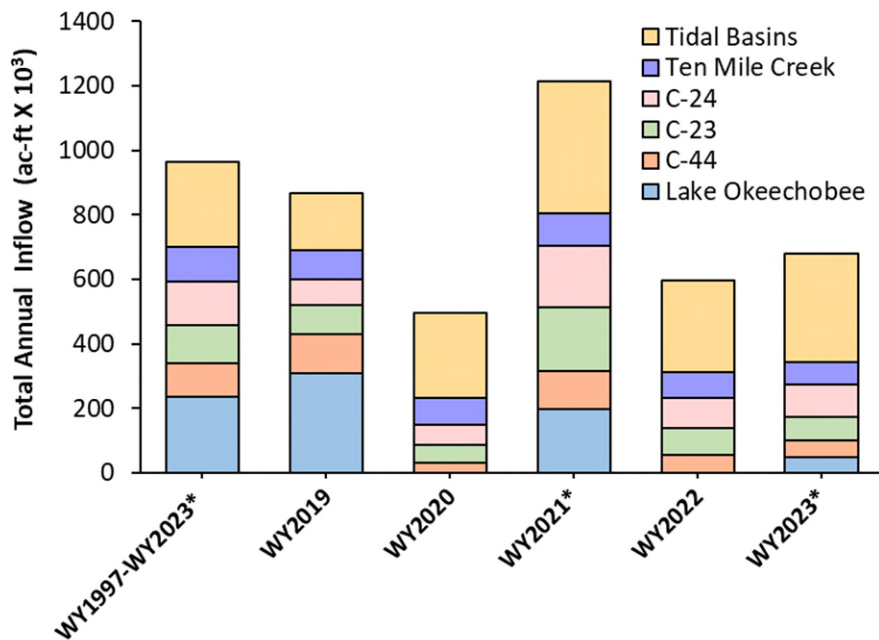


Figure 8C-7. Total annual freshwater inflow from the SLRW into the SLE by water year for the most recent 5-year period (WY2019–WY2023) and the long-term average for the POR (WY1997–WY2023). (*TMC flow data were estimated from October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing from October 21–26 and November 2–17, 2020.)

ST. LUCIE RIVER WATERSHED BASIN LOADING

Basin loading and flow from three primary contributing areas for the past five water years (WY2019–WY2023) and the POR (WY1997–WY2023) are summarized in **Table 8C-2** and **Figures 8C-8** through **8C-11**. Although the C-25 Basin discharges to the IRL and not directly to the SLE, flow volumes and nutrient loading for the past five water years (WY2019–WY2023) are also summarized in **Table 8C-2** for reference.

The Tidal Basins were the largest contributor of flow (50%) and TN load (49%) to the SLE in WY2023 (**Figure 8C-6** and **Figure 8C-9**). The contribution of TN load from the Tidal Basins in WY2023 (570 metric tons or t) was higher than the previous five water years and 81% higher than the POR average (314 t). In WY2023, the St. Lucie Basins had slightly lower contributions of flow (43%) and TN load (44%) than the Tidal Basins but had the largest contribution of TP load (63%; **Figure 8C-8**). Of the St. Lucie Basins, the C-24 Basin had the largest contribution of flow (15%), TP load (28%), and TN load (18%) for WY2023 (**Table 8C-2** and **Figures 8C-10** and **8C-11**). Lake Okeechobee contributed 7% of total flow, 4% of TP load, and 7% of TN load for WY2023.

An overview of the recent 5-year TP and TN loads and flow-weighted mean concentrations (FWMCs) from each basin to the SLE is provided in **Figures 8C-12** and **8C-13**, and **Table 8C-2**. The C-24 Basin had the highest TP and TN FWMC, based on the average of the past five water years (300 micrograms per liter or µg/L and 1.5 mg/L, respectively). Time series for flow, TN load, TP load, TN FWMC, and TP FWMC are provided for the WY1997 through WY2023 POR in **Figure 8C-14**.

Table 8C-2. Annual flow volumes, TP loads, TN loads, TP FWMCs and TN FWMCs for contributing areas of the SLRW to the SLE.

Time Period	Lake Okeechobee ^a	St. Lucie Basins ^b	Tidal Basins	Total St. Lucie	St. Lucie Basins ^b				C-25 Basin ^c
					C-44 Basin	C-23 Basin	C-24 Basin	TMC Basin	
Total Flow (ac-ft X 10³)									
WY2019	308	383	176	868	121	92	77	93	219
WY2020	0	233	262	494	31	56	59	86	81
WY2021*	199	606	411	1,215	117	198	190	101	230
WY2022	0	310	288	598	54	85	92	80	158
WY2023*	48	295	339	681	54	71	103	68	169
5-Year Average ^{d*}	111	365	295	771	75	100	104	85	171
5-Year % ^{e*}	14%	47%	38%	100%	10%	13%	14%	11%	----
WY1997–WY2023*	236	466	263	965	104	117	135	110	----
TP Load (t)									
WY2019	73.5	157.4	17.3	248.2	51.0	36.7	40.9	28.8	80.1
WY2020	0.0	59.3	31.9	91.2	4.8	16.9	15.1	22.5	20.9
WY2021*	47.8	227.3	59.0	334.1	38.1	86.3	70.5	32.3	90.0
WY2022	0.0	81.4	33.5	115.0	10.9	25.4	23.1	22.0	47.7
WY2023*	8.6	123.1	63.3	194.9	12.7	26.7	54.5	29.1	71.6
5-Year Average ^{d*}	26.0	129.7	41.0	196.7	23.5	38.4	40.9	26.9	62.1
5-Year % ^{e*}	13%	66%	21%	100%	12%	20%	21%	14%	----
WY1997–WY2023*	50.9	202.7	44.1	297.7	37.6	60.6	58.4	46.0	----
TP FWMC (mg/L)									
WY2019	0.193	0.333	0.080	0.232	0.342	0.323	0.430	0.251	0.297
WY2020	---	0.207	0.0998	0.150	0.124	0.243	0.207	0.213	0.210
WY2021*	0.195	0.304	0.116	0.223	0.264	0.354	0.300	0.260	0.317
WY2022	---	0.213	0.0945	0.156	0.165	0.242	0.204	0.224	0.245
WY2023*	0.146	0.338	0.151	0.232	0.192	0.307	0.430	0.349	0.343
5-Year Average ^{d*}	0.178	0.279	0.108	0.199	0.217	0.294	0.314	0.259	0.283
5-Year FWMC ^{f*}	0.190	0.288	0.113	0.207	0.253	0.310	0.317	0.256	----
WY1997–WY2023*	0.175	0.353	0.136	0.250	0.294	0.419	0.350	0.340	----

Table 8C-2. Continued.

Time Period	Lake Okeechobee ^a	St. Lucie Basins ^b	Tidal Basins	Total St. Lucie	St. Lucie Basins ^b				C-25 Basin ^c
					C-44 Basin	C-23 Basin	C-24 Basin	TMC Basin	
TN Load (t)									
WY2019	546.0	593.5	179.1	1,318.6	160.6	166.5	154.0	112.4	421.1
WY2020	0.0	359.3	307.4	666.7	44.6	98.4	109.0	107.4	157.1
WY2021*	382.9	992.7	478.5	1,854.2	163.3	355.5	346.1	127.8	444.3
WY2022	0.0	467.6	315.4	783.0	77.3	143.3	161.2	85.7	262.4
WY2023*	81.4	505.9	570.2	1,157.4	78.2	126.2	210.0	91.4	325.3
5-Year Average ^{d*}	202.1	583.8	370.1	1,156.0	104.8	178.0	196.1	104.9	322.0
5-Yearr % ^{e*}	17%	51%	32%	100%	9%	15%	17%	9%	----
WY1997-WY2023*	489.7	855.3	313.9	1,658.9	202.3	228.6	268.6	155.8	----
TN FWMC (mg/L)									
WY2019	1.44	1.26	0.82	1.23	1.08	1.47	1.62	0.98	1.56
WY2020	---	1.25	0.95	1.09	1.16	1.41	1.49	1.02	1.58
WY2021*	1.56	1.33	0.94	1.24	1.13	1.46	1.47	1.03	1.57
WY2022	---	1.22	0.89	1.06	1.17	1.37	1.42	0.87	1.35
WY2023*	1.39	1.39	1.36	1.38	1.18	1.45	1.66	1.09	1.56
5-Year Average ^{d*}	1.46	1.29	0.99	1.20	1.14	1.43	1.53	1.00	1.52
5-Year FWMC ^{f*}	1.48	1.30	1.02	1.22	1.13	1.44	1.52	1.00	----
WY1997-WY2023*	1.68	1.49	0.97	1.39	1.58	1.58	1.61	1.15	----

a. Due to sensor error resulting in the USGS data being unavailable, flow volumes reported from Lake Okeechobee to the C-44 Basin through S-308 for the period October 8–December 6, 2018, are sourced from USACE flow records. Based upon measured rainfall in the basin, the flow data available to estimate runoff from the C-44 Basin for this period, computed from the difference in S-308 flow and S-80 flow, appears to overestimate contributions from Lake Okeechobee and underestimate C-44 Basin runoff.

b. The St. Lucie Basins are C-44, C-23, C-24, and TMC.

c. Calculated at S-50 structure, which discharges to the IRL and not directly to the SLE.

d. 5-Yearr Average = arithmetic mean of annual data

e. 5-Yearr % = % of Total St. Lucie for Lake Okeechobee, St. Lucie Basins, Tidal Basins and C-44, C-23, C-24, and TMC Basins. Rounded to the nearest whole percentage.

f. 5-Year FWMC – the overall FWMC for the 5-year period (calculated from 5-year load and 5-year flow).

* Flow data for GORDYRD structure in the TMC Basin were estimated using the WaSh hydrodynamic model for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020.

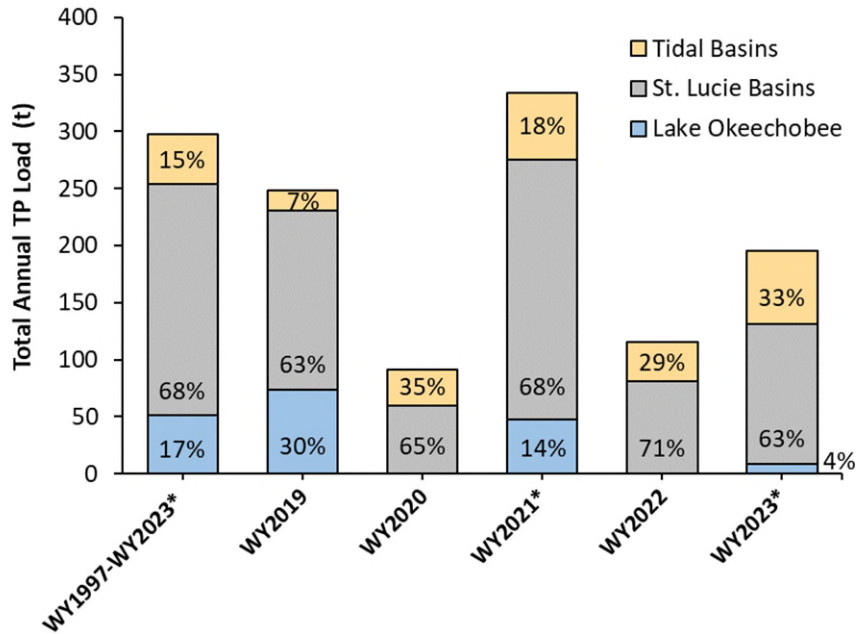


Figure 8C-8. Total annual TP load for the SLRW and from each contributing area by water year for WY2019–WY2023 and the long-term annual average (WY1997–WY2023) with relative percent contribution to total. (*TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020.)

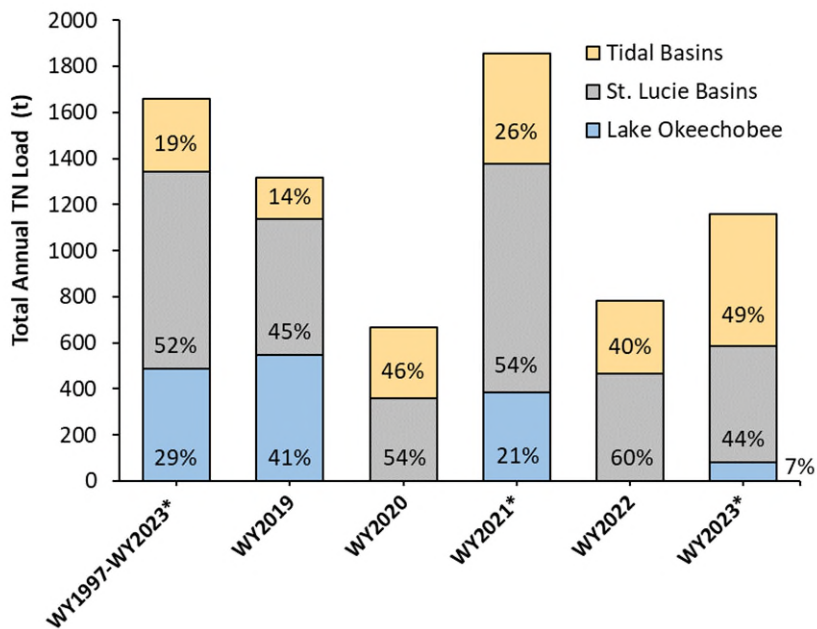


Figure 8C-9. Total annual TN load for the SLRW and from each contributing area by water year for WY2019–WY2023 and the long-term annual average (WY1997–WY2023) with relative percent contribution to total. (*TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020.)

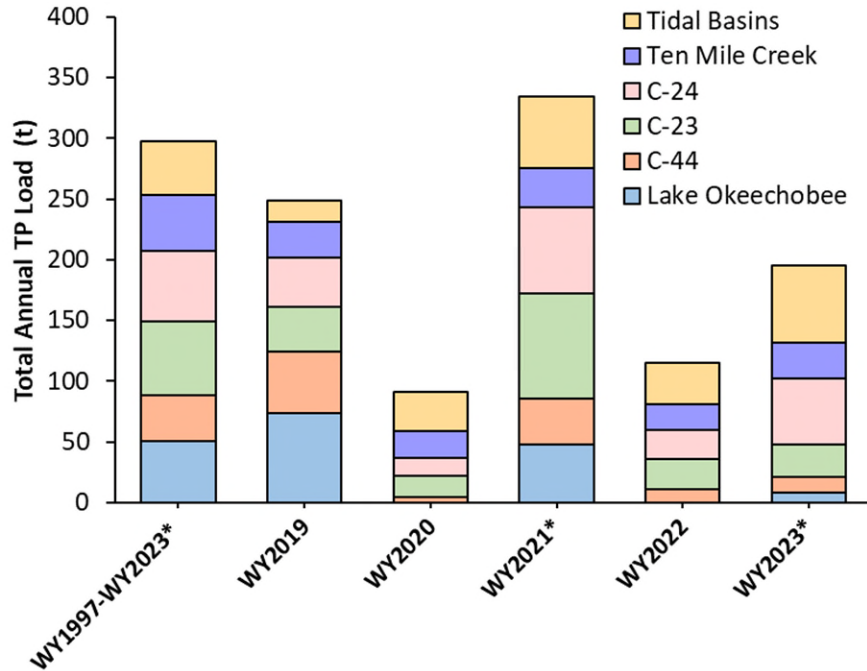


Figure 8C-10. Total annual TP load for the contributing basins by water year for WY2019–WY2023 and the long-term annual average (WY1997–WY2023). (*TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020.)

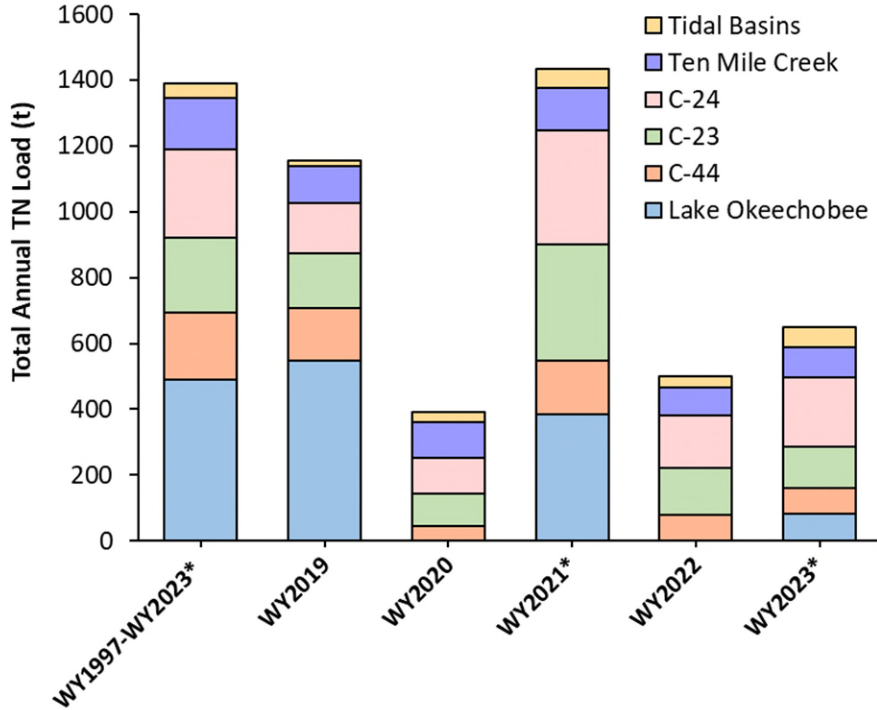


Figure 8C-11. Total annual TN load for the contributing basins by water year for WY2019–WY2023 and the long-term annual average (WY1997–WY2023). (*TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020.)

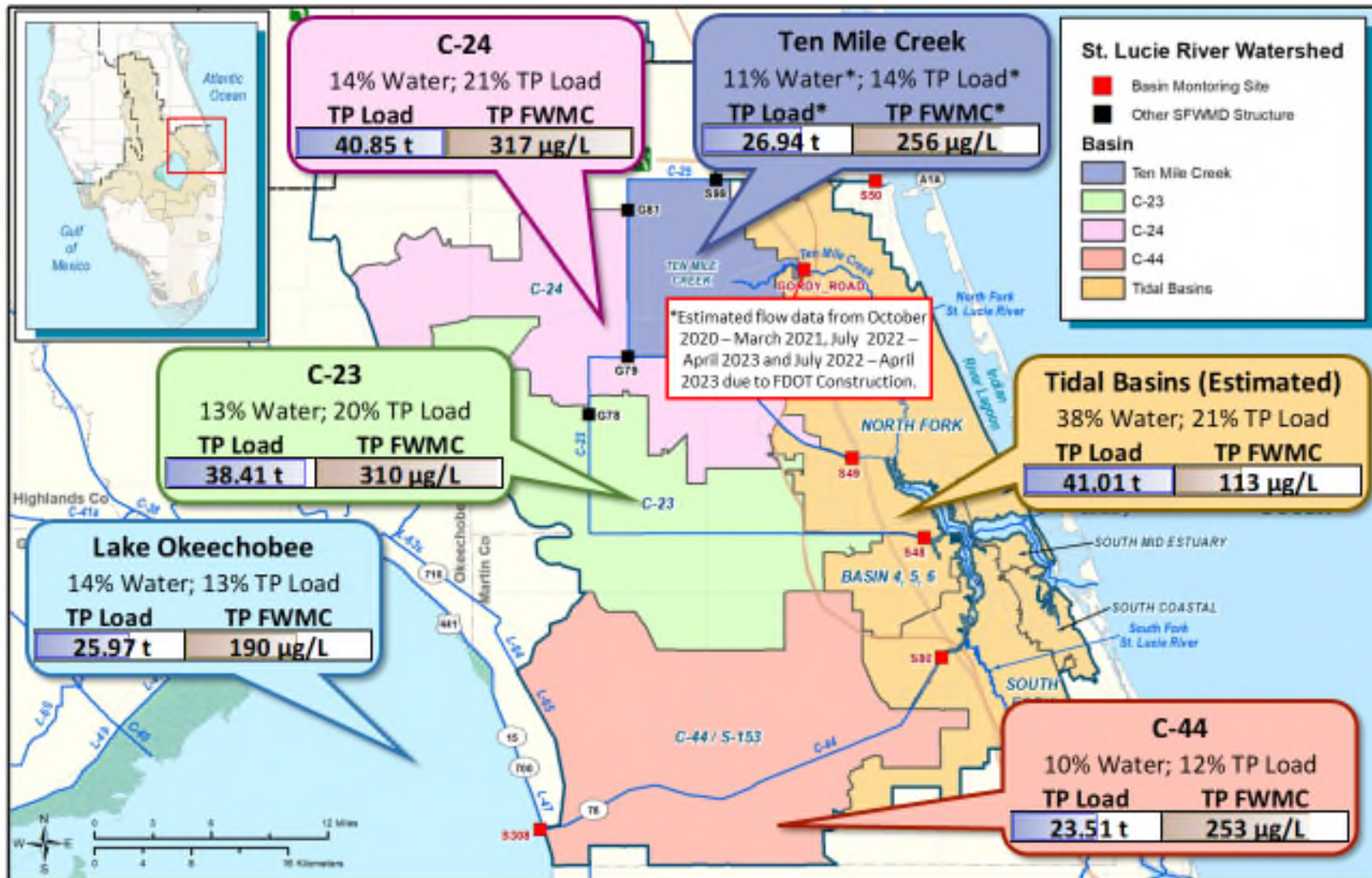


Figure 8C-12. Summary of contributions from each basin for the most recent 5-year period (WY2019–WY2023) with annual average TP Load, TP FWMC, and relative percent contributions for TP load and flow volume. (Note: TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and some days had missing data for October 21–26, 2020, November 2–17, 2020, July 24–August 3, 2022, and September 22–October 2, 2022.)

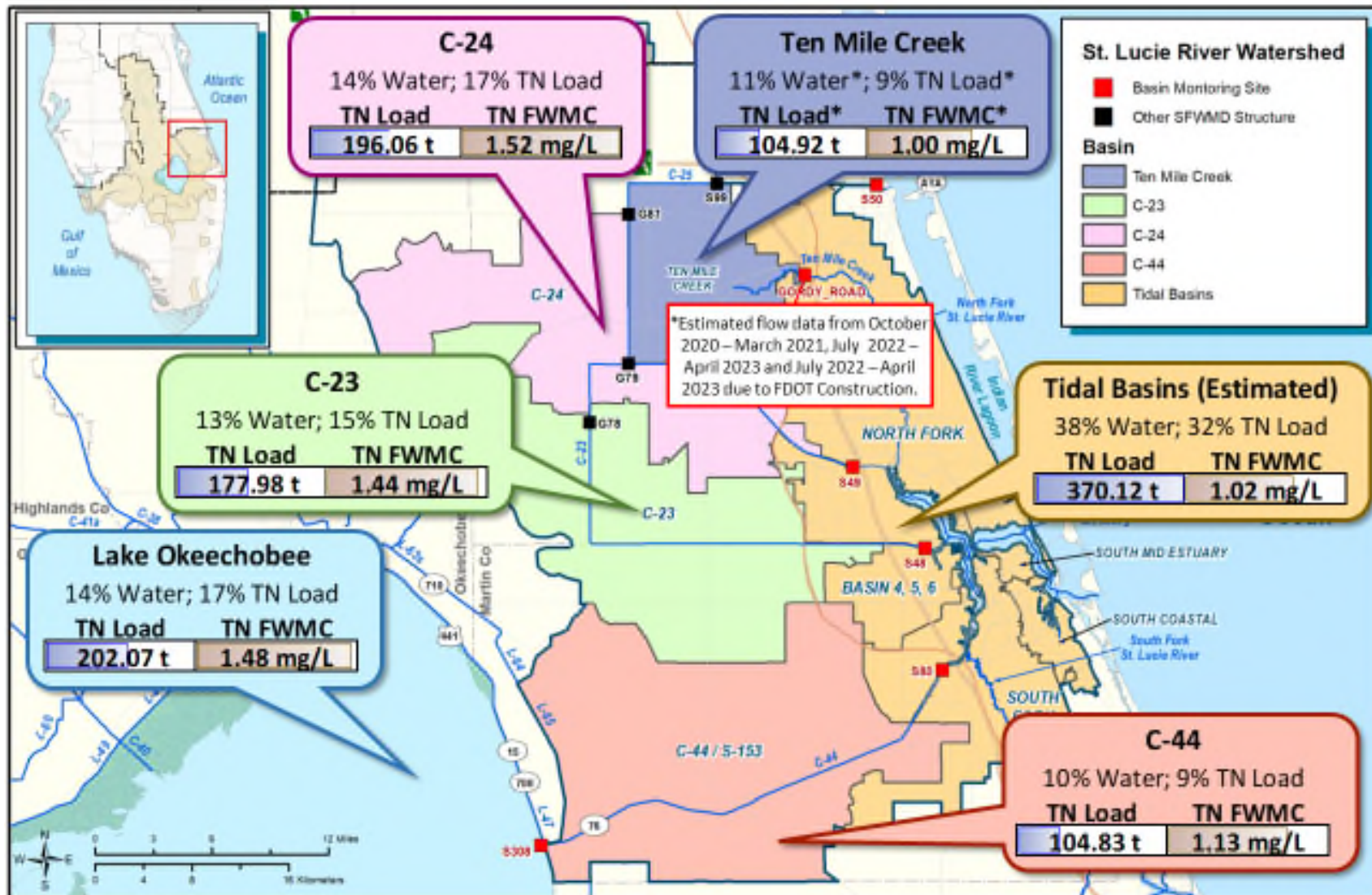


Figure 8C-13. Summary of contributions from each basin with the most recent 5-year period (WY2019–WY2023) with annual average TN Load, TN FWMC, and relative percent contributions for TN load and flow volume. (Note: TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and some days had missing data for October 21–26, 2020, November 2–17, 2020, July 24–August 3, 2022, and September 22–October 2, 2022.)

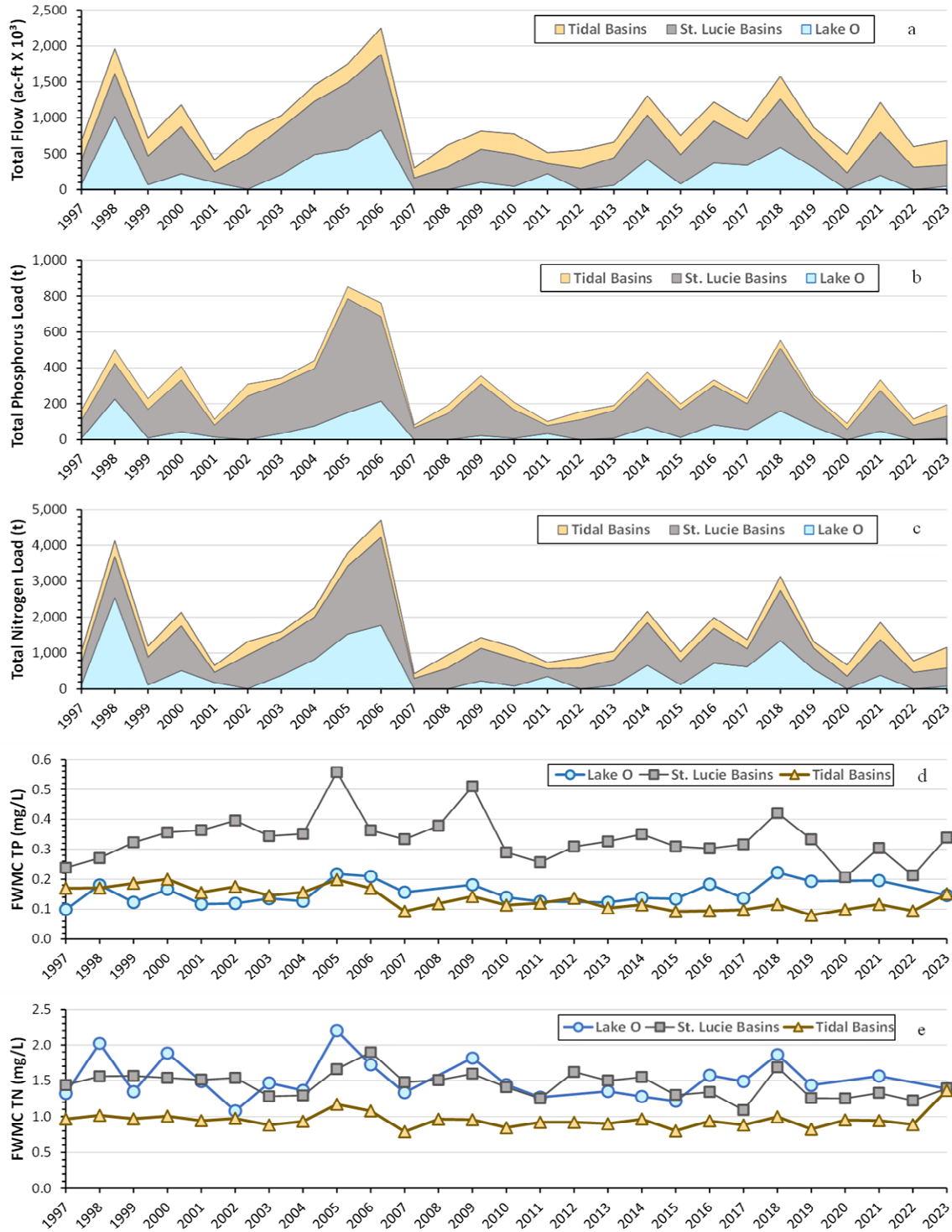


Figure 8C-14. Time series of (a) flow, (b) TP load, (c) TN load, (d) TP FWMC, and (e) TN FWMC for the contributing basins for the Tidal Basin (yellow), St. Lucie Basins (gray), and Lake Okeechobee (blue) for the WY1997–WY2023 period (x-axis in water years). (Notes: TMC flow data were estimated for October 8, 2020–April 30, 2021, and November 8, 2022–April 30, 2023, and missing for October 21–26 and November 2–17, 2020. Tropical cyclones affected the SLRW, either directly or indirectly, in 1998, 1999, 2001, 2004, 2008, 2012, 2016, 2017, and 2022.)

PART II: RESEARCH AND WATER QUALITY MONITORING PROGRAM – ST. LUCIE ESTUARY

Inflows to SLE exhibit intra- and interannual variability depending on the source and magnitude of those inflows due to changes in water management, weather, and climate, which may subsequently affect water quality and ecology (Doering 1996, Graves et al. 2004, Lapointe et al. 2012, Buzzelli et al. 2013b). Estuaries naturally exhibit gradients in water quality parameters from upstream to downstream. Anthropogenically-impacted estuarine systems with modified hydrology can have reduced ecosystem function and increased instability. For example, estuarine organisms may experience prolonged periods outside the organisms' optimum environmental conditions, thereby promoting mortality or negatively impacting reproduction strategies (Gunter 1961, Doering and Chamberlain 2000, Hanisak 2002, Barletta et al. 2005, Kahn and Durako 2008, Volety et al. 2009, Petes et al. 2012) leading to ecosystem impairment.

The volume and source of freshwater inflow to tributaries and the estuary directly affect water quality within the SLE and can alter nutrient concentrations, salinity conditions, and light availability. Changes in water quality and flushing rate due to the timing, duration, and volume of freshwater delivery can affect the abundance, distribution, and health of key benthic indicator species such as seagrass and oysters (Lirman and Cropper 2003, La Peyre et al. 2003, Buzzelli et al. 2012, 2013c, Wilson et al. 2005, Borja and Tunberg 2011, Parker et al. 2013, McKeon et al. 2015). Higher volumes of freshwater inflow decrease salinity levels and can alter the concentration and form of nutrients (such as TP and TN), the levels of colored dissolved organic matter (CDOM or color), and the amount of suspended solids in the water column (Doering 1996, Ji et al. 2007, Wan et al. 2012, Buzzelli et al. 2013a, 2014, Hanisak and Davis 2018). Increased levels of CDOM in the system are a major contributor to reduced light availability in the estuarine water column (Gallegos and Kenworthy 1996, Buzzelli et al. 2012), which can reduce biological processes such as photosynthesis. Higher nutrient levels can lead to increased concentrations of algae as measured by chlorophyll *a*, and together with suspended solids, further reduce light availability in the water column and negatively impact seagrass growth (Gallegos and Kenworthy 1996, Buzzelli et al. 2012, 2013a, Paczkowska et al. 2020).

To represent current and past ecological conditions in the SLE, this report summarizes monitoring data for several water quality parameters and benthic habitat indicators at select sites in the estuary (**Figure 8C-15**): TP, TN, chlorophyll *a*, eastern oysters (*Crassostrea virginica*), and seagrass.

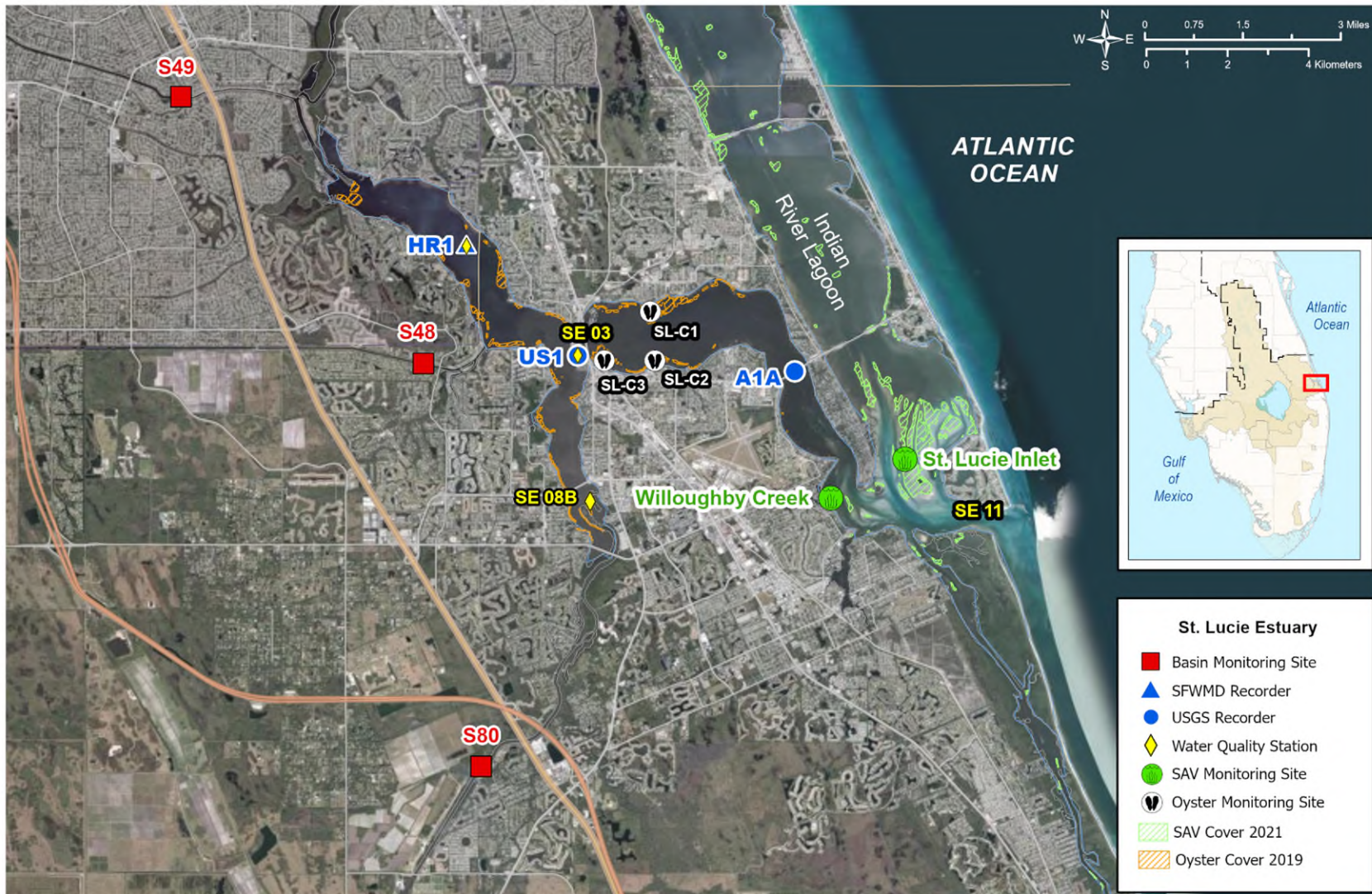


Figure 8C-15. SLE monitoring locations for water quality (HR1, SE 03, SE 08B, and SE 11), salinity recording stations (HR1, US1 and A1A), submerged aquatic vegetation (SAV), and oysters. SAV cover data are based on aerial imagery collected in 2021 of the Southern IRL and lower SLE, and oyster cover data are based on 2019 sidescan-sonar mapping results for oyster substrate, which includes live oysters and oyster shell.

WATER QUALITY

Water samples were obtained via grab sample at a depth of 0.5 m from the surface of the water for TP and TN and at half Secchi depth for chlorophyll *a* at ten stations in the SLE as part of the RWQMP. Water samples were collected at monthly intervals and processed according to the SFWMD *Field Sampling Manual* (SFWMD 2020a) and *Quality Manual* (SFWMD 2020b). Four representative stations were chosen to evaluate water quality conditions along the estuarine gradient based upon the best available long-term data set: HR1 in the upper estuary in the North Fork, SE 08B in the upper estuary in the South Fork, SE 03 in the middle estuary at the US1 Roosevelt Bridge, and SE 11 in the lower estuary near the St. Lucie Inlet (**Figure 8C-15**).

This assessment focuses on summarizing TP, TN and chlorophyll *a* concentrations annually and for the long-term POR available for each station. The POR was WY1997–WY2023 for HR1 and SE 03, WY2004–WY2023 for SE 08B, and WY1998–WY2023 for SE 11. Annual and seasonal concentrations for the last five water years (WY2019–WY2023) are presented as average (Avg) and standard deviation (SD) for each nutrient and compared to the long-term POR average for each site (**Tables 8C-3 through 8C-5**). Average nutrient concentrations for WY2023 and the long-term POR for the four SLE stations are presented in **Figure 8C-16a through 16c**.

Average nutrient levels in the SLE for WY2023 were lower than the long-term POR at all sites (**Tables 8C-3 through 8C-5 and Figure 8C-16a through 16c**). Similar to previous years, nutrient levels were highest in the upper estuary sites (SE 08B and HR1) and lowest at the lower estuary site SE 11. In WY2023, the South Fork site, SE 08B, experienced the highest concentrations of TN and TP. Seasonally, TP and TN are typically highest in summer months and decrease in the fall. However, in WY2023 there was an increase in TP and TN in October 2022 at all stations in the estuary. This increase in nutrient concentrations was most likely due to flows associated with Hurricane Ian, which hit Florida in late September 2022.

Chlorophyll *a* concentrations were plotted in a time series for WY2022–WY2023 along with the long-term seasonal POR for each SLE station (**Figures 8C-17a through 17d**). The seasonal POR is the average concentration for the wet and dry season over the long-term POR at each station. The SLE did not have any algal blooms in WY2023 (as defined by FDEP as 40 µg/L chlorophyll *a* for Lake Okeechobee), and chlorophyll *a* concentrations remained low throughout the estuary. In WY2023, chlorophyll *a* values were highest at HR1 in June and August 2022 (24.2 and 24 µg/L, respectively). Over the past five water years, chlorophyll *a* concentrations in the SLE were not correlated to TN, TP, dissolved inorganic N, or soluble reactive P concentrations nor their respective mass ratios. This may be due to the monthly sampling frequency, which may not be sufficient to capture the biological processes that occur on a sub-daily time scale.

Table 8C-3. Annual average (Avg) and standard deviation (SD) of TP concentrations for four stations in the SLE for the most recent 5-year period (WY2019–WY2023) and the POR. (Note: wet season is May–October and dry season is November–April.)

Total Phosphorus (mg/L)						
HR1 (North Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997–WY2023	0.249	0.100	0.138	0.047	0.195	0.096
WY2019	0.207	0.088	0.145	0.016	0.176	0.068
WY2020	0.183	0.036	0.123	0.020	0.153	0.042
WY2021	0.234	0.114	0.134	0.056	0.184	0.101
WY2022	0.203	0.040	0.115	0.018	0.159	0.055
WY2023	0.195	0.064	0.125	0.033	0.160	0.061
SE 08B (South Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY2004–WY2023	0.220	0.059	0.153	0.045	0.186	0.062
WY2019	0.192	0.062	0.186	0.032	0.189	0.047
WY2020	0.218	0.045	0.157	0.034	0.187	0.049
WY2021	0.213	0.033	0.155	0.052	0.184	0.051
WY2022	0.232	0.029	0.141	0.028	0.187	0.055
WY2023	0.215	0.047	0.143	0.037	0.179	0.055
SE 03 (Middle Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997–WY2023	0.214	0.082	0.125	0.042	0.171	0.079
WY2019	0.192	0.071	0.122	0.021	0.157	0.062
WY2020	0.163	0.015	0.120	0.026	0.142	0.030
WY2021	0.219	0.085	0.128	0.056	0.174	0.084
WY2022	0.184	0.028	0.101	0.013	0.143	0.048
WY2023	0.160	0.048	0.113	0.032	0.137	0.046
SE 11 (Lower Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1998–WY2023	0.082	0.068	0.040	0.031	0.061	0.057
WY2019	0.075	0.074	0.042	0.008	0.059	0.053
WY2020	0.051	0.015	0.038	0.010	0.045	0.014
WY2021	0.083	0.040	0.056	0.048	0.069	0.044
WY2022	0.055	0.028	0.029	0.011	0.042	0.024
WY2023	0.045	0.045	0.051	0.036	0.049	0.038

Table 8C-4. Annual average (Avg) and standard deviation (SD) of TN concentrations for four stations in the SLE for the most recent 5-year period (WY2019–WY2023) and the POR. (Note: wet season is May–October and dry season is November–April.)

Total Nitrogen (mg/L)						
HR1 (North Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997–WY2023	1.12	0.37	0.74	0.30	0.94	0.39
WY2019	0.98	0.32	0.71	0.08	0.85	0.26
WY2020	0.91	0.18	0.72	0.18	0.81	0.20
WY2021	1.06	0.27	0.76	0.31	0.91	0.32
WY2022	1.01	0.21	0.57	0.12	0.79	0.28
WY2023	0.85	0.27	0.68	0.19	0.77	0.24
SE 08B (South Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY2004–WY2023	1.17	0.30	0.94	0.36	1.06	0.35
WY2019	1.16	0.24	0.99	0.24	1.08	0.24
WY2020	1.02	0.12	0.88	0.22	0.95	0.18
WY2021	1.04	0.13	1.04	0.43	1.04	0.30
WY2022	1.09	0.23	0.72	0.15	0.91	0.27
WY2023	0.93	0.25	1.00	0.29	0.97	0.26
SE 03 (Middle Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997 - WY2023	1.09	0.37	0.75	0.37	0.92	0.40
WY2019	1.04	0.29	0.63	0.15	0.83	0.31
WY2020	0.79	0.15	0.66	0.19	0.73	0.17
WY2021	0.98	0.25	0.79	0.42	0.89	0.34
WY2022	0.92	0.24	0.50	0.09	0.71	0.28
WY2023	0.74	0.22	0.66	0.19	0.70	0.20
SE 11 (Lower Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1998–WY2023	0.58	0.39	0.37	0.31	0.48	0.37
WY2019	0.41	0.25	0.28	0.07	0.35	0.19
WY2020	0.34	0.11	0.27	0.04	0.31	0.09
WY2021	0.49	0.22	0.40	0.31	0.45	0.26
WY2022	0.36	0.16	0.19	0.06	0.27	0.15
WY2023	0.30	0.25	0.26	0.20	0.28	0.22

Table 8C-5. Annual average (Avg) and standard deviation (SD) of chlorophyll *a* concentrations for four stations in the SLE for the most recent 5-year period (WY2019–WY2023) and the POR. (Note: wet season is May–October and dry season is November–April.)

Chlorophyll <i>a</i> (µg/L)						
HR1 (North Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997–WY2023	16.5	14.6	8.4	5.8	12.5	11.9
WY2019	17.4	4.8	9.4	3.2	12.9	5.6
WY2020	28.2	24.3	6.8	1.0	16.5	19.0
WY2021	12.5	8.0	5.2	3.6	8.9	7.0
WY2022	19.7	17.8	5.6	2.3	12.7	14.2
WY2023	16.1	6.9	6.1	2.8	11.1	7.3
SE 08B (South Fork in the Upper Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY2004–WY2023	11.1	12.8	8.4	4.6	9.7	9.6
WY2019	18.0	15.7	9.9	2.9	13.5	10.7
WY2020	15.0	8.8	6.7	2.5	10.5	7.3
WY2021	7.1	3.2	9.4	5.4	8.2	4.4
WY2022	8.9	6.3	9.2	3.0	9.1	4.7
WY2023	7.0	4.4	10.5	6.9	8.7	5.8
SE 03 (Middle Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1997–WY2023	10.2	9.6	5.7	3.7	8.0	7.7
WY2019	9.9	4.9	5.7	2.7	7.6	4.2
WY2020	6.6	1.8	3.6	1.5	5.0	2.2
WY2021	6.0	3.2	4.0	1.3	5.0	2.6
WY2022	6.3	3.0	5.0	1.9	5.6	2.5
WY2023	8.0	3.5	5.0	4.3	6.5	4.0
SE 11 (Lower Estuary)						
Period	Wet Season		Dry Season		Total	
	Avg	SD	Avg	SD	Avg	SD
WY1998–WY2023	4.1	3.0	2.8	2.2	3.5	2.7
WY2019	5.8	2.2	4.3	2.8	4.9	2.5
WY2020	4.8	1.6	2.9	1.0	3.9	1.6
WY2021	4.7	2.0	2.8	1.9	3.8	2.1
WY2022	3.1	0.9	2.3	0.9	2.7	0.9
WY2023	2.7	1.3	2.5	1.8	2.6	1.5

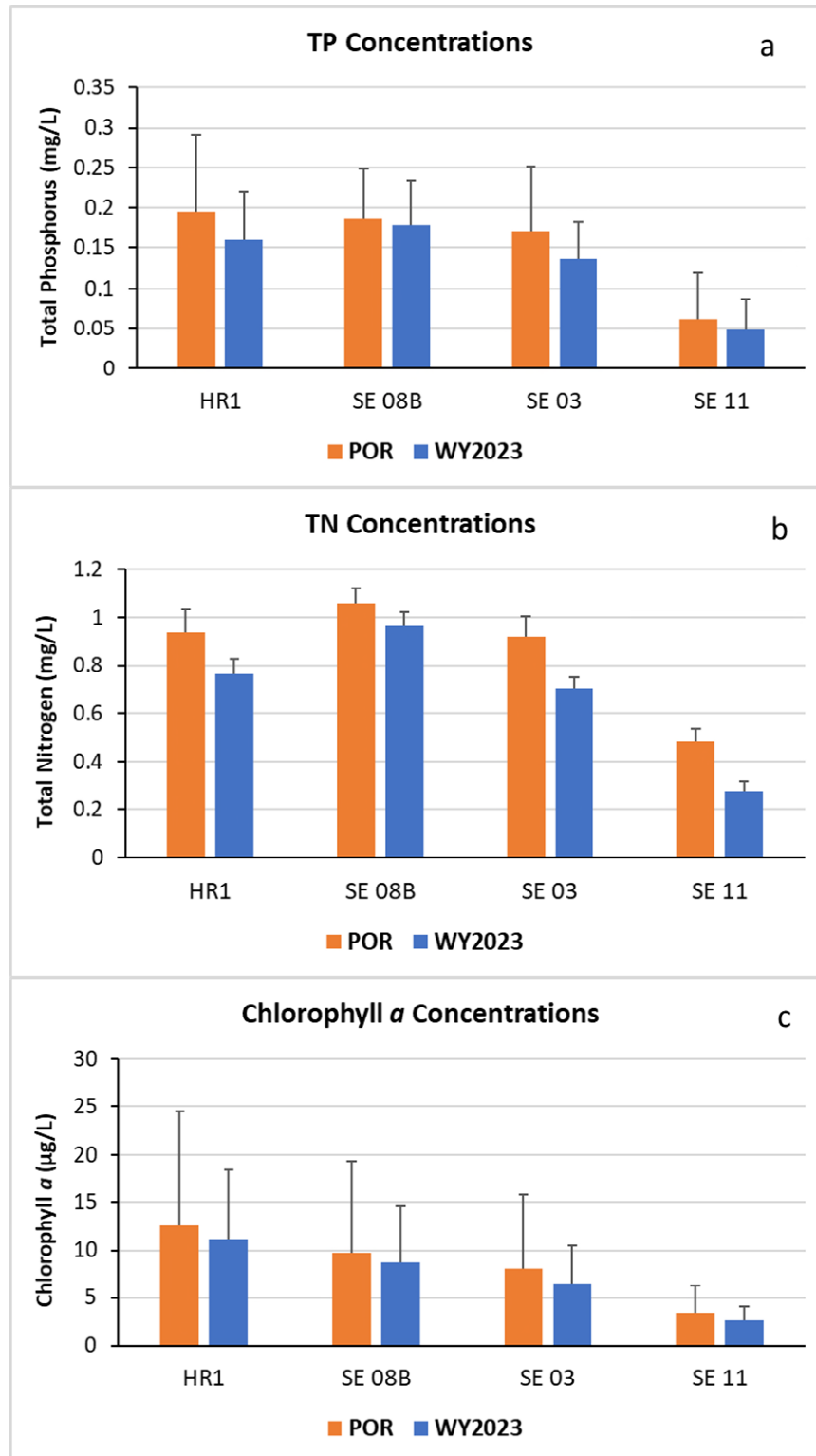


Figure 8C-16. Concentrations of (a) TP, (b) TN, and (c) chlorophyll *a* for the POR and WY2023 for HR1 (North Fork; POR WY1997–WY2023), SE 08B (South Fork; POR WY2004–WY2023), SE 03 (mid-estuary; POR WY1997–WY2023), and SE 11 (lower estuary; POR WY1998–WY2023).

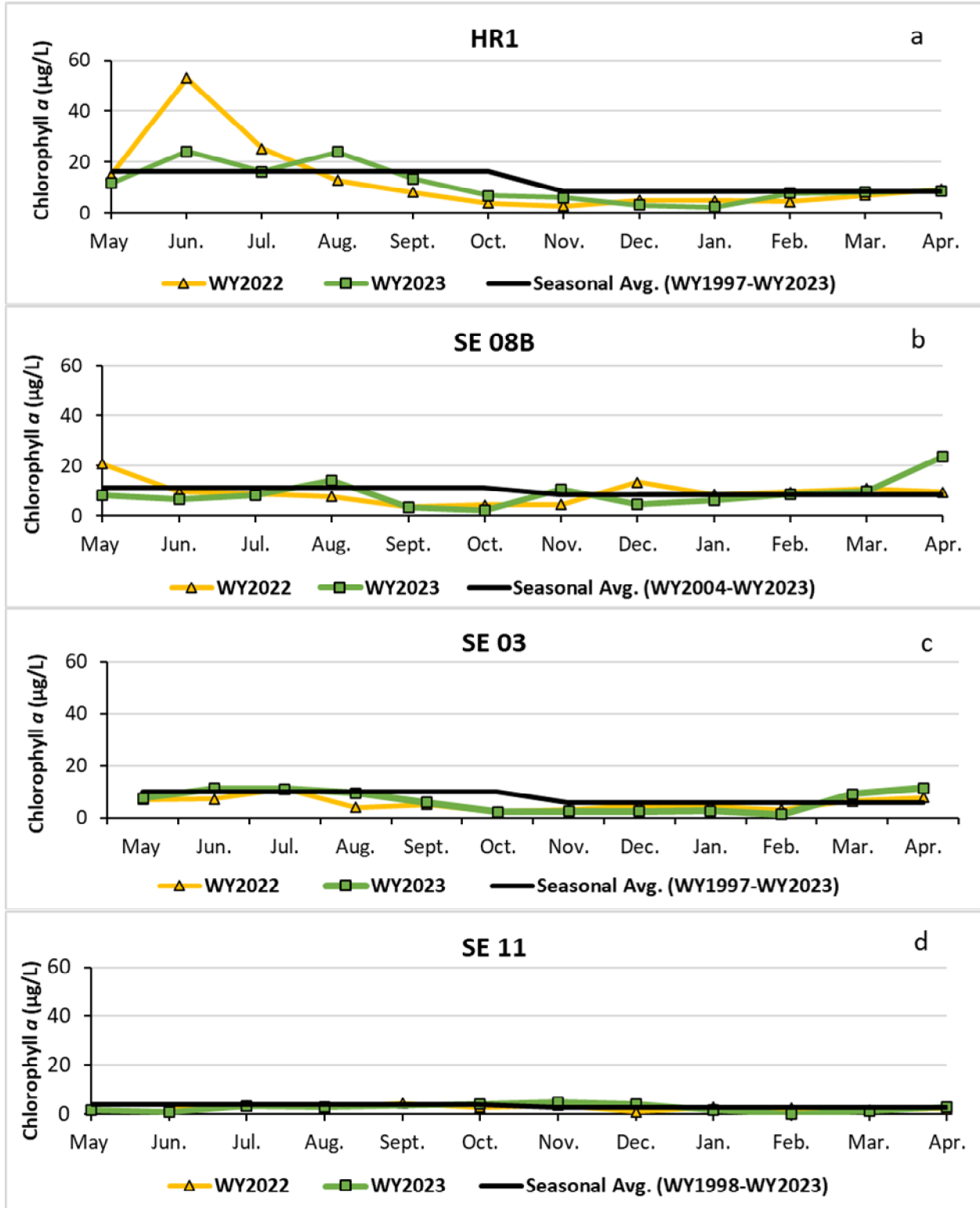


Figure 8C-17. Monthly chlorophyll a concentrations at (a) HR1: North Fork, (b) SE 08B: South Fork, (c) SE 03: mid-estuary, and (d) SE 11: lower estuary for WY2022, WY2023, and the long-term seasonal (wet and dry season) average for the POR.

The mid-estuary (SE 03) is most impacted by freshwater inflow because the North and South Forks converge at the middle estuary (**Figure 8C-15**). The mid-estuary station, SE 03, is also the Roosevelt Bridge compliance point that FDEP uses to assess the TMDL in the SLE (Parmer et al. 2008). Monthly nutrient concentrations at station SE 03 in WY2023 were compared to the monthly values in WY2022 and to the POR seasonal (wet and dry season) averages (**Figures 8C-18a** and **18b**). In WY2023, peak nutrient concentrations were observed in October 2022 at SE 03 and are likely a result of excess flows associated with Hurricane Ian in early September.

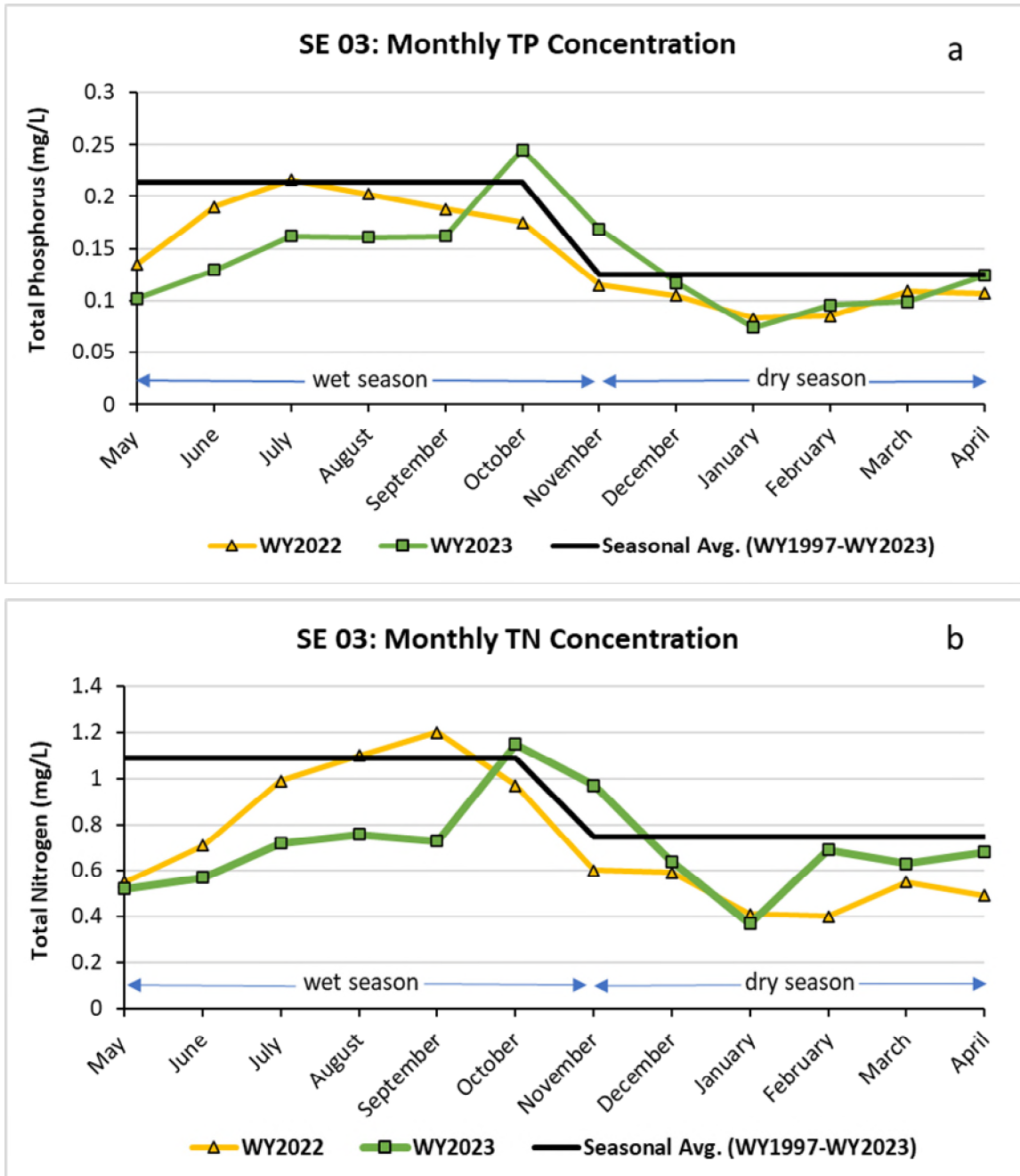


Figure 8C-18. Monthly concentrations of (a) TP and (b) TN at SE 03 station in the mid-estuary for WY2022, WY2023, and the long-term seasonal (wet and dry season) average for the POR.

Monthly TP and TN concentrations for the mid-estuary station SE 03 were compared to monthly flows for the SLRW for WY2019–WY2023 (Figure 8C-19). Nearly 50% of the variability in nutrient concentrations at the mid-estuary over the past five years can be explained by estuary inflow. Nutrient concentrations in the mid-estuary increase with increasing flow, but as flows increase above 200,000 ac-ft per month, concentrations do not increase (Figure 8C-19). The North Fork (HR1) and South Fork (SE 08B) nutrient concentrations are similarly impacted by SLRW flow but to a lesser extent, i.e., less variability in concentration explained by flow. Chlorophyll *a* concentrations were not correlated to SLRW flow at any sampling station.

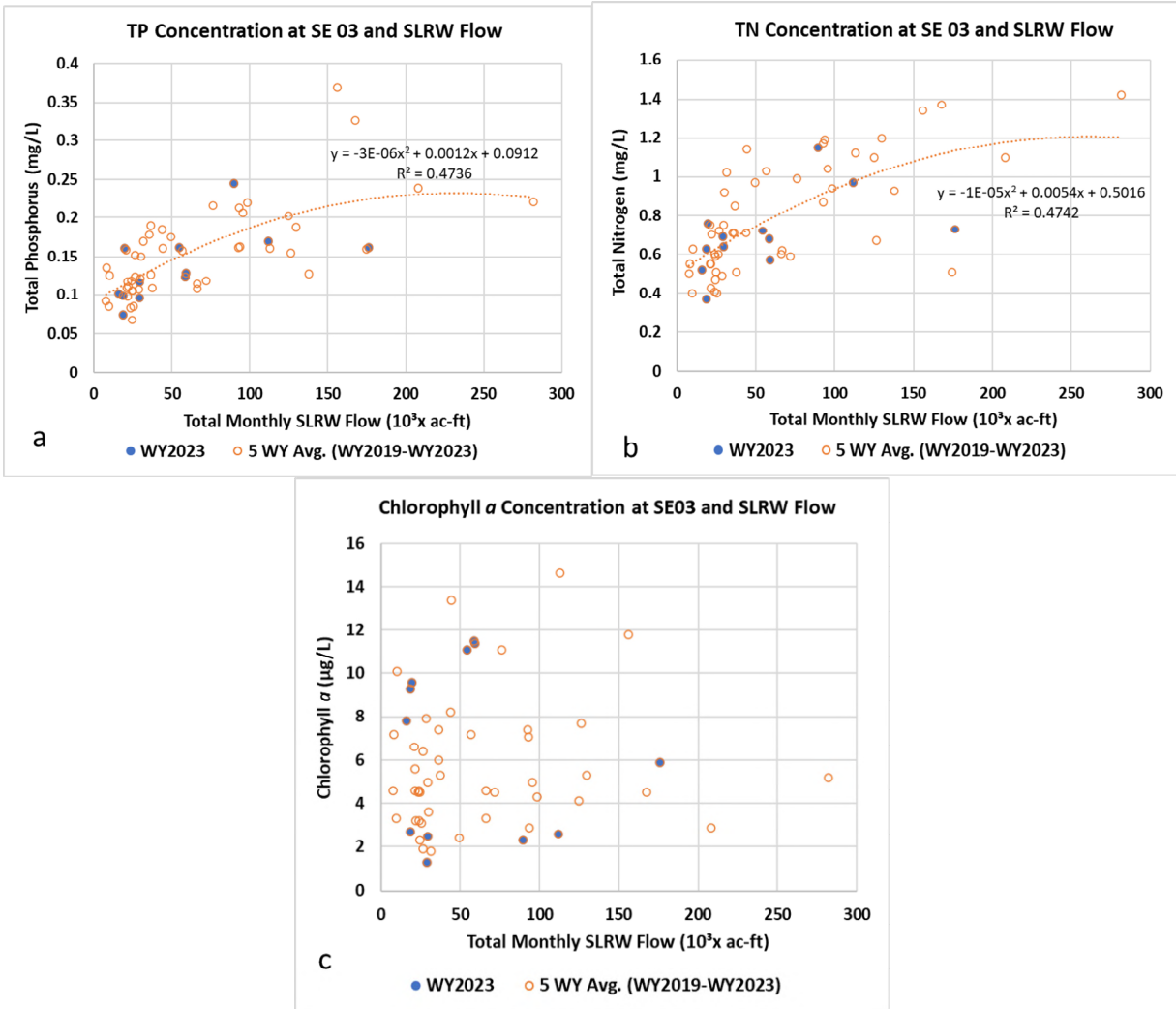


Figure 8C-19. Concentrations of (a) TP, (b) TN, and (c) chlorophyll *a* at the mid-estuary station SE 03 compared to monthly SLRW flows for WY2023 and the most recent 5-year period (WY2019–WY2023).

Monthly TP and TN concentrations for station SE 03 were compared to monthly nutrient loading for the SLRW for WY2019–WY2023 (Figures 8C-20 and 8C-21). Nutrient loading was highly correlated to nutrient concentrations in the mid-estuary. Phosphorus loading explained nearly 60% of the phosphorus concentration, while nitrogen loading explained 50% of nitrogen concentrations at SE 03. The correlations between nutrient loading and nutrient concentration were not as strong in the North Fork (HR1) or South Fork (SE 08B). The lower estuary experienced a lower correlation between flow and nutrient concentration due to the stronger tidal influence. Other factors that can contribute to nutrient concentrations at each site include nutrient exchange with the sediment (either influx or efflux) and biological uptake/release of nutrients. There was no correlation between chlorophyll *a* and either TP loading or TN loading at any site in the estuary.

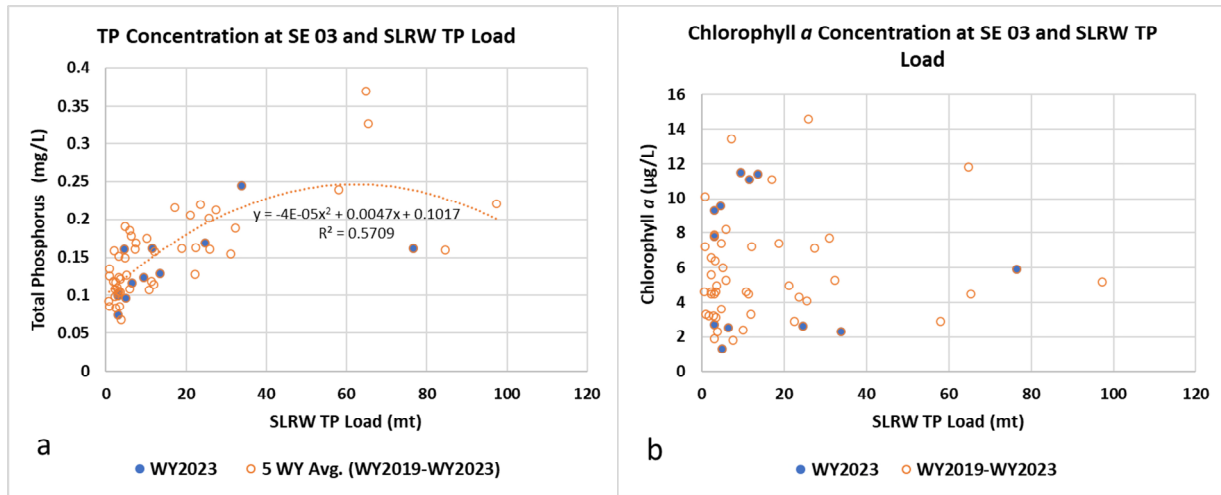


Figure 8C-20. Concentrations of (a) TP and (b) chlorophyll *a* at the mid-estuary station SE 03 compared to total SLRW TP loading for WY2023 and the most recent 5-year period (WY2019–WY2023).

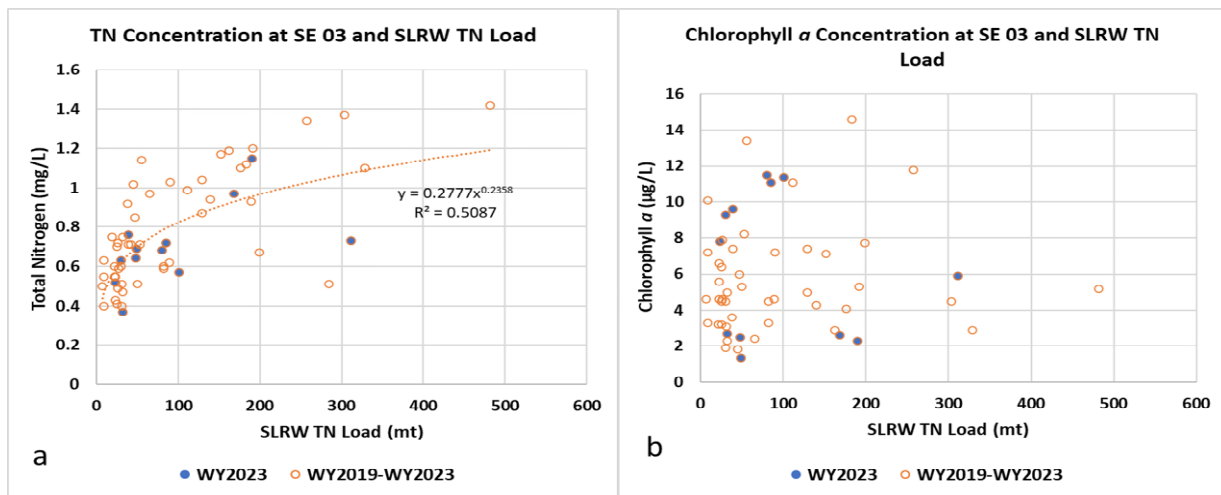


Figure 8C-21. Concentrations of (a) TN and (b) chlorophyll *a* at the mid-estuary station SE 03 compared to total SLRW TN loading for WY2023 and the most recent 5-year period (WY2019–WY2023).

Nutrient and Phytoplankton Modeling

The SFWMD has made significant efforts in hydrodynamic and water quality modeling for the SLE. A comprehensive modeling effort started in the early 2000s with the development of the Environmental Fluid Dynamic Code (EFDC) hydrodynamic and water quality model (Ji et al. 2007, Wan et al. 2012). The early efforts calibrated and verified the EFDC model with data from 1999 to 2000. The model was later extended to include more years of data with improvement in boundary conditions and calibration with measured primary production data. The EFDC model performed well for hydrodynamics and water quality in the estuary including nutrients, phytoplankton, and dissolved oxygen concentrations, but it was a complex model with hundreds of model parameters each containing significant uncertainties. The EFDC model is also computationally intensive and often beyond the capabilities of ecologists. In recent years, a more simplified water quality model was developed and is described in detail in Appendix 8C-2.

In this simplified model, a box model approach (Officer 1980, Hagy and Sanford 2000, Dettmann 2001) was used in which the estuary was represented by a single compartment cell. A salt-balanced approach (Rattray and Officer 1979) was adapted using measured salinity to represent mixing and transport behavior in the estuary. For water quality, first order kinetic assumptions were made for nutrient and phytoplankton concentrations, which is a common practice in water quality modeling (Park et al. 1995, Cerco 2000, Ji 2017).

Under idealized tidally-averaged conditions assuming steady freshwater inflows and loadings, and constant kinetic reaction rates, analytical solutions were found that consisted of steady state and non-steady state components. The steady state solution is a typical mixing equation between fresh water and seawater for a conservative constituent like salt. For phytoplankton, the non-steady solution is an exponential growth or decay rate depending on the difference between the net growth rate and flushing rate. The steady state solution suggests that algal loading rather than nutrient loading could account for an important part of algal biomass in the estuary. The steady state solutions were applied to the SLE for a 19-year period from 1999 to 2017. The R^2 values between modeled and observed estuarine mean concentrations were 60 to 70% for nutrients and 45% for chlorophyll *a*. The results suggest physical transport and mixing are dominant processes influencing nutrient concentrations in the SLE. Physical transport and mixing are also major processes for algal dynamics in the estuary suggesting upstream sources of phytoplankton should be included in water management considerations.

The model can be used to explain some of the observations made in the previous section for nutrients and phytoplankton. Model analysis (Equation 16 in Appendix 8C-2 of this volume) suggests estuarine nutrient concentrations are correlated to the flow-weighted concentrations in the incoming fresh water or concentrations in front of the structures. It also has a positive correlation with freshwater inflow as flow increases, estuarine concentration increases because of less dilution from seawater but will not exceed the concentrations at the upstream sources. This is very much in agreement with **Figures 8C-19a** and **8C-19b**. For phytoplankton, it's more complicated. When the net growth rate is low, it behaves similar to nutrients, i.e., phytoplankton concentration is more controlled and limited by the upstream sources (upper panel of Figure 13 in Appendix 8C-2); when the net growth rate is high (lower panel of Figure 13), high fresh water does inhibit phytoplankton growth as high flushing pushes the biomass out of the estuary before they can grow further. However, the threshold flow would depend on the actual net growth rate.

Phytoplankton Dynamics in the St. Lucie Estuary

The SLE Phytoplankton project began in January 2019 to examine the effects of freshwater inflows on phytoplankton dynamics in the SLE. Project objectives include identifying phytoplankton biomass patterns, long-term trends, predictor variables, indicator taxa, nutrient levels, salinity conditions, origins of harmful algal blooms (HABs), and to develop quantitative and forecasting models. Results from this project will be used to assist with managing the volume, timing, and duration of freshwater releases into the SLE to reduce occurrence of HABs.

Phytoplankton monitoring was conducted at ten sites throughout the SLE (**Figure 8C-22**). Several of these sites were collocated near SFWMD long-term water quality monitoring stations with access to continuous data. Field collection and analysis included assessing the physicochemical properties of water influencing phytoplankton community dynamics (both vertically and spatially), nutrient concentrations, light attenuation, phytoplankton biomass (chlorophyll *a*), and community structure (composition and abundance of taxa).

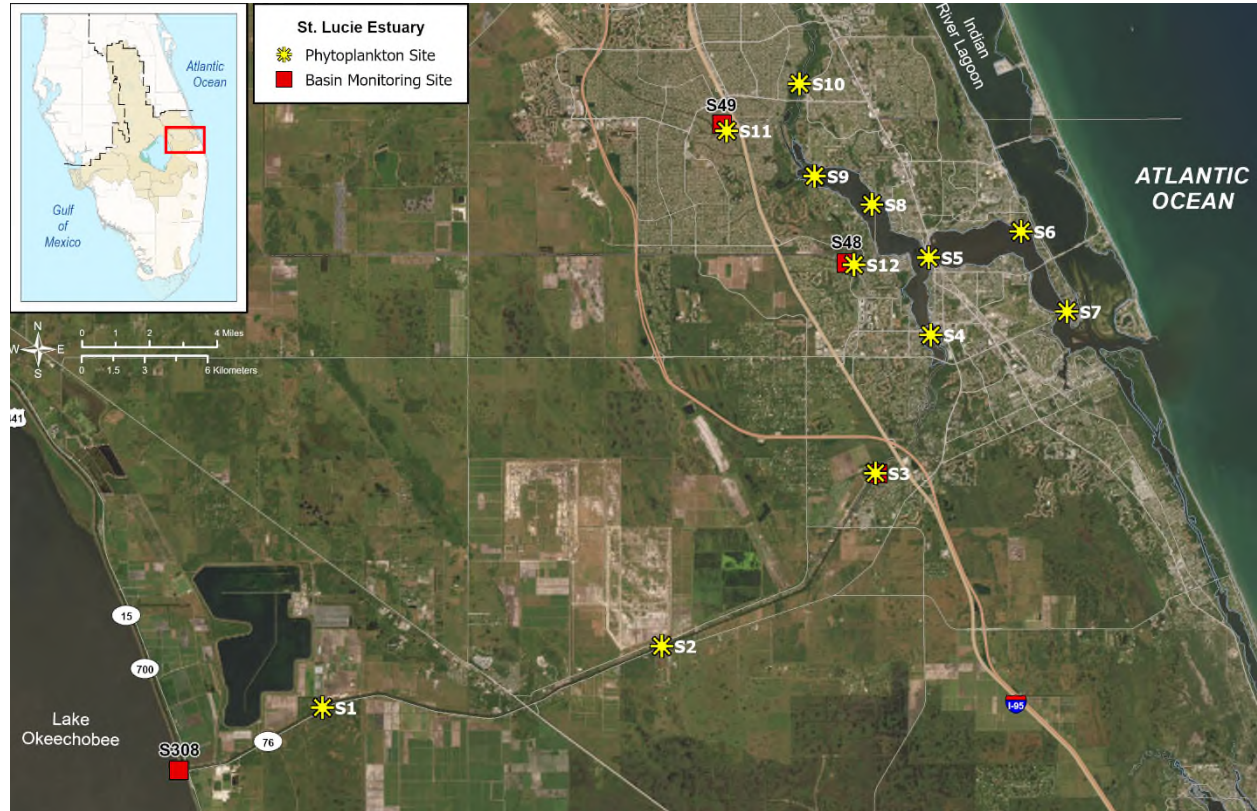


Figure 8C-22. Phytoplankton sampling site locations: three along the C-44 Canal (S1, S2, S3), and seven within the SLE (S4, S5, S6, S7, S8, S9, S10). *Note: S11 and S12 were added in January 2023.

While there were no visible algal blooms noted during the study period, the most prevalent phytoplankton groups collected in the SLE were diatoms and dinoflagellates (typically during the summer) and occasionally cryptophytes generally collected in the North Fork and South Fork. A couple of the abundant diatoms identified were various *Skeletonema* species and *Trieres regia*. A few of the abundant dinoflagellates identified were *Prorocentrum cordatum*, *Akashiwo sanguinea* and *Gonyaulax digitale*. Cyanobacteria algae were low throughout the estuary except at site S10, the farthest North Fork region sampled, where it could be occasionally found. Cyanobacteria (*Microcystis*) capable of producing toxins were not detected during this period likely due to the minimal freshwater releases from Lake Okeechobee and S-80. Dinoflagellates and mixed-species blooms were detected in the upper SLE, and C-44 Canal during summer months following the few low freshwater discharges.

A two-year (2019–2022) summary report on the phytoplankton monitoring project in the SLE can be found in Appendix 8C-3. The SLE and C-44 Canal were species rich with almost 300 different species identified, mostly dominated by diatoms. Five separate community groups were identified along the estuarine salinity gradient from freshwater communities in the C-44 Canal (S1 to S3) to more marine communities closer to the inlet (S7) and fresh to brackish assemblages in-between. Water quality and

phytoplankton community group correlations showed structuring of communities related to salinity, nutrients, and light. Phytoplankton abundance (chlorophyll *a*), turbidity, and colored dissolved organic matter were high throughout and contributed to high water column light attenuation. In addition, low light levels limited phytoplankton production at most sites over this period.

FISH MONITORING IN THE ST. LUCIE ESTUARY

A fish monitoring study was initiated under the Comprehensive Everglades Restoration Plan (CERP) to address a knowledge gap to determine how freshwater inflow and habitat availability affects the distributions of large-bodied fish species in the IRL and SLE. A goal of this study was to determine species thresholds, the use of essential fish habitats, and ecological costs to the fish regarding freshwater management and future urbanization of the estuarine system. Understanding the causes of change in species distributions, particularly for species that support recreational fisheries and garner public attention, can aid in habitat restoration efforts within the IRL and SLE.

A report, found in Appendix 8C-4, includes findings from the first year of a study conducted in the IRL and SLE, utilizing acoustic telemetry to identify fish movement and distribution patterns in relation to freshwater inflow and other environmental variability. Species highlighted in this report include the common snook (*Centropomus undecimalis*), smallscale fat snook (*Centropomus parallelus*), sheepshead (*Archosargus probatocephalus*), spotted seatrout (*Cynoscion nebulosus*), and juvenile goliath grouper (*Epinephelus itajara*). Movement data were paired with environmental data sets to investigate the effects of temperature and salinity on the movement patterns and distribution of these five species, and evaluate which species best serve as ecological indicators.

In evaluating the above species as ecological indicators for environmental variability in the SLE and IRL, sheepshead demonstrated the most promise. Oysters are currently used by CERP as ecological indicators, and sheepshead tagged in this study were consistently detected in areas overlapping oyster habitat. Sheepshead can be caught in large numbers using haul seines, making it possible to tag and track cohorts of fish to analyze movement patterns and use of oyster beds. Smallscale fat snook, a subspecies of snook in southeast Florida unique to riverine habitats, may be beneficial as an ecological indicator in the farther freshwater reaches of the SLE. Smallscale fat snook utilize the upper reaches of an estuary before migrating to inlets to spawn. It is possible to identify shifts in habitat use by this species outside of spawning season when salinity drops further downstream in the SLE. Although common snook survival documented during a cold snap in 2010 provided managers with necessary information to keep the fishery open, there was no evidence of movement in response to freshwater inflow. Juvenile goliath grouper survived for multiple years, withstanding a wide range in salinity and temperatures in the SLE and IRL during multiple periods of high magnitude freshwater inflows and storms (see Figures 8, 10, 11, and 12 in **Appendix 8C-4**). Decline in the spotted seatrout population has been anecdotally associated with a decline in seagrass habitat. Many spotted seatrout tagged in this study had few detections, and some were observed being predated on shortly after release. A larger effort would be needed to obtain an adequate sample size to better evaluate this species as an ecological indicator for restoration.

Most notably, during the life of the acoustic tags on the fish species in the study, apart from common snook, fish that were tagged in the SLE were never observed being pushed out of the system by freshwater inflows and resultant changes in salinity. Likewise, fish initially tagged within the IRL were rarely, if ever, detected in the SLE. Other than the common snook, each species exhibited high site fidelity.

AQUATIC HABITAT

Eastern Oysters (*Crassostrea virginica*)

Eastern oysters (*C. virginica*) are benthic, immobile, filter-feeding organisms that contribute valuable ecosystem services by filtering phytoplankton and suspended particles from the water column by providing food, shelter, and habitat for other estuarine organisms. This makes them an ideal indicator species for assessing the effects of water quality restoration on estuarine ecosystems (Volety et al. 2009). Oyster monitoring in the SLE was initiated in 2005 and is supported by the CERP Restoration Coordination and Verification (RECOVER) program. This long-term monitoring program measures the effects of CERP restoration efforts on oyster population health and distribution. Data also provide adaptive management information to assist in determining the flows and volumes required to maintain and promote healthy oyster populations in the SLE. Oyster density, recruitment, and disease prevalence and intensity were monitored at one site with three stations in the SLE middle estuary (Figure 8C-23). Results from the last five water years (WY2019–WY2023) are presented in this section.

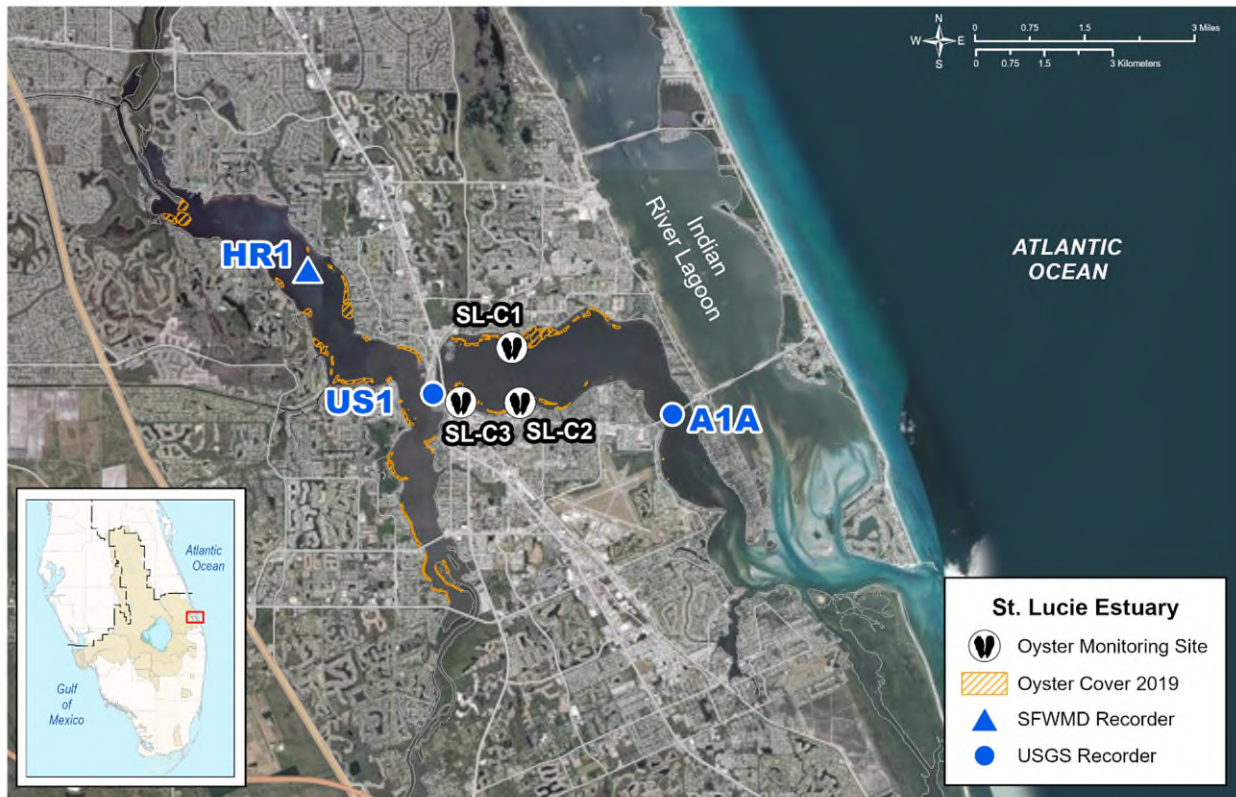


Figure 8C-23. SLE oyster monitoring site locations, oyster cover in 2019, and salinity recording stations (HR1, US1, and A1A). Oyster cover data are based on data from 2019 sidescan-sonar mapping results for oyster substrate, which includes live oysters and oyster shell.

Salinity

The health, survivorship, and distribution of oyster populations are greatly influenced by water quality. Rapid changes in salinity, high temperatures, low dissolved oxygen concentrations, and siltation can all be stressors (Parker 2015, Parker and Radigan 2020). Temperature and salinity are two of the most influential environmental factors affecting oyster populations (Shumway 1996). Oysters are capable of tolerating salinities from 5 up to 40 (Galtsoff 1964) though salinities of approximately 14 to 28 have been widely recognized as an ideal range for *C. virginica* (Shumway 1996, McFarland et al. 2022). Estuarine salinity regimes, and the frequency and magnitude of variations in those regimes, are the driving force behind patterns of oyster survival, abundance, and health in the SLE (Parker and Radigan 2020). The CERP RECOVER salinity performance measure defines the optimal salinity envelope for oysters (*C. virginica* specifically) as 10 to 25 (**Table 8C-6**; RECOVER 2020). Salinities outside of this range are considered stressful (5 to 9; > 25) or damaging (< 5) as prolonged periods with salinities in these ranges can have increasingly detrimental effects on the oysters.

Salinity at the US1 Bridge station, located near the SLE oyster monitoring sites (**Figure 8C-23**), was measured every 15 minutes at the surface and bottom. Salinity measures were averaged to obtain daily water column means as well as annual means for the most recent five water years and the POR (WY2001–WY2023). To relate salinity conditions to oyster population responses in the SLE, the RECOVER salinity performance measure was applied by calculating 14-day moving average water column salinities and determining the percentage of time when salinities were within and outside the optimal salinity envelope (**Table 8C-6**).

Table 8C-6. Salinity envelopes for eastern oysters (*Crassostrea virginica*) in the SLE based on the CERP RECOVER salinity performance measure (RECOVER 2020).

	Salinity Envelopes ^a		
	Optimum	Stress	Damaging
<i>Crassostrea virginica</i>	10 to 25	5 to 9; > 25	< 5
Description of Envelope	Yielding highest response variables (e.g., growth, density, recruitment, and photosynthesis).	Decline in some response variables (e.g., growth) but tolerable. Survivability and persistence possible or likely for a time.	Significant declines in all response variables. Survivability and persistence low and loss over the long term likely.

a. Salinity is reported as a dimensionless value (Fofonoff and Millard 1983).

The 14-day moving average water column salinity at the US1 Bridge station ranged from 6 to 26 in WY2023 (**Figure 8C-24**). Salinity in WY2023 was in the optimal range for oysters most of the year (87%) but increased to the upper stressed range (> 25) for 5% of days, which were all in the late dry season, and decreased into the lower stressed range (5 to 9) for 8%, or 30 days, following Hurricane Ian in September 2022 (**Table 8C-7**). Lower percentages of days in the optimal range occurred in WY2019 (41%) and WY2021 (55%) when freshwater inflows to the estuary were higher. As in WY2023, salinities in WY2020 and WY2022 were in the optimal range for oysters much longer, ranging from 79 to 87% of the year. The increased percentages of estuarine salinities occurring within the optimal envelope for oysters were due to the lack of, or substantially lower, freshwater inflows from Lake Okeechobee to the estuary during those three water years (**Figure 8C-6**). For the POR (WY2001–WY2023), salinities were in the optimal range 60% of days (**Table 8C-7**).

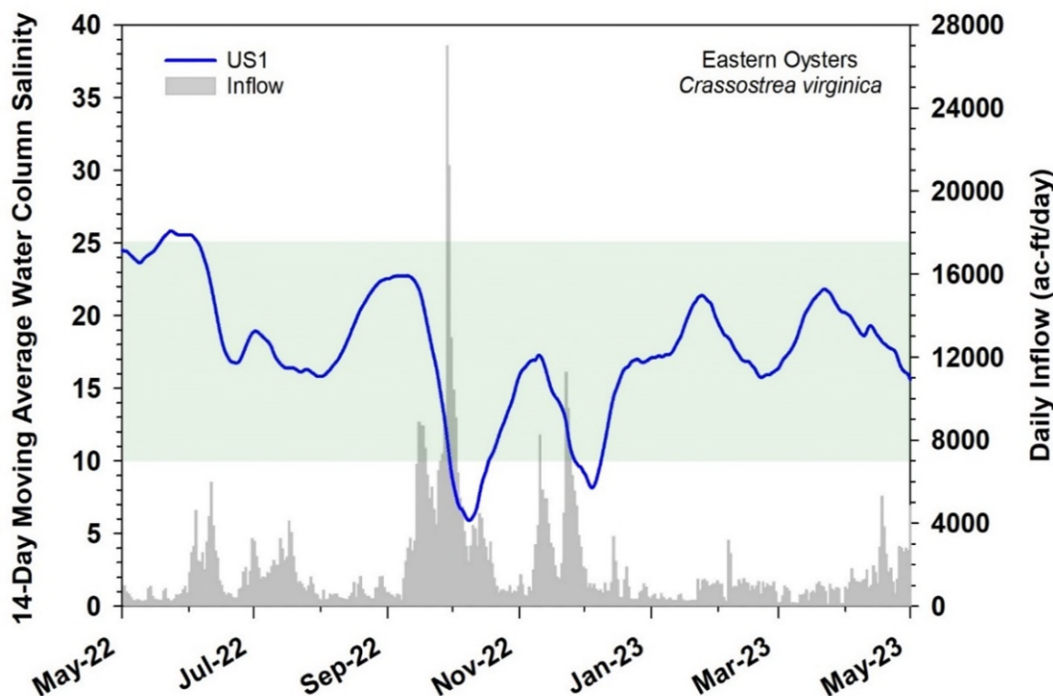


Figure 8C-24. Time series of the 14-day moving average water column salinity at the US1 monitoring station and daily total freshwater inflow (gray) for WY2023. Green shading indicates the optimum salinity envelope (10 to 25) for oysters (*C. virginica*).

Table 8C-7. Percent of days for the most recent 5-year period and the POR (WY2001–WY2023) when the 14-day moving average salinity in the water column was in each salinity envelope for oysters (*C. virginica*) at the US1 salinity monitoring station.

C. virginica 14-Day Moving Average Water Column Salinity				
Period	Days with Damaging Salinity < 5 (%)	Days with Stressed Salinity 5 to 9 (%)	Days with Optimum Salinity 10 to 25 (%)	Days with Stressed Salinity > 25 (%)
WY2001–WY2023	14	15	60	11
WY2019	25	15	41	20
WY2020	0	8	87	5
WY2021	19	25	55	0
WY2022	0	16	79	6
WY2023	0	8	87	5

Live Oyster Density

Live oyster densities were measured biannually (fall and spring) using methods adapted from Lenihan and Peterson (1998) and Grizzle et al. (2005) at three sites in the middle estuary (Figure 8C-25). At each site, 15 replicate 0.25-square meter (m²) quadrats were haphazardly deployed, and all live oysters were collected and counted. During the five-year period from WY2019 through WY2023, the highest mean density counts (786 live oysters/m²) occurred in the WY2020 wet season when salinities fell within optimum range for 90% of the days between the previous March 2019 survey and the September 2020 survey (Figure 8C-24). The lowest mean counts of 145 oyster/m² live occurred in the WY2021 dry season (March 2021) when oysters were stressed and exposed to salinities < 10 for 54% of the year prior to the March 2021 survey. After the decrease in densities in WY2021, mean density counts increased and

remained relatively stable, ranging from 268 to 315 live oysters/m² in WY2022 and WY2023 when salinities were within the optimal range for 79% or more of each water year. During this time, there were only 13 days with mean salinities of < 5 and 40 days with salinities > 25 and durations were short enough to avoid detrimental impacts to oysters.

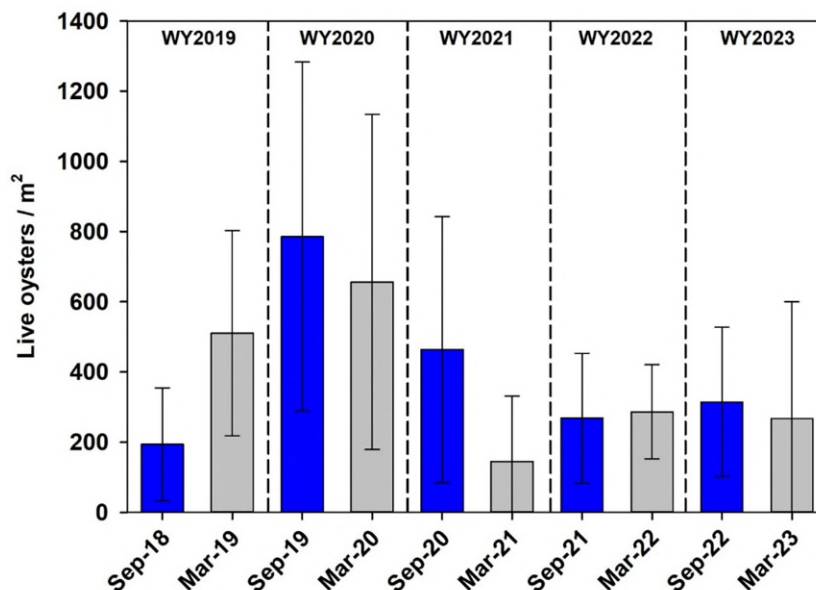


Figure 8C-25. Mean live oyster density (\pm SD) at the SLE middle estuary site for WY2019–WY2023. Blue bars represent wet season and gray bars represent dry season sampling events.

Recruitment

Juvenile recruitment, or settlement of oyster larvae to the substrate, was measured by counting settled oyster spat (permanently attached juvenile oysters) from the underside of shells strung on three replicate arrays deployed at each site in the middle estuary. Recruitment rates were determined by dividing the number of spat per shell by the number of days the shell was deployed and then standardizing to a 28-day month. Spawning and larval settlement typically occurred during the wet season months. In the SLE, the first spring recruits were most often detected in April with recruitment continuing through the summer months before peaking in late fall (Parker and Radigan 2020). Recruitment occurred consistently from May to October during each of the last 5 water years (WY2019–WY2023). Mean monthly recruitment rates ranged from 0 to 21.0 spat/shell during the last five water years, with the highest rate occurring in June 2022 (**Figure 8C-26**). Salinities were in the stressed or damaging range (< 10; see **Table 8C-6** in the previous *Salinity* subsection) for a prolonged period during peak oyster spawning season from the middle of May through October in WY2019. Another prolonged decline in salinity caused recruitment rates to drop to near zero in late fall 2020 when no juvenile recruits were detected from November to March. Oysters exhibited the most consistent recruitment rates during the spawning seasons of WY2022 and WY2023 which can be attributed to the high percentage of days (79 and 87%, respectively) when salinities were in the optimal range (see **Table 8C-7** in the previous *Salinity* subsection). Recruitment rates in late WY2022 and early WY2023 were overall the highest of the last five water years with mean values of 18.5 spat/shell in April 2022 and 21.0 spat/shell in June 2022.

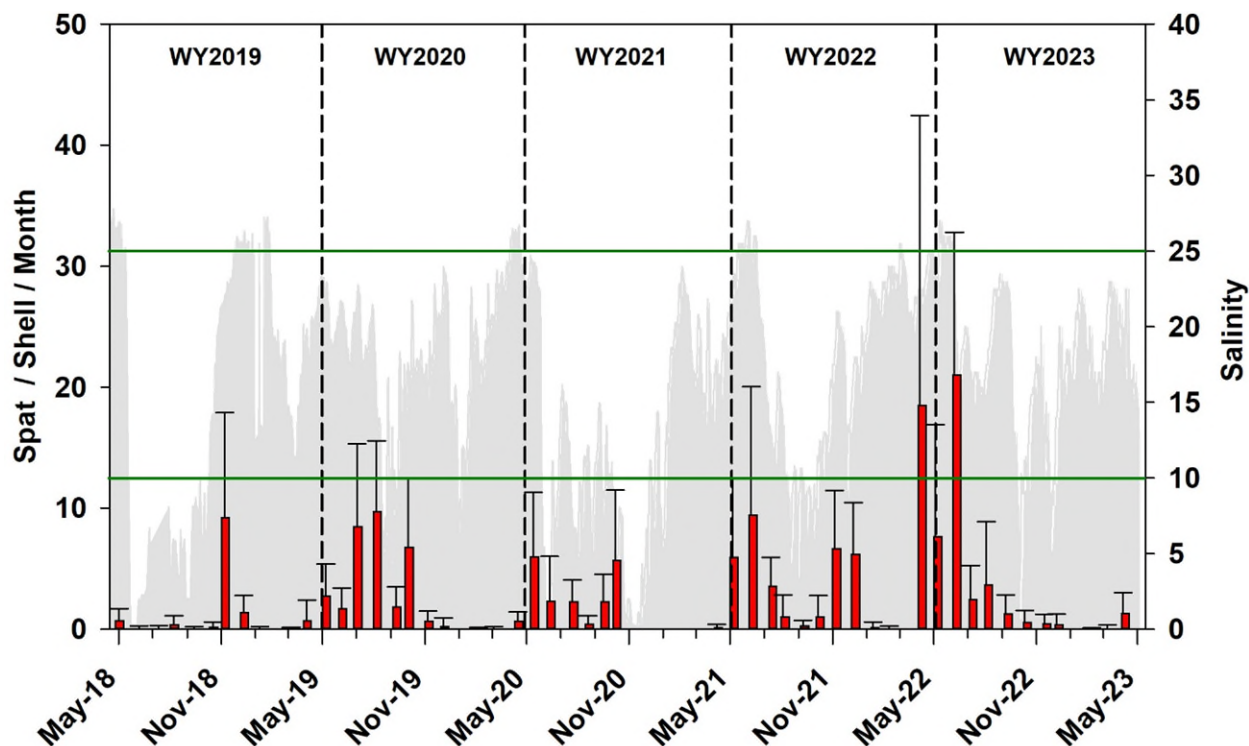


Figure 8C-26. Mean monthly juvenile recruitment (\pm SD; red bars) in the SLE middle estuary for WY2019–WY2023 and mean daily salinity (gray) at the US1 Bridge. The optimum salinity envelope (10 to 25) is indicated by the green lines.

Dermo Infection Prevalence and Intensity

Dermo (*Perkinsus marinus*) is a marine protozoan parasite that infects oysters. The dermo parasite favors high salinity and high temperature environments, so infections often decline when estuarine salinities fall below the optimum range for oysters. Dermo infection prevalence (% infected) and intensity (severity of infection) were assessed by examining mantle and gill tissues from 15 individual oysters collected monthly from the middle estuary site. Mean monthly dermo prevalence ranged from 0 to 80% from WY2019 through WY2023. Mean wet season prevalence ranged from 9 to 50% and mean dry season values ranged from 5 to 72% (**Table 8C-8**). Over the last five water years, dermo infection rates were highest during WY2023 for both the wet and dry seasons (**Table 8C-8**).

Dermo infection intensity was scored according to the Mackin scale of 1 to 5 (Mackin 1962) with mean monthly values ranging from 0 (no infection) to 0.85 (very light infection) for WY2019 through WY2023. Mean wet season infection intensities ranged from 0.02 to 0.36 and mean dry season infection intensities ranged from 0.02 to 0.63 during this 5-year period (**Table 8C-8**). The high prevalence and infection rates during WY2023 are most likely due to high salinities during the warmer summer months. In WY2023, salinity was frequently near the upper boundary of the optimal salinity range (20 to 25) and exceeded the optimal range (> 25) 47% of the year providing the ideal environmental conditions for dermo to proliferate.

Table 8C-8. Mean prevalence (% infected) and intensity (0 to 5 based on the Mackin scale with 0 = no infection and 5 = heavy infection; Mackin 1962) of dermo (*Perkinsus marinus*) infections in oysters from the SLE middle estuary site from WY2019–WY2023.

Water Year	Season	Dermo Prevalence (%)	Dermo Intensity (0 to 5)
WY2019	Wet	9.1 ^{a,b}	0.02 ^{a,b}
	Dry	13.3	0.04
WY2020	Wet	12.2	0.04
	Dry	5.3 ^c	0.02 ^c
WY2021	Wet	8.9 ^c	0.02 ^c
	Dry	8.0	0.07
WY2022	Wet	13.3	0.10
	Dry	20.0	0.16
WY2023	Wet	50.0	0.36
	Dry	72.2	0.63

a. No live *C. virginica* were available for collection in May 2018 due to mortalities associated with low estuarine salinities following Hurricane Irma.

b. No live *C. virginica* were available for collection in July 2018.

c. *C. virginica* were not sampled in April and May 2020 due to COVID-19 restrictions.

Submerged Aquatic Vegetation

Seagrasses, a type of submerged aquatic vegetation (SAV), are marine flowering plants (angiosperms) capable of forming dense beds that offer structural habitat and food for a variety of fish, invertebrates, manatees, and sea turtles (Williams and Heck 2001, Unsworth et al. 2019). Beyond interactions with aquatic organisms, seagrasses provide a multitude of other ecosystem services that include assimilating nutrients from the water column and sediments, sequestering carbon (McLeod et al. 2011, Fourqurean et al. 2012) and stabilizing local sediments (Bos et al. 2007, Furman et al. 2019). Through their ecosystem services, seagrasses are not only considered foundation species, but also indicator species (Morris et al. 2022) signaling when environmental conditions are suboptimal. Stressed or damaged seagrass will not grow and may lose biomass and diversity, therefore reducing their overall ecological function (Morris et al. 2022). Monitoring the abundance and health of seagrass habitats provides insight into the health of an estuary.

The distribution, diversity, and abundance of seagrasses were assessed within the SLE to detect changes in seagrass habitat across multiple spatial and temporal scales. Large-scale monitoring involved estimating percent cover during the wet and dry season for each seagrass species at spatially random sites in the middle and lower estuary to determine changes in seagrass distribution and diversity. Small-scale monitoring was conducted nine times per year at two fixed transect sites to evaluate seagrass percent cover and diversity (**Figure 8C-27**). This multiscale approach enables the detection of long-term trends and subtle changes within the seagrass communities.



Figure 8C-27. SLE SAV monitoring site locations, SAV cover in 2021, and salinity recording stations (US1 and A1A). SAV cover data are based on aerial imagery collected in 2021 from the southern IRL and lower SLE.

Salinity

Seagrass health and distribution are driven by water quality conditions within the estuary. Salinity, water temperature and light availability are the three most important environmental factors affecting seagrass populations in South Florida (Morris et al. 2021). Salinity and light availability dictate the distribution, depth, and diversity of seagrass beds, while water temperature influences growth (biomass and expansion) (Morris et al. 2021, 2022). Each seagrass species has a unique range of tolerance for environmental factors such as salinity (**Table 8C-9**) and thrive when those conditions fall within their optimal range. One goal of CERP for the SLE is to maintain ecologically optimal conditions to support seagrass habitats. Through this goal, the CERP RECOVER salinity performance measure defines the optimal salinity envelope for the indicator species, *Halodule wrightii* (shoal grass), as 15 to 45 (**Table 8C-10**; RECOVER 2020). Salinities outside of this range are considered stressful (5 to 14; > 45) or damaging (< 5) and may result in loss of critical seagrass habitat.

Table 8C-9. Salinity ranges for Florida seagrasses within the SLE and southern IRL.

Florida Seagrasses	Optimal Salinity Range
<i>Halodule wrightii</i>	15 to 45 ^{a,b,c}
<i>Halophila johnsonii</i>	19 to 35 ^b
<i>Halophila engelmannii</i>	20 to 35 ^b
<i>Thalassia testudinum</i>	24 to 40 ^{b,c}
<i>Halophila decipiens</i>	26 to 35 ^b
<i>Syringodium filiforme</i>	28 to 40 ^{b,c}

- a. RECOVER 2020
- b. Morris et al. 2021
- c. Koch et al. 2007

Table 8C-10. Salinity envelopes for shoal grass (*Halodule wrightii*) in the SLE based on the CERP RECOVER salinity performance measure (RECOVER 2020).

	Salinity Envelopes ^a		
	Optimum	Stress	Damaging
Halodule wrightii	15 to 45	5 to 14; > 45	< 5
Description of Envelope	Yielding highest response variables (e.g., growth, density, recruitment, and photosynthesis).	Decline in some response variables (e.g., growth) but tolerable. Survivability and persistence possible or likely for a time.	Significant declines in all response variables. Survivability and persistence low and loss over the long term likely.

a. Salinity is reported as a dimensionless value (Fofonoff and Millard 1983).

Continuous salinity data were recorded at the A1A Bridge station located upstream of the two fixed transect seagrass monitoring sites in the SLE (**Figure 8C-27**). Salinity was measured every 15 minutes near the surface and at the bottom of the water column. Salinity measures were averaged to obtain daily water column means as well as annual means for the most recent five water years and the POR (WY2001–WY2023). To relate salinity conditions to *H. wrightii* in the SLE, the RECOVER salinity performance measure was applied by calculating 14-day moving average water column salinities and determining the percentage of time when those salinities were within and outside the optimal salinity envelope (**Table 8C-9**).

The 14-day moving average water column salinity at the A1A Bridge station ranged from 15 to 32 in WY2023 (**Figure 8C-28**), which was within the optimum range (15 to 45) for *H. wrightii*. Salinity conditions at this station were ideal for seagrass the entire water year and were greatly improved from previous years when salinities frequently dropped below optimal into the stressed range (5 to 15) (**Table 8C-11**).

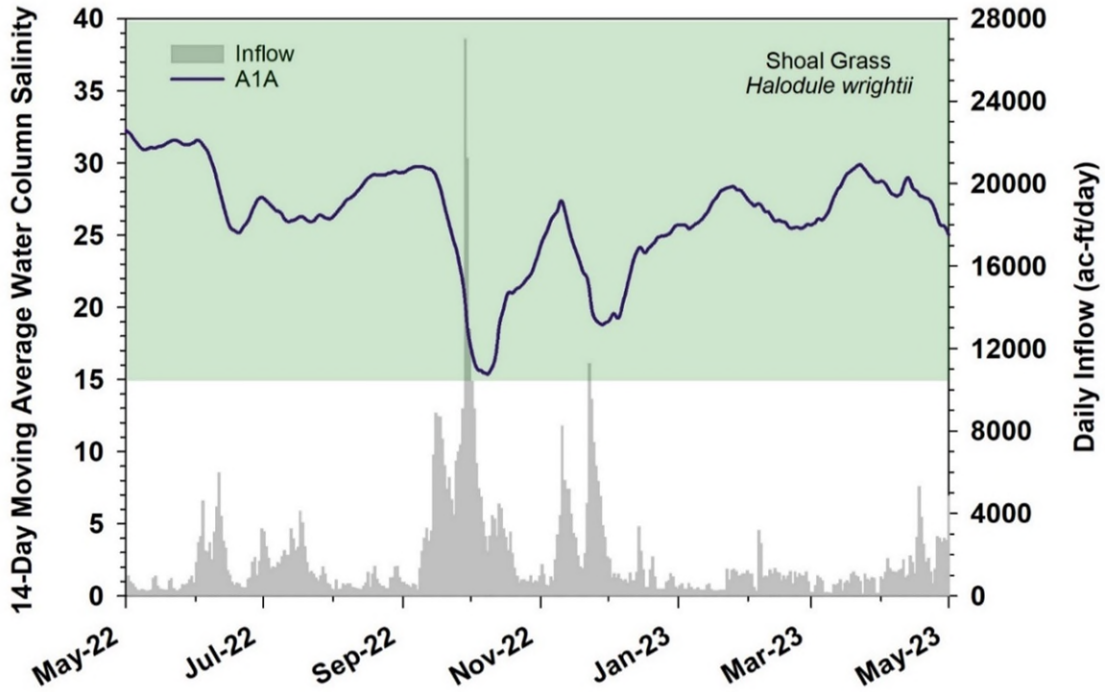


Figure 8C-28. Time series of the 14-day moving average water column salinity at the A1A salinity monitoring station and daily total freshwater inflow (gray) for WY2023. Green shading indicates the optimum salinity envelope (15 to 45) for *H. wrightii*.

Table 8C-11. Percent of days for the most recent 5-year period and the POR (WY2001–WY2023) when the 14-day moving average water column salinity was in each salinity envelope for shoal grass (*H. wrightii*) at the A1A Bridge station.

<i>Halodule wrightii</i> : 14-Day Moving Average Water Column Salinity				
Period	Days with Damaging Salinity < 5 (%)	Days with Stressed Salinity 5 to 15 (%)	Days with Optimum Salinity 15 to 45 (%)	Days with Stressed Salinity > 45 (%)
WY2001–WY2023	1	11	88	0
WY2019	1	13	85	0
WY2020	0	0	100	0
WY2021	0	18	82	0
WY2022	0	0	100	0
WY2023	0	0	100	0

Large-Scale Monitoring

Large-scale monitoring was conducted in the wet (May) and dry (November) seasons of WY2023 to determine the variation in the distribution, diversity, and abundance of seagrass within the SLE. Seagrass percent cover was assessed at 30 randomly selected sites using eight haphazardly placed 0.25-m² (50 cm x 50 cm) quadrats in the middle and lower SLE (**Figure 8C-29**). Results were then used to compare the mean percent cover of seagrass present and the relative seagrass species composition within the SLE between the WY2023 wet and dry seasons. Relative species composition is the proportion each seagrass species contributes to the total seagrass abundance within the study area and provides an estimate of the species diversity. Sites without seagrass were not included in the relative species composition estimates. Seagrass percent cover and diversity directly relate to the functionality of seagrass habitats as well as their resiliency to and recovery from disturbances (Irlandi 1994, McCloskey and Unsworth 2015, Nowicki et al. 2017, Furman et al. 2019).

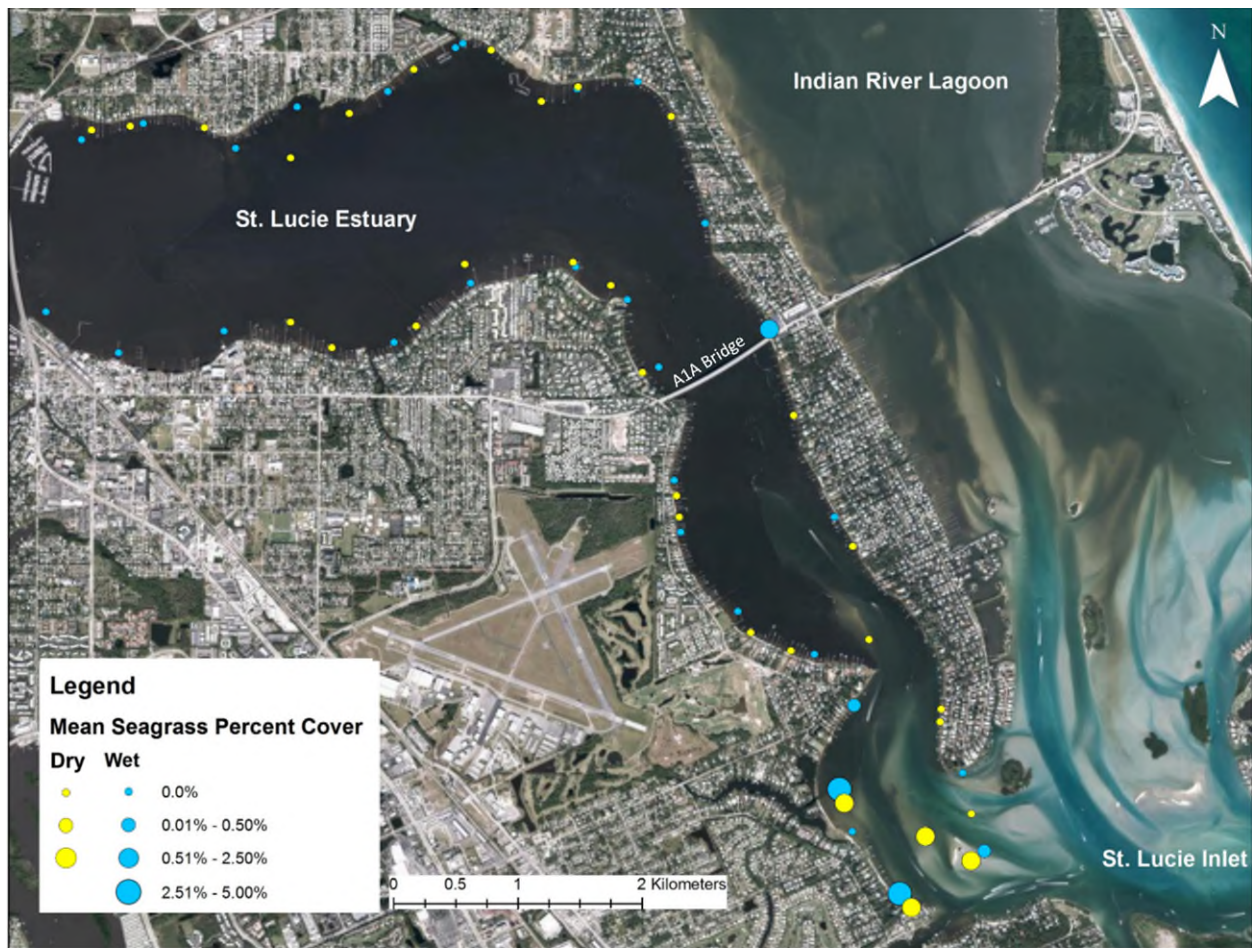


Figure 8C-29. Percent cover of seagrasses within the large-scale sampling area of the SLE during WY2023. Each point represents the randomly sampled sites in the SLE during the wet (blue circles) and dry (yellow circles) seasons. The size of each circle corresponds to the seagrass mean percent cover (0 to 5%).

Total seagrass (all species present) cover was extremely low, and distribution and diversity were limited within the SLE. Mean percent cover of all seagrasses was $0.29 \pm 1.69\%$ during the wet season, which declined by 51% to $0.14 \pm 0.58\%$ in the dry season (**Figure 8C-29**). The spatial extent of seagrass was confined to the downstream portion south of the A1A Bridge near the St. Lucie Inlet where few, isolated patches occurred (**Figure 8C-29**). Within these seagrass patches, only three species were observed in WY2023: *H. wrightii*, *Halophila johnsonii* (Johnson’s seagrass), and *Halophila decipiens* (paddle grass) (**Figure 8C-30**). During the wet season, *H. johnsonii* was the most abundant, contributing approximately 81% to the total seagrass cover (**Figure 8C-30**). However, *H. wrightii* displaced both *Halophila* species in the dry season, accounting for approximately 99.7% of the total seagrass cover (**Figure 8C-30**). Though salinity was within (*H. wrightii*) or near (*Halophila* spp.) optimal ranges during WY2023, shifts in species composition as well as the low total seagrass coverage may be caused by other factors such as season, light availability, and wave action. Season can affect the species composition observed during surveys. For example, *H. johnsonii* and *H. decipiens* are ephemeral species and aboveground biomass is visible only during the wet (growing) season. Though the belowground rhizomes of *Halophila* spp. may be present during the dry season, the rhizomes would not be visible from the surface and would not be observed during the surveys. Further, *H. wrightii* is considered a pioneering species and will colonize bare, stable sediments under preferred environmental conditions. If light availability is reduced in the SLE due to increased tannins from groundwater or watershed run-off and from the resuspension of muck, seagrasses may not establish and grow despite optimal salinity conditions. Wave energy can also limit successful seagrass colonization. Areas throughout the SLE are lined with concrete seawalls which reflect wave energy and can limit successful recruitment and establishment of seagrass beds.

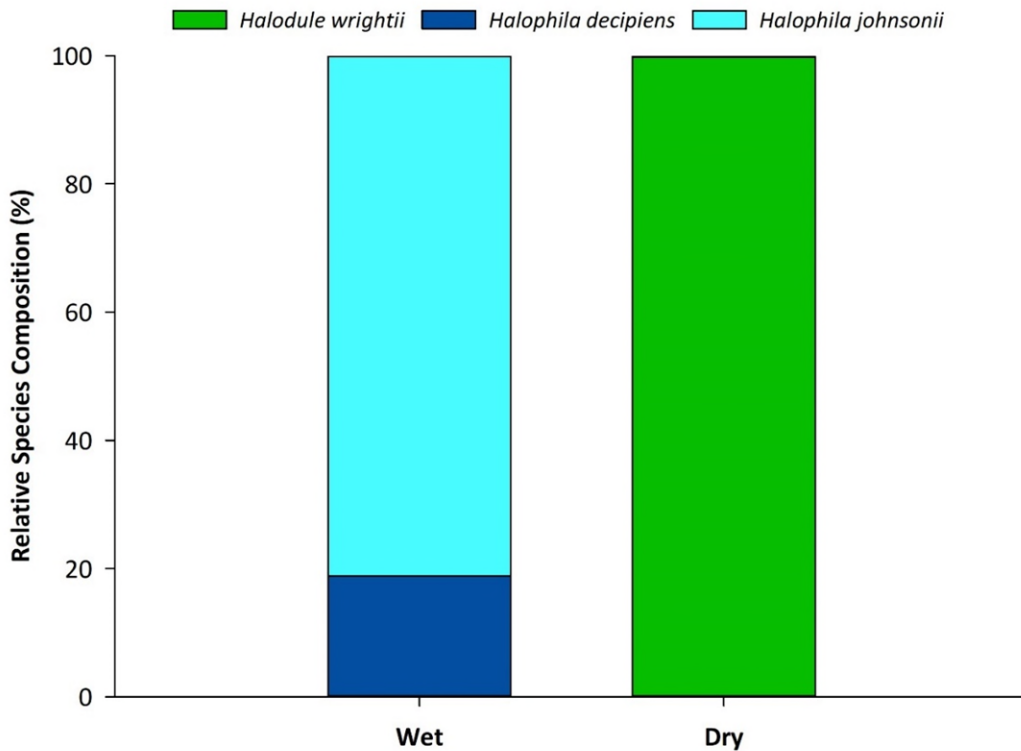


Figure 8C-30. Relative species composition during the wet and dry seasons of WY2023.

Small-Scale Monitoring

Small-scale monitoring using fixed transects was initiated in the WY2019 wet season to allow for repeatable surveys at the same location at fixed spatial and frequent temporal intervals. Transect sites were established within the lower portion of the SLE near Willoughby Creek (WC) and the St. Lucie Inlet (SLI) to evaluate changes in seagrass percent cover and species diversity (**Figure 8C-27**). The Willoughby Creek site is a shallow, nearshore sandy habitat with variable salinity that is located 4 kilometers (km) upstream of the St. Lucie Inlet at the downstream reach of the SLE (**Figure 8C-26**) adjacent to a navigational channel. The SLI site is a sandy habitat located north of the St. Lucie Inlet at the downstream reach of the SLE (**Figure 8C-27**) between two navigational channels. Seagrass cover was estimated using a 0.25-m² quadrat at 10-m increments along three fixed, parallel 100-m transects monthly from March through November at both sites. December through February is the dormant, or non-growing, season for seagrass so monthly monitoring was not conducted. However, seagrass was monitored in November to capture the end of the growing season and again in March and April to ensure the beginning of the new growing season was captured. Mean total seagrass percent cover (all species present) and percent cover for each individual species was compared between seasons and water years. Changes in species diversity and dominance were evaluated between seasons and water years using relative species composition.

Mean total seagrass percent cover remained under 30% at both the SLI and WC sites from WY2019 to WY2023 (**Figure 8C-31**). At SLI, mean total seagrass percent cover fluctuated between 13 ± 10 to $24 \pm 18\%$ over the POR (**Figure 8C-31**). At WC, mean total seagrass percent cover ranged from 0.5 ± 1.4 to $2.5 \pm 4.7\%$ from WY2019 to WY2023. Overall, mean percent cover at both sites was higher during the wet (growing) season than the dry (dormant) season of each water year. However, both sites experienced a loss of approximately 20% cover from wet to dry season during WY2020, despite salinity being within the optimal range for *H. wrightii*. The decline in cover may be the result of decreased light availability due to turbidity or the presence of drift algae. As the SLI site continued to experience a decline in seagrass cover through WY2023, mean percent cover increased fivefold at WC between WY2021 ($0.4 \pm 2\%$) and WY2023 ($2.5 \pm 4.7\%$) (**Figure 8C-31**). The differences in total seagrass cover between the sites reflect the variability of site-specific characteristics (e.g., salinity, wave energy) and species composition within each site.

Four seagrass species were observed at SLI (**Figure 8C-32**): *H. johnsonii*, *H. wrightii*, *Syringodium filiforme* (manatee grass), and *Thalassia testudinum* (turtle grass). Only two of those species, *H. wrightii* and *H. johnsonii*, were observed at WC (**Figure 8C-33**). The two most abundant species were *H. wrightii* and *H. johnsonii* at both sites (**Figures 8C-32 to 8C-35**). Mean seagrass percent cover remained below 20% at SLI and below 2% at WC for each species for all seasons and water years, except in the wet season of WY2020 when *H. wrightii* reached approximately $26 \pm 18\%$ at SLI (**Figure 8C-32**). At SLI, percent cover of all seagrass species declined (*H. wrightii* -16%, *H. johnsonii* -70%, and *T. testudinum* -87%) from WY2019 to WY2023, except for *S. filiforme*, which increased by 140% (**Figure 8C-32**). Both *S. filiforme* and *T. testudinum* were present but extremely sparse at SLI in all monitoring events, with mean percent cover values of < 1%, which provides very little habitat or other ecosystem services (**Figures 8C-32 and 8C-34**). At WC, *H. wrightii* persisted throughout the POR and was the most abundant species until the WY2021 wet season when *H. johnsonii* became the most abundant species (**Figures 8C-33 and 8C-35**). The increased cover of *H. johnsonii* observed at WC may help stabilize the sediment, thus enhancing *H. wrightii* colonization and cover, but the mean coverage remains below 5% for both species at this site. *S. filiforme* and *T. testudinum*, though low (< 1%), were only observed at SLI and may be the result of the difference in environmental conditions (i.e., salinity) at both sites. Salinity ranged from 31 to 37 at SLI and 21 to 35 at WC during the POR. Stenohaline seagrasses, *S. filiforme* and *T. testudinum*, prefer higher salinity ranges (24 to 40) and may favor the more stable salinity regime at SLI. Euryhaline seagrasses, *H. johnsonii* and *H. wrightii*, tolerate a broader salinity range and are prevalent at both SLI and WC (Dawes et al. 1989, Doering and Chamberlain 2000, Lirman and Cropper 2003, Kahn et al. 2013).

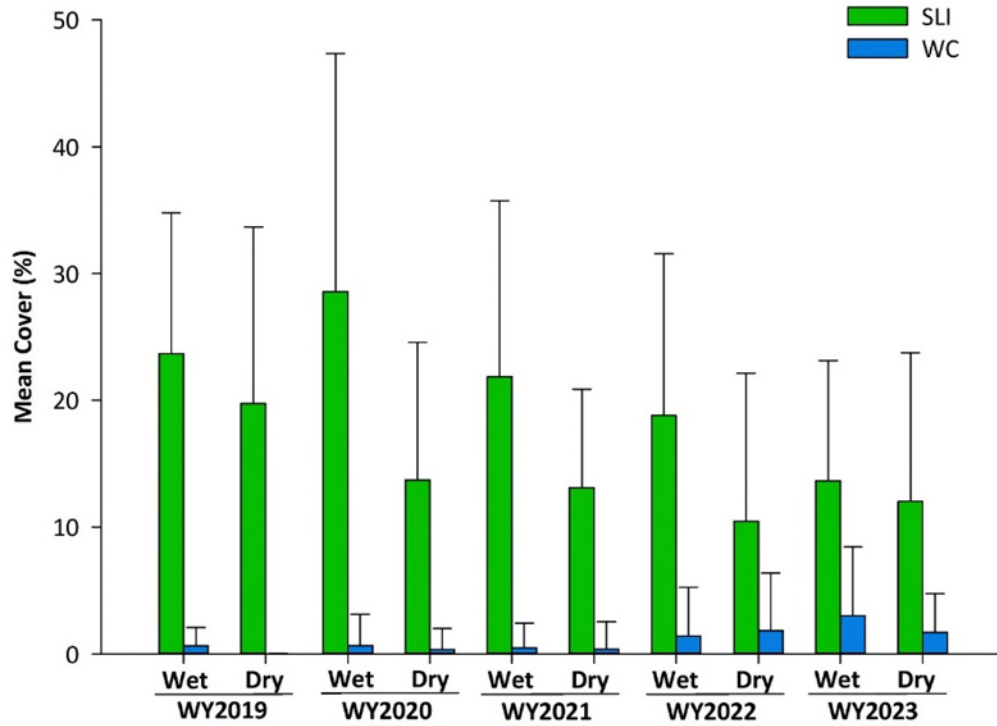


Figure 8C-31. Mean total seagrass percent cover (\pm SD) at the St. Lucie Inlet (SLI) and Willoughby Creek (WC) fixed transect sites for the WY2019–WY2023 period.

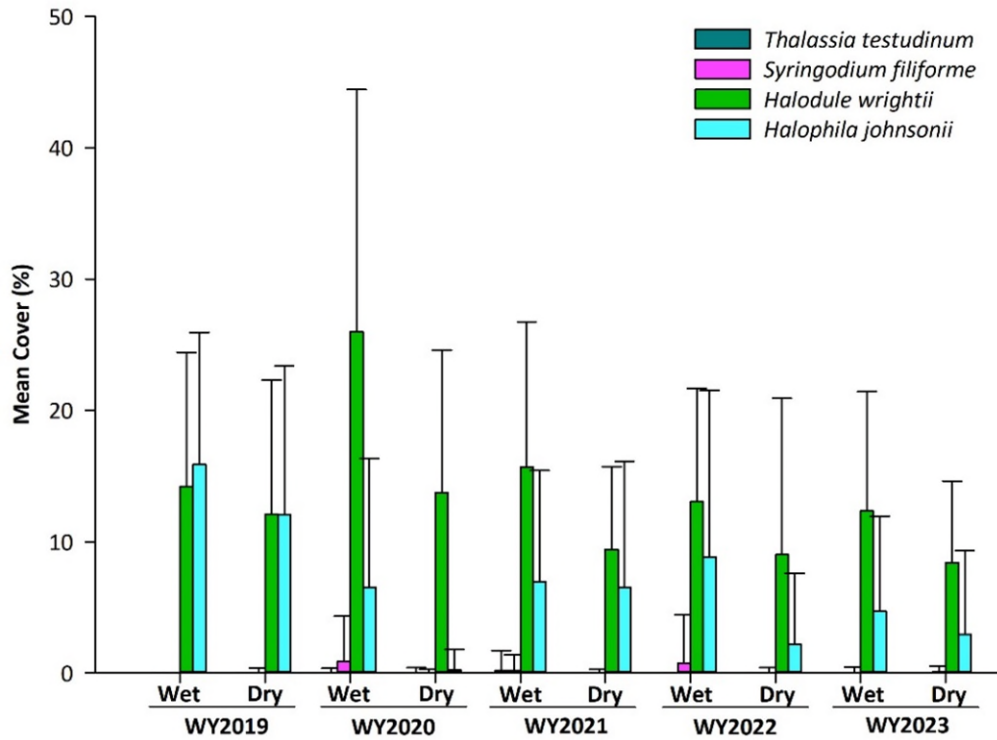


Figure 8C-32. Mean seagrass percent cover (\pm SD) for each species observed at the St. Lucie Inlet (SLI) site for the WY2019–WY2023 period.

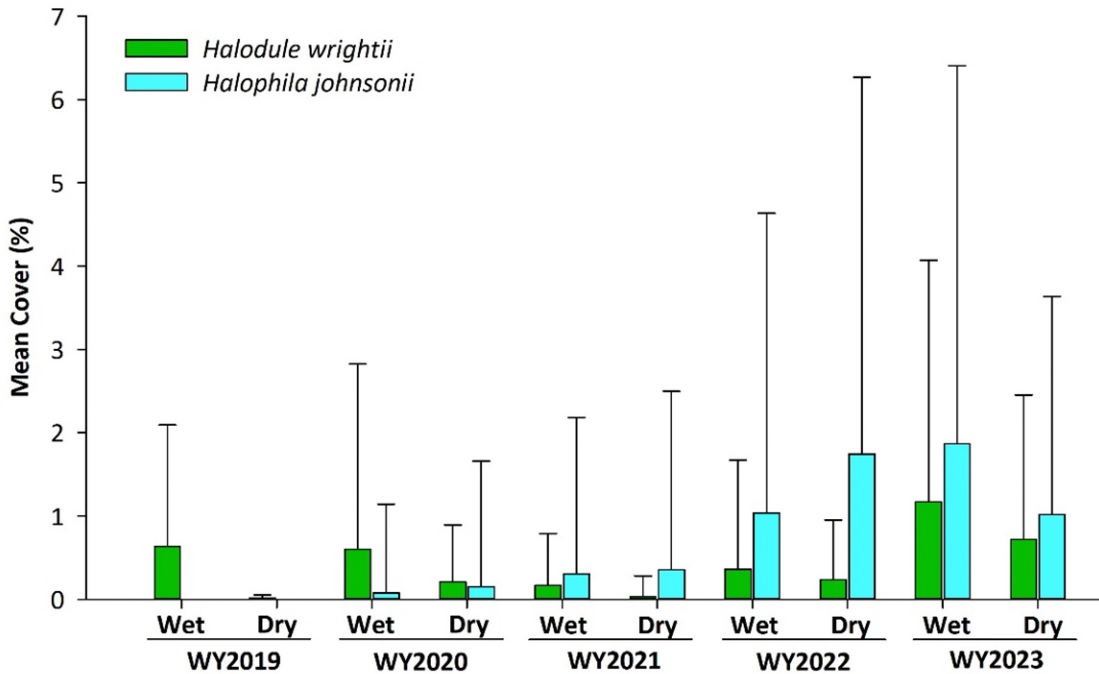


Figure 8C-33. Mean seagrass percent cover (\pm SD) for each species observed at the Willoughby Creek (WC) site for the WY2019–WY2023 period.

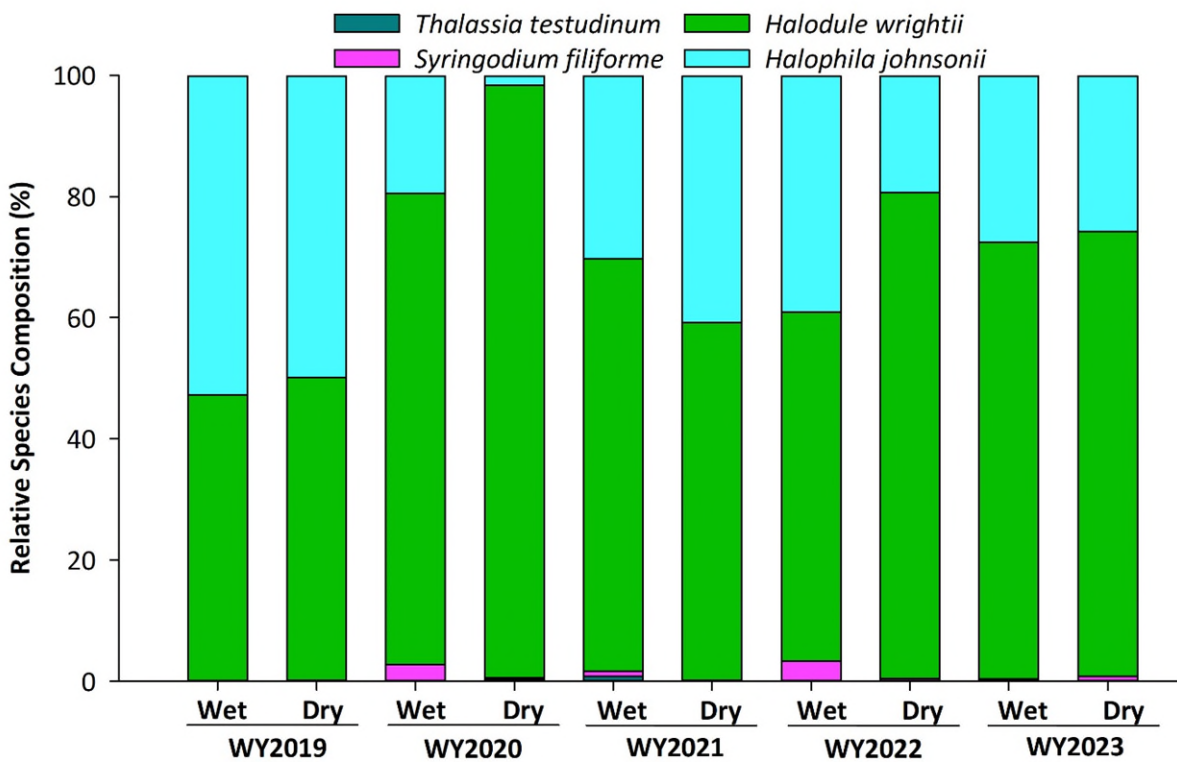


Figure 8C-34. Relative species composition at the St. Lucie Inlet (SLI) site for the WY2019–WY2023 period.

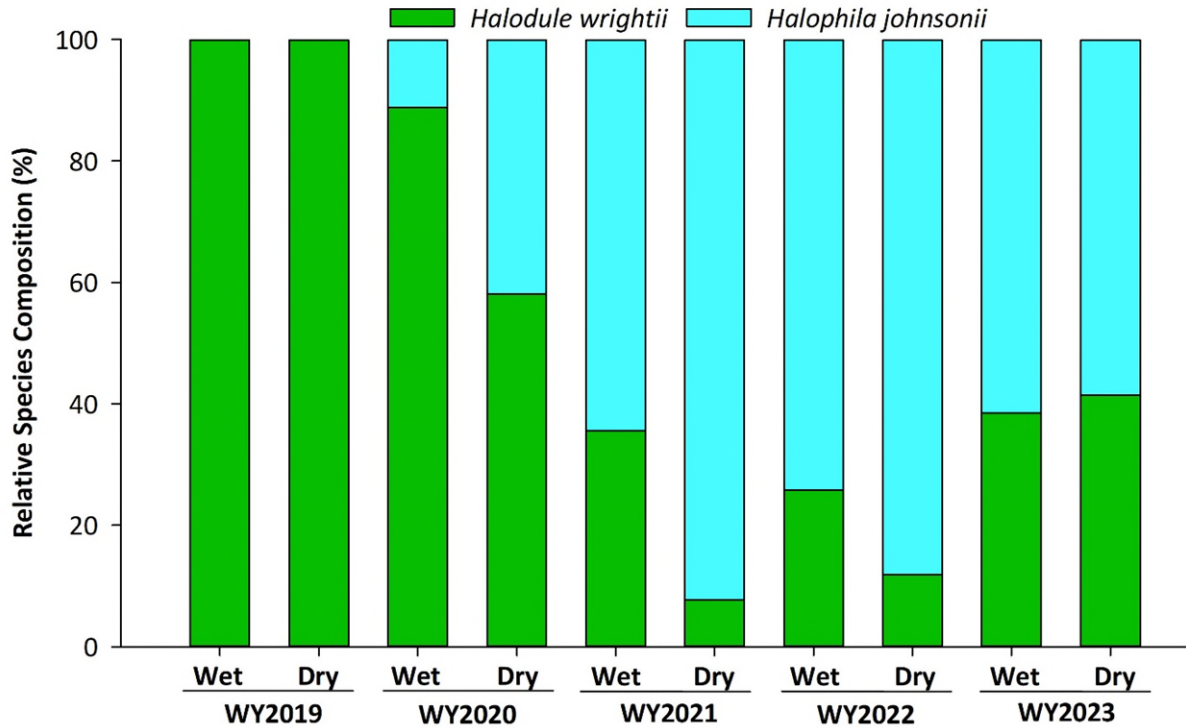


Figure 8C-35. Relative species composition at the Willoughby Creek (WC) site for the WY2019–WY 2023 period.

Summary

Seagrass cover was extremely low within the SLE, and distribution and diversity were confined to the downstream portion of the estuary near the St. Lucie Inlet where few, isolated patches occurred. While salinity is important for seagrass survival, other environmental parameters or physical disturbances can affect seagrass distribution and density. Light availability is essential for seagrass health and can be reduced in highly tannic or turbid waters. The WC site is adjacent to a freshwater source and influenced by rainfall and run-off. Increased rainfall and watershed runoff may result in higher CDOM and sedimentation, therefore reducing light availability in the water column. Physical disturbances from excessive waves and currents can also affect seagrass distribution and density, especially in high energy environments (Stevens and Lacey 2012). Both SLI and WC sites are tidally influenced, sandy habitats located adjacent to a dredged navigational channel. Wave energy from wind, tides, or boat traffic directly impacts these sites. Excessive exposure to such physical disturbances contributes to particle resuspension (reduced light), sediment erosion, and leads to burial of diminutive seagrasses such as *H. johnsonii*, patchy beds, or their absence (Koch et al. 2007). Field observations during these monitoring events included reports of strong currents, partial burial of *H. johnsonii*, and exposed rhizomes of *H. wrightii* at both sites. These factors may contribute to the low seagrass occurrence and coverage at the WC site as seagrass cover remained below 3% from WY2019 through WY2023.

PART III: ST. LUCIE RIVER WATERSHED CONSTRUCTION PROJECT

In WY2020, SFWMD initiated annual St. Lucie River Watershed Construction Project (SLRWCP) reviews as part of the SLRWPP reviews in support of the BMAP process. These annual reviews are critical to maintaining transparency and accountability in the BMAP process and for assisting to progressively move towards the achievement of TMDLs. For the first annual review, public workshops were held to facilitate stakeholder participation in the process to ensure consideration of local expertise and comprehensive problem solving.

This section describes how the collective efforts of the Coordinating Agencies contribute to the SLRWPP and provides updates to the SLRWCP for the reporting period. Information is summarized within the following sections: *Overview of Current Project Benefits*, *Overview of Programs*, and *Basin Updates*.

The Coordinating Agencies—FDEP, FDACS, and SFWMD—partner with local stakeholders to develop and implement projects and programs to improve hydrology, water quality, and aquatic habitat throughout the SLRW. In the BMAP, projects include constructed treatment and storage facilities, regulatory and incentive-based programs, and other nonstructural activities. FDEP models initial estimates of many project and program benefits. Once projects are operational, measured data, where available, may be used to verify or improve these reduction estimates as part of the iterative process of updating the BMAP until the TMDL is achieved. This iterative or adaptive management process is established by the Florida Watershed Restoration Act, Subparagraph 403.067(7)(a)1., F.S. This approach allows for incremental reduction in nutrient loading through the implementation of projects and programs while simultaneously monitoring water quality and researching environmental dynamics (sources and response variables) for improved management.

The SLRWCP is SFWMD’s comprehensive strategy for tracking project and program benefits (e.g., water storage/attenuation and nutrient reductions) and planning new efforts to assist in achieving the SLE TMDL. The strategy utilizes an adaptive management approach consistent with FDEP’s BMAP process. The SLRWCP annual review considers the latest science and data available to verify and update project benefits. When available, measured data will supersede estimated (modeled) data. Therefore, the collective benefits of project and program benefits described in the SLRWCP will be adjusted for accuracy as needed to facilitate an effective method for gauging progress.

A key aspect of the annual SLRWCP review is the basin updates. The objective of the updates is to relate project and program activities within each basin to measured progress in hydrology and water quality, as measured by the SFWMD’s monitoring network, and make recommendations for future restoration activities. The sections below present basin characteristics such as a description of the regional stormwater system, flow patterns, primary structures, and basin-level monitoring locations. Results from SFWMD’s comprehensive upstream monitoring program for the SLRW can be found in Appendix 8C-1 of this volume. The basin updates also present an inventory of current Coordinating Agencies projects and associated attributes including location, status (e.g., planning, design, construction, operation), estimates of project benefits (storage and nutrient reductions), and implementation costs.

The basin updates also lay the foundation for more detailed assessments. These detailed assessments focus resources on high priority areas by gathering information, identifying nutrient sources and water quality problems, evaluating existing and planned projects and programs, and recommending strategic actions where deficits can be identified. Basin-specific detailed assessments within priority basins are underway.

OVERVIEW OF CURRENT PROJECT BENEFITS

As pollutant sources and dominant factors and mechanisms affecting water quality are identified, the information is utilized to inform decisions for selecting new projects and refining existing projects to effectively assist in achieving the SLE TMDL.

The SLRW project storage target is 200,000 ac-ft (SFWMD et al. 2009) and the SLE TMDL target concentrations are 0.081 mg/L of TP and 0.72 mg/L of TN (Parmer et al. 2008). The 2023 5-Year BMAP Review (FDEP 2023a) estimates the TP and TN load reductions needed to achieve these TMDLs are 407,980 pounds per year (lb/yr; 185 metric tons per year [t/yr]) of TP and 1,252,107 lb/yr (568 t/yr) of TN. FDEP’s 2023 review of the BMAP states, “to achieve the TMDL in 15 years, stakeholders must identify and submit additional local projects and the Coordinating Agencies must identify additional regional projects as well as determine sources for the significant funding that will be necessary” (FDEP 2023a). The BMAP notes that enhancements to programs addressing basin-wide sources will also be required.

To track progress toward achieving these targets, a summary of WY2023 project benefits (storage and nutrient removal) are presented relative to the overall SLRW restoration targets in **Table 8C-12**. In WY2023, existing SFWMD and select Coordinating Agencies projects in the SLRW removed 40.5 t of TP and 266.1 t of TN. The [2022 Statewide Annual Report on Total Maximum Daily Loads, Basin Management Action Plans, Minimum Flows or Minimum Water Levels, and Recovery or Prevention Strategies](#) (FDEP 2023b) reports progress made on implementation of NEEPP BMAPs through December 31, 2022. Completed and ongoing projects are estimated to achieve total reductions of 203,836 lb/yr (92 t) of TP and 839,854 lb/yr (381 t) of TN (FDEP 2023b). Remaining reductions can be addressed through projects and programs implemented by the local BMAP stakeholders and the Coordinating Agencies; for further details, see the *St. Lucie River and Estuary Basin* section in Chapter 8A of this volume.

Planned or existing projects in the SLRW include components of CERP and NEEPP, including priority projects accelerated by the Governor’s Executive Order 19-12: Achieving More Now For Florida’s Environment (<https://www.sfwmd.gov/our-work/AchieveMoreNow>) (**Figure 8C-36**). Refer to the *St. Lucie River and Estuary Basin Management Action Plan* for a comprehensive list of other local stakeholder projects (FDEP 2023a). Refer to Chapter 8A of this volume for more information on the NEEPP and priority projects across the Northern Everglades watersheds.

Table 8C-12. Summary of select Coordinating Agencies’ and USACE CERP projects by basin with the estimated and actual storage and nutrient reductions compared to the SLRW storage target and SLE reduction targets. ^a

Basin	Project Storage Estimates (ac-ft/yr)	WY2023 Storage (ac-ft)	Project TP Reduction Estimates (t/yr)	WY2023 TP Reduction (t)	Five Year Average TP Load (t/yr)	Project TN Reduction Estimates (t/yr)	WY2023 TN Reduction (t)	Five Year Average TN Load (t/yr)
C-23	50,765	44,096	12.9	17.3	38.4	58.1	85.1	178.0
C-24	9,402	2,950	1.8	1.6	40.9	7.7	6.0	154.0
C-25	34,544	33,221	12.2	11.6	62.1	49.3	70.0	322.0
C-44	124,597	44,293	28.1	7.6	23.5	111.7	100.2	104.8
Tidal Basins	—	—	3.8	0.7	41.0	20.2	2.1	370.1
Ten Mile Creek	2,302	3,451	22.3	1.7	26.9	44.9	2.7	104.9
Regional Projects	178,242	—	37.4	—	—	291.9	—	—
SLRW Totals ^b	399,852	128,011	118.5	40.5		434.3	266.1	
SLE Targets ^c	200,000		185.0			568.0		

a. ac-ft/yr – acre-feet per year, N/A – not available, and TBD – to be determined.

b. The totals for estimated and actual storage and TP and TN reductions do not include projects where this information is not yet available. These totals also do not include estimates from local entity BMAP projects.

c. The targets for estimated TP and TN reductions are from the 2023 5-Year BMAP Review (FDEP 2023a).

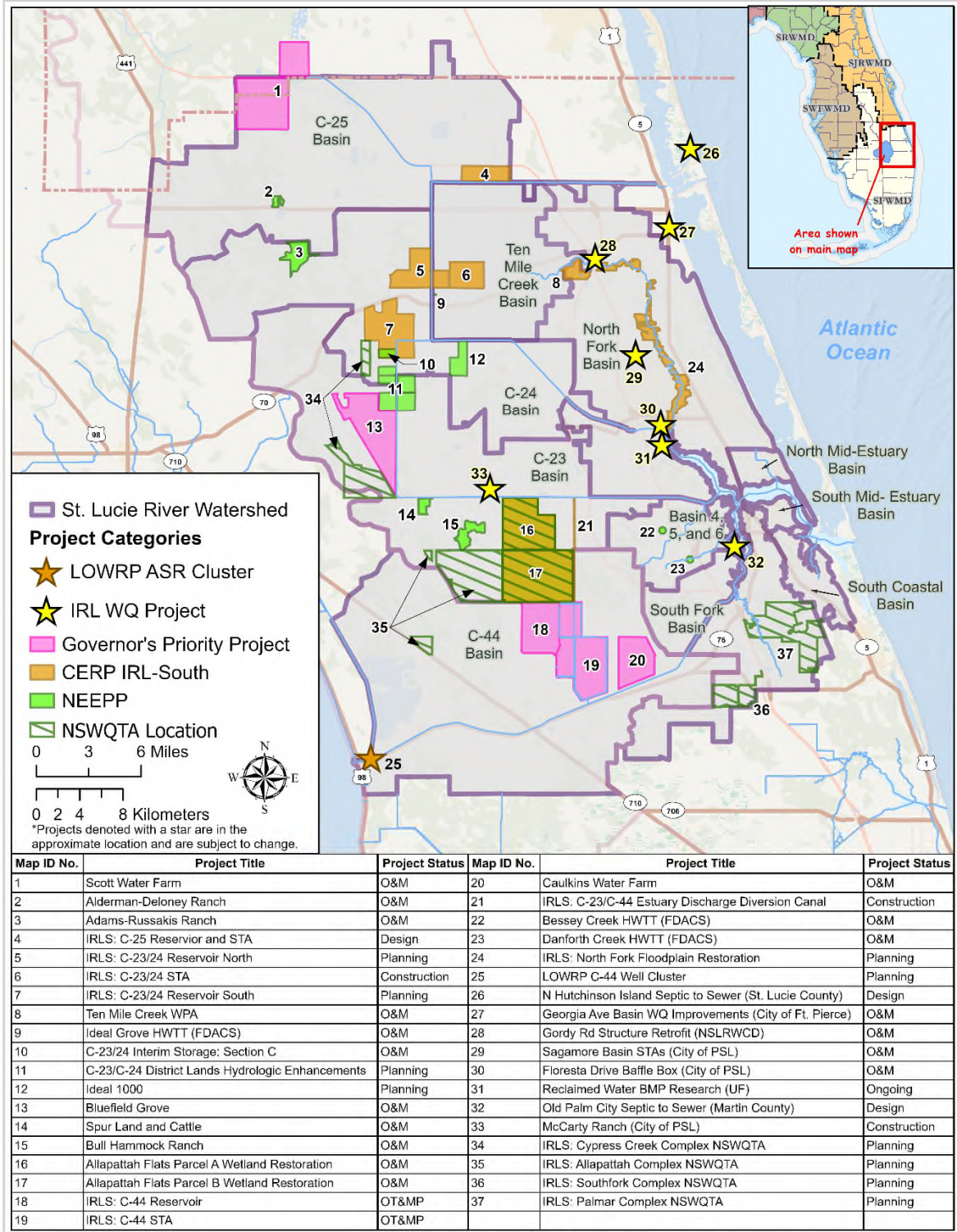


Figure 8C-36. SLRW project location map.

(Notes: Project footprints for the C-23/24 Reservoir and C-25 Reservoir were revised and approved by the United States Army Corps of Engineers in 2020 and 2021, respectively. Key to abbreviations: Ave – Avenue; BMP – Best Management Practice; HWTT – Hybrid Wetland Treatment Technology; IRLS – Indian River Lagoon – South Project; LOWRP – Lake Okeechobee Watershed Restoration Project; N – North; NSLRWCD – North St. Lucie River Water Control District; NSWQTA – Natural Storage and Water Quality Treatment Area; O&M – Operations and Maintenance; OT&MP – Operational Testing and Maintenance Period; PSL – Port St. Lucie; Rd – Road; STA – Stormwater Treatment Area; UF – University of Florida; WPA – Water Preserve Area; and WQ – Water Quality.)

Regional Projects

Large-scale regional efforts in the SLRW include the CERP Indian River Lagoon - South project (IRL-S), the Indian River Lagoon Water Quality Improvement Projects Grant Program (IRL Grants), and the Northern Everglades Watersheds Water Retention and Nutrient Load Reduction Projects Request for Proposals (NEWWRNLRP RFP). Note not all large-scale projects are included in **Table 8C-12**; only those projects that may affect water quality and/or water storage are included.

IRL-S employs a regional approach to restore the SLE and southern portion of the IRL. Based on the project implementation report and environmental impact statement (PIR/EIS) approved by the United States Congress in 2007 (USACE and SFWMD 2004), IRL-S includes reservoirs, STAs, flow diversions, natural areas, and floodplain restoration components. For this annual review, specific project components located within a single basin are described in more detail in the associated *Basin Update* section below. IRL-S components providing direct benefits to multiple basins are described here and in **Table 8C-12** as “Regional Projects”.

- **IRL-S C-23/C-24 North and South Reservoirs and Stormwater Treatment Area (STA).** A 2,438-ac reservoir and a 4,672-ac reservoir in the C-24 Basin, and a 2,568-ac STA estimated to store 95,242 acre-feet per year (ac-ft/yr).
- **IRL-S C-23/C-44 Estuary Discharge Diversion Canal.** This project will result in the interconnect canal directing excess water from the C-23 Canal through the C-44 Reservoir and STA and into the St. Lucie Canal (C-44). From there it could be diverted to Lake Okeechobee anytime the lake is below 14.5 ft National Geodetic Vertical Datum of 1929 (NVGD29), used to meet local irrigation demands, or sent to tide at a point less damaging than the C-23 Canal. The PIR/EIS estimates, in an average year, 31,000 ac-ft could be gravity discharged to Lake Okeechobee via S-308 and 22,000 ac-ft could be sent to tide through the S-80 structure, providing the diversion of approximately 53,000 ac-ft annually.
- **IRL-S Natural Storage and Water Quality Treatment Area (NSWQTA).** This project includes the Cypress Creek Complex (30,328 ac), Palmar Complex (12,000 ac), South Fork Complex (5,300 ac), and Allapattah Complex (42,348 ac) natural water storage and treatment areas. Also, wetland and upland restoration is planned on approximately 90,000 ac.

In addition, Governor Ron DeSantis and the Florida legislature approved \$25 million in funding in 2020 for water quality improvement projects that specifically benefit the IRL. The IRL Grant projects depicted in **Figure 8C-36** in the *C-23 Basin* subsection below and the other *Basin Update* subsections below are the result of this cost-share funding opportunity. Eight water quality improvement construction projects (providing approximately 43 t/yr of TP reductions and 192 t/yr of TN reductions) and one research project were selected within SFWMD’s jurisdiction. Collectively, these projects will total \$8.3 million in grant awarded funds. Locations of these projects are as follows: one in the C-23 Basin, six in the Tidal Basins, and two outside of the SLRW in the southern IRL (**Figure 8C-36**).

Lastly, to identify potential new projects, SFWMD issued the NEWWRNLRP RFP in November 2021. Proposals were reviewed and scored by subject matter experts in the Northern Everglades. In May 2022, the SFWMD Governing Board authorized SFWMD staff to proceed in contract negotiations for up to four projects in the SLRW. Subsequently, 10-year contract extensions have been executed for the Alderman-Deloney Ranch and Spur Land and Cattle Water Farm projects. Additionally, one new project, Ideal 1000, is in the planning phase. More information on these projects can be found in the relevant *Basin Update* subsections below.

OVERVIEW OF PROGRAMS

Table 8B-20 in Chapter 8B of this volume provides an overview of nutrient source control programs and the responsible entities related to the Lake Okeechobee Watershed Construction Project. These incentive-based and regulatory programs of the Coordinating Agencies are essential for controlling nutrients at the source and assisting with to reduce nutrient loading to the Northern Everglades water bodies including the St. Lucie River and Estuary. Both point and nonpoint sources of nutrients in runoff are addressed through these collective programs (SFWMD et al. 2011).

SFWMD is responsible for two source control programs: (1) Environmental Resource Permitting (ERP) and (2) Chapter 40E-61, Florida Administrative Code (F.A.C.). Updates of FDACS and FDEP programs can be found in Chapter 8A of this volume.

SFWMD's ERP program regulates any activity involving the alteration of surface water flows and includes residential and commercial development, roadway construction, and agriculture. An operating agreement specifies the division of responsibilities between FDEP and SFWMD and is used to determine which agency processes the ERP applications. Senate Bill 712 required FDEP and the water management districts to initiate rulemaking to update ERP rules to include best management practices (BMPs) and design criteria to increase the removal of nutrients from stormwater discharges. In response, SFWMD published a Notice of Rule Development regarding Rule 40E-4.091 on December 18, 2020. SFWMD has updated the [*Environmental Resource Permit Applicant's Handbook Volume II for Use Within the Geographic Limits of the South Florida Water Management District*](#) (SFWMD 2016) in conjunction with FDEP's rulemaking effort in accordance with Section 5 of Chapter 2020-150, Laws of Florida, to update the stormwater design and operation regulations adopted under Section 373.4131, F.S., using the most recent scientific information available. FDEP and SFWMD have developed amendments to update the stormwater design and operation regulations and have considered and addressed low-impact design BMPs and design criteria that increase the removal of nutrients from stormwater discharges, and measures for consistent application of the net improvement performance standard to ensure significant reductions of any pollutant loadings to a water body. FDEP's rulemaking includes amendments to Chapter 62-330, F.A.C., and the *Environmental Resource Permit Applicant's Handbook Volume I (General and Environmental)* (FDEP et al. 2018) that applies statewide. SFWMD adopted its rule on April 13, 2023. An effective date has not been established for the SFWMD's rule pending legislative ratification of FDEP's rule adopted on April 28, 2023.

Under the 2016 NEEPP legislation, SFWMD was directed to amend Chapter 40E-61, F.A.C., to provide for a monitoring program for nonpoint source dischargers that are required to monitor water quality under Section 403.067, F.S. In 2020, SFWMD conducted a series of public workshops related to the amendments and amendments to Chapter 40E-61 became effective in April 2021. The rules were expanded to encompass the entirety of the three Northern Everglades watersheds and provide a monitoring program for nonpoint source dischargers not implementing BMPs to submit a SFWMD-approved water quality monitoring plan and regularly report associated monitoring data.

BASIN UPDATES

A basin update is presented for each of the basins within the SLRW: C-23, C-24, C-25, C-44, TMC, and Tidal Basins. General hydrologic characteristics are described and comprehensive updates for SLRWCP projects are provided for each basin.

Each basin section presents information on current projects where SFWMD is the lead agency or provides funding and other select Coordinating Agencies projects. Previously completed SFWMD projects are not included as it is assumed those project benefits are already reflected in the current loading. The first table in each subsection (**Tables 8C-13, 8C-16, 8C-19, 8C-22, 8C-25, and 8C-28**) provides general information about the projects and lists the FY2022 status. The project status is listed as one of five possible phases: Planned – to be implemented in the future or funding not allocated; Design – has received funding or is scheduled for further design; Construction – project is under construction; O&M – project is in Operation and Maintenance, and Extension - project agreement extended for an additional term.

Additionally, projects may be described as passive storage, when the primary objective is to retain direct rainfall and reduce runoff to the regional system, or active storage where project inflow is actively pumped from the regional drainage system into the project for storage. These tables also contain information for storage capacity and nutrient retention associated with each project and summarized for the basin. Note, all basins are also aggregated in **Table 8C-12** above. Project estimates are based on modeling and represent expected long-term annual average performance. Project monitoring is implemented to determine actual project benefits. Note, in addition to the project benefits listed here, projects may provide many peripheral benefits such as wetland hydration, groundwater recharge, and flow attenuation, among others. The second table in each subsection (**Tables 8C-14, 8C-17, 8C-20, 8C-23, 8C-26, and 8C-29**) displays a project timeline including the project phase for each past year and projected phase for the next five fiscal years. The third table (**Tables 8C-15, 8C-18, 8C-21, 8C-24, 8C-27, and 8C-30**) presents cost information available for each project. Costs presented in these tables are actual costs-to-date (i.e., up to FY2023) and projected costs beginning in FY2024. Additional funding information for SFWMD-funded BMAP projects (FY2024–FY2028) is presented in Volume II, Appendix 5A-1 (to be included in the final report only). Lastly, results from the SFWMD’s comprehensive upstream monitoring program within each basin can be found in Appendix 8C-1 of this volume.

C-23 Basin

The C-23 Canal is the main drainage canal in the C-23 Basin. Water flows north to south to the Martin–St. Lucie County line and heads east discharging into the North Fork of the St. Lucie River. The main functions of the canal and control structure include removing excess water from the basin; supplying water to the C-23, C-24, and Basin 4,5,6 basins under low flow conditions; and maintaining a groundwater table elevation west of S-48 (a fixed crest weir located at the outlet of the C-23 Canal to the North Fork) adequate to prevent saltwater intrusion into local groundwater. Discharges from the C-23 Basin are controlled by the S-48 structure. For water supply and flood protection purposes, SFWMD may occasionally divert water in the north-south leg of the C-23 Canal north into the C-24 Basin via control structure G-78 (Cooper and Santee 1988). Flow and water quality data observed at S-48 were used to calculate the annual nutrient loads in runoff from the C-23 Basin.

Projects within the C-23 Basin are depicted in **Figure 8C-37**. The projects are listed and described in **Table 8C-13**, a timeline for each project and FY2023 project status are shown in **Table 8C-14**, and cost information is provided in **Table 8C-15**. There are six project components of the IRL-S project in the C-23 Basin that work in conjunction with adjacent basins such as the C-24, TMC, and C-44 basins. These components are the (1) C-23/24 STA, (2) C-23/24 North Reservoir, (3) C-23/24 South Reservoir, (4) C-23/C-44 Estuary Discharge Diversion Project, (5) Cypress Creek Complex NSWQTA, and (6) Allapattah Complex NSWQTA. The diversion of C-23 Basin excess runoff is also included in the IRL-S components listed above, e.g., the diversion of C-23 and C-24 discharges to the headwaters of TMC with operation of the C-23/24 reservoirs and STAs, and the diversion of C-23 Canal flows to the C-44 Canal, where flows will be directed to the St. Lucie’s South Fork (C-23/C-44 Estuary Discharge Diversion Project). More information on these projects can be found in the *Regional Projects* subsection above.

Additional projects within the C-23 Basin provide for basin runoff retention. These include the Bluefield Grove Water Farm, Spur Land and Cattle Water Farm, Bull Hammock Ranch Water Management Area (WMA), and the City of Port St. Lucie’s McCarty Ranch IRL Water Quality Improvement Project. The Allapattah Flats Parcels A and B Natural Resources Conservation Service Water Reserve Program Wetland Restoration was completed in September 2020. These parcels overlap a portion of the CERP IRL-S Allapattah Complex NSWQTA. Although restoration is complete under the Natural Resources Conservation Service Water Reserve Program, additional restoration opportunities in Parcels A and B are being explored as part of CERP. In addition, significant project milestones were accomplished in WY2023, including the following:

- The first full year of operation of Bluefield Grove Water Farm was completed.
- The Spur Land and Cattle Water Farm project was extended for an additional 10 years, under NEWWRNRLP.

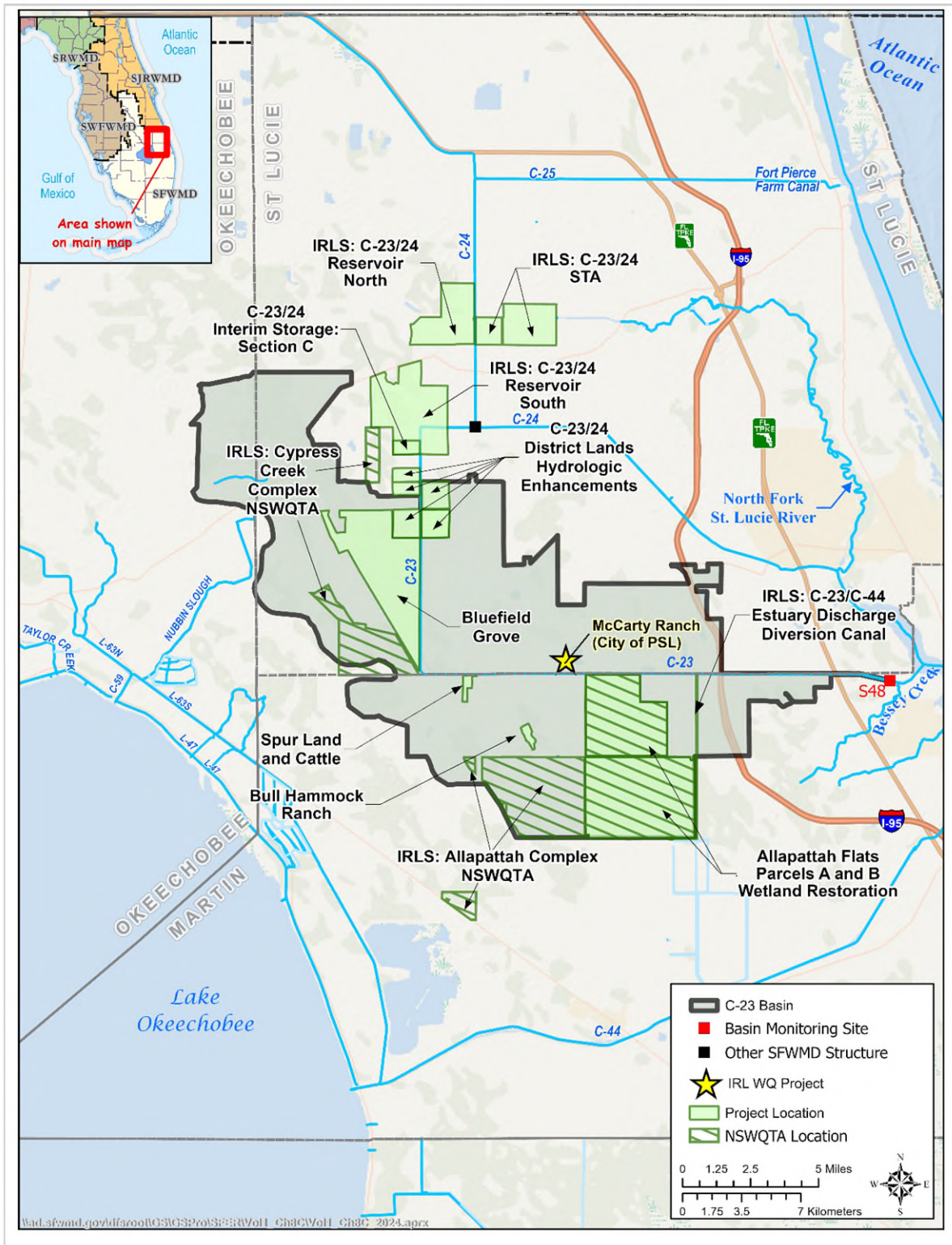


Figure 8C-37. Current projects in the C-23 Basin. (Note: IRL WQ Project – Indian River Lagoon Water Quality Improvement Project and City of PSL – City of Port St. Lucie.)

Table 8C-13. Select Coordinating Agencies projects in the C-23 Basin including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr)	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
Allapattah Flats Parcels A and B Natural Resources Conservation Service Wetland Reserve Program	12,755	O&M	The project restores 6,621 ac of wetlands and will provide average storage retention of 13,300 ac-ft/yr. The project improves water quality through rainfall retention, decreases runoff, and curtails ecologically harmful freshwater flows to the SLE.	13,312	5,350	N/A ^b	2.0	N/A ^b	9.6
Bluefield Grove Water Farm ^c	6,104	O&M	Northern Everglades Public Private Partnership project pumps excess water from the C-23 Canal and stores it within a 6,104-ac aboveground impoundment located on former agricultural lands.	28,360	35,931	5.1	14.2	25.5	70.4
Bull Hammock Ranch WMA	608	O&M	The project retains water in the ditch network and surrounding wetlands and pastures. The project is located in the SLRW and drains into the C-23 Canal. The project objectives are to provide on-site water retention, attenuate stormwater runoff, and extend hydroperiods of on-site wetlands.	228	996	N/A ^b	0.4	N/A ^b	1.8
Spur Land and Cattle Water Farm	210	O&M	This public-private partnership project retains rainfall and excess water pumped from the C23 Canal in a 210-ac water farm on-site.	1,500	1,819	N/A ^b	0.7 ^d	N/A ^b	3.3 ^d
C-23 Water Quality Restoration – McCarty Ranch (City of Port St. Lucie)	701	Construction	SFWMD administered grant project with the City of Port St. Lucie to construct four STAs (Areas 3, 4, 5, and 6). Project will treat water from the C-23 to reduce nutrient loading to the SLE.	7,365	TBD ^e	7.8	TBD ^e	32.6	TBD ^e
C-23 Basin Totals				50,765	44,096	12.9	17.3	58.1	85.1

a. Reflects the project status at the end of FY2023 (September 30, 2023).

b. N/A – not applicable. Storage or nutrient reduction is not associated with the project’s primary objective; however, actual performance may be calculated if data are available.

c. Project completed construction August 2021 and, therefore, was not operational for the full water year.

d. Project nutrient monitoring data are not available. Nutrient loads were calculated based on FWMCs measured at downstream station G-79.

e. TBD – to be determined. Project performance has not yet been established or is under development.

Table 8C-14. Project timeline for current SFWMD and select Coordinating Agencies projects in the C-23 Basin.

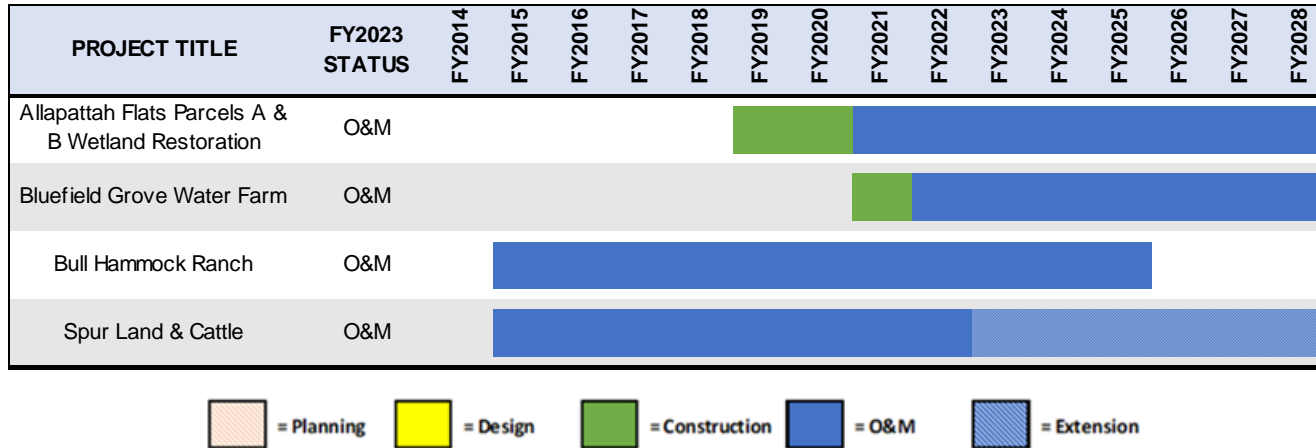


Table 8C-15. Project cost estimates for current SFWMD projects in the C-23 Basin. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
Allapattah Flats Parcels A & B	SFWMD Ad Valorem / Federal	\$0	\$5.1M	\$74K	\$74K	\$75K	\$74K	\$74K
Bluefield Grove	State Appropriations	N/A ^d	\$13.0M	\$5.6M	\$5.5M	\$5.5M	\$5.5M	\$5.5M
Bull Hammock Ranch WMA	State Appropriations	N/A ^d	\$228K	\$33K	\$37K	TBD ^e	TBD ^e	TBD ^e
Spur Land and Cattle Water Farm	State Appropriations/SFWMD Ad Valorem	N/A ^d	\$1.1M	\$155K	\$156K	\$156K	\$156K	\$156K
C-23 Water Quality Restoration – McCarty Ranch (City of Port St. Lucie)	State Grant	N/A ^d	\$334K	\$442K	\$0	\$0	\$0	\$0

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Land acquisition, monitoring, and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

e. TBD – To Be Determined

C-24 Basin

The C-24 Canal and a portion of the C-23 Canal are the main drainage canals in the C-24 Basin. Discharges from the C-24 Basin are controlled by S-49 (a gated spillway that controls water surface elevations in the C-24 Canal and controls discharges from the C-24 Canal to tidewater), G-78 (a gated culvert southwest of the confluence of the C-23 and C-24 canals), and G-81 (a steel sheet-pile dam with a gated weir that functions as a divide between the C-24 and C-25 basins). Water in the C-24 Canal can flow north through G-81 where it converges with the C-25 Canal and flows east, or it can flow south to structure G-79 where it can either continue east and discharge into the North Fork of the St. Lucie River through the S-49 structure or flow west and then south to the C-23 Canal through the G-78 structure. The main functions of the canals and control structures in the C-24 Basin include removing excess water, supplying water, and maintaining a groundwater table elevation west of S-49 to prevent saltwater intrusion into local groundwater. Flow and water quality data observed at S-49 were used to calculate the annual nutrient loads in runoff from the C-24 Basin.

Projects within the C-24 Basin are depicted in **Figure 8C-38**. Projects are listed and described in **Table 8C-16**. A timeline for each project and FY2023 project status is shown in **Table 8C-17**. Cost information is provided in **Table 8C-18**. There are four project components of the IRL-S project in the C-24 Basin that work in conjunction with adjacent basins such as the C-23 and TMC basins. These components are the C-23/24 STA, C-23/24 North Reservoir, C-23/24 South Reservoir, and Cypress Creek Complex NSWQTA. The diversion of excess runoff is also included in the IRL-S components listed above, e.g., the diversion of C-23 and C-24 canals discharges to the headwaters of TMC with operation of the C-23/24 reservoirs and STAs. More information on these projects can be found in the *Regional Projects* subsection above.

Additional projects that reside in the C-24 Basin provide for the retention of basin runoff. These include the Adams-Russakis Ranch WMA; C-23/24 Interim Storage Section C; C-23/C-24 District Lands Hydrologic Enhancements; and Ideal 1000. Significant project milestones for WY2023 include the following:

- Planning for Ideal 1000 began. This is a public-private partnership that will expand on a previous pilot project and is anticipated to provide 5,944 ac-ft of storage a year.
- The C-23/24 Interim Storage project has been expanded to include more acreage and renamed the C-23/C-24 District Lands Hydrologic Enhancements project.

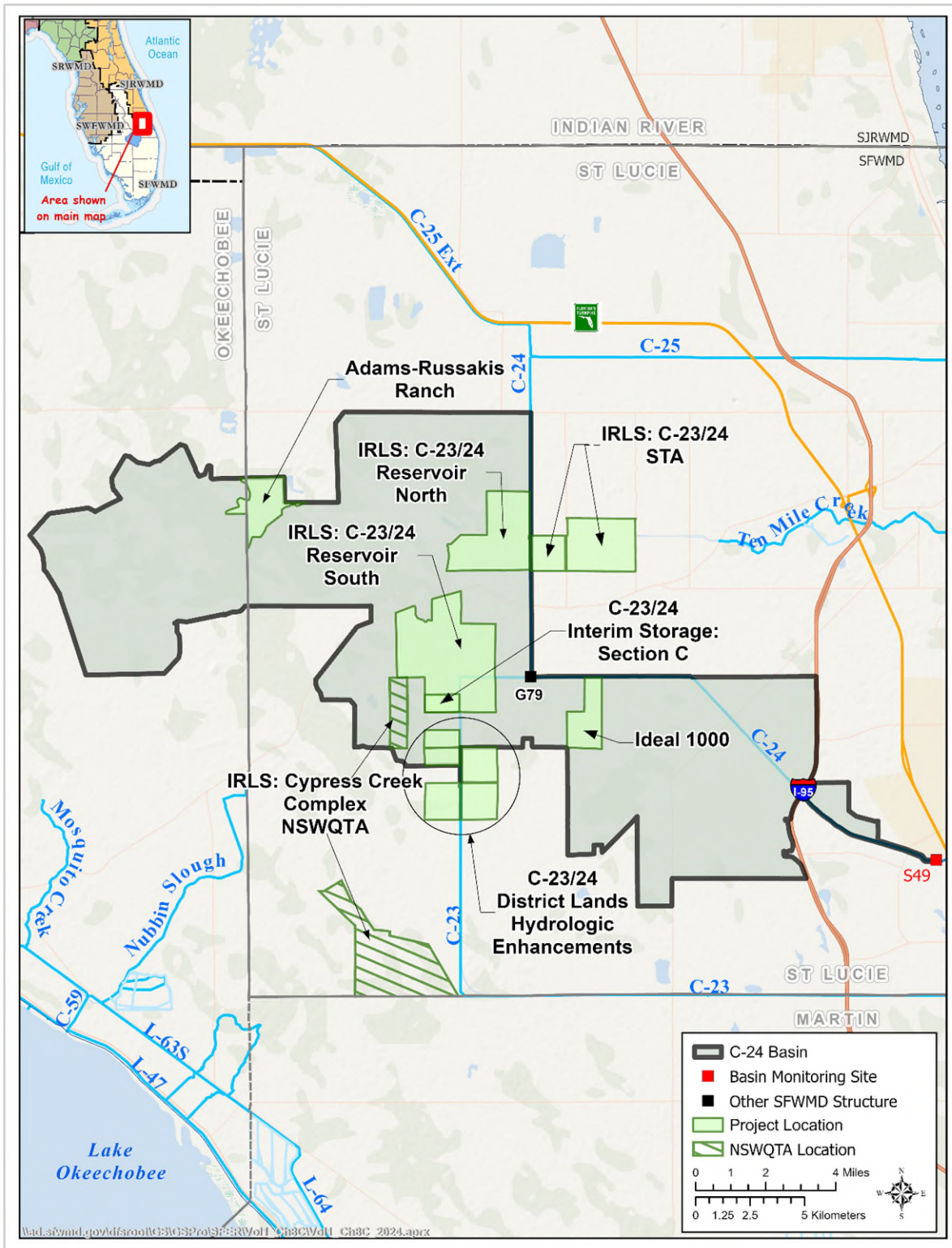


Figure 8C-38. Current projects in the C-24 Basin.

Table 8C-16. Select Coordinating Agencies projects in the C-24 Basin including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr)	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
Adams-Russakis Ranch WMA	1,000	O&M	This project reduces stormwater releases to the C-24 Canal and IRL and mimics the pre-canal sheetflow that once existed. Additionally, the project provides hydrologic restoration and groundwater recharge.	508	501	N/A ^b	0.3	N/A ^b	1.0
C-23/24 Interim Storage Section C	297	O&M	Section C is an interim Dispersed Water Management Program project and 297-ac reservoir constructed on public land. The project will operate until the land is required as part of the IRL-S C-23/24 South Reservoir and Section C is integrated into the overall reservoir concept.	2,950	2,449	N/A ^b	1.3 ^c	N/A ^b	5.0 ^c
C-23/C-24 District Lands Hydrologic Enhancements ^d	2,648	Planning	Study evaluating the current site condition benefits with the intention of future hydrologic enhancements.	TBD ^e	N/A ^f	TBD ^e	N/A ^f	TBD ^e	N/A ^f
Ideal 1000	977	Planning	Public-private partnership to withdraw excess water from the C-24 for storage within three aboveground impoundments. Project includes construction improvements and resumes operation at the pilot project, which was operational from 2015 to 2018.	5,944	N/A ^f	1.8	N/A ^f	7.7	N/A ^f
C-24 Basin Totals				9,402	2,950	1.8	1.6	7.7	6.0

- a. Reflects the project status at the end of FY2023 (September 30, 2023).
- b. N/A – not applicable. Storage or nutrient reduction is not associated with the project’s primary objective; however, actual performance may be calculated if data are available.
- c. Project nutrient monitoring data are not available. Nutrient loads were calculated based on FWMCs measured at downstream station G-79.
- d. Project area comprises of Parcels A, B, F, G, and Unnamed.
- e. TBD – to be determined. Estimated project performance has not yet been established or is under development.
- f. N/A – not applicable. Project was not operational during WY2023.

Table 8C-17. Project timeline for current SFWMD and select Coordinating Agencies projects in the C-24 Basin.

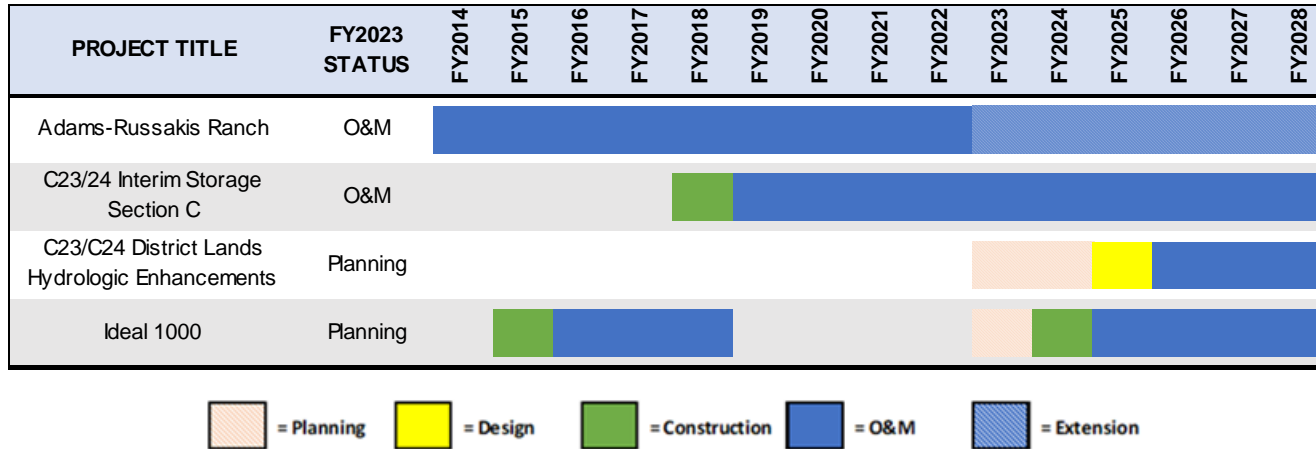


Table 8C-18. Project cost estimates for current SFWMD projects in the C-24 Basin. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
Adams-Russakis Ranch WMA	State Appropriations	N/A ^d	\$166K	\$74K	\$75K	\$75K	\$75K	\$75K
C-23/24 Interim Storage Section C	State Appropriations/ SFWMD Ad Valorem	\$0	\$3.2M	\$43K	\$43K	\$43K	\$0	\$0
C-23/C-24 District Lands Hydrologic Enhancements	State Appropriations/ State Grant	\$37K	\$445K	TBD ^e	TBD ^e	TBD ^e	TBD ^e	TBD ^e
Ideal 1000	State Grant	N/A ^d	\$0	TBD ^e	TBD ^e	TBD ^e	TBD ^e	TBD ^e

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Land acquisition, monitoring, and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

e. TBD – To Be Determined.

C-44 Basin

The C-44 Canal, also known as the St. Lucie Canal, is the main drainage canal in the C-44 Basin and connects Lake Okeechobee to the South Fork of the St. Lucie River. There are two control structures located in the C-44 Canal: S-80 gated spillway (also known as the St. Lucie Lock and Spillway) and S-308 gated spillway (also known as the Port Mayaca Lock and Spillway). The operational goals of this system are to remove excess waters from the C-44 Basin, supply surface water to the C-44 Basin when needed. And maintain groundwater elevations sufficient to prevent saltwater intrusion. The C-44 Canal is also an integral part of the Okeechobee Waterway Navigational Project and, along with the Caloosahatchee River, provides a primary outlet from Lake Okeechobee for flood control. Water surface elevations in the C-44 Basin are regulated by S-80 and regulatory releases from Lake Okeechobee are made by way of S-308. Flow and water quality data from S-80 and S-308 were used to calculate annual nutrient loads in runoff from the C-44 Basin.

Projects within the C-44 Basin are depicted in **Figure 8C-39**. Projects are listed in **Table 8C-19**. A timeline for each project and FY2023 project status is shown in **Table 8C-20**. Cost information is provided in **Table 8C-21**. There are four project components of the IRL-S project in the C-44 Basin that work in conjunction with adjacent basins such as the C-23 and South Fork basins. These components are the C-44 Reservoir, C-44 STA, Palmar Complex NSWQTA, and a portion of the Allapattah Complex NSWQTA. The diversion of excess runoff is also included in the IRL-S components as the C-23/C-44 Estuary Discharge Diversion Project, which will result in the diversion of C-23 Basin flows to the C-44 Canal where flows will be directed to the St. Lucie's South Fork. More information on the Palmar and Allapattah Complex NSWQTA projects can be found in the *Regional Projects* subsection above.

Additional projects within the C-44 Basin provide for the retention of basin runoff. These include Caulkins Water Farm Expansion and the C-44 Aquifer Storage and Recovery (ASR) Well Cluster as part of the regional LOWRP (see Chapter 8B of this volume for further details on this second project). Significant project milestones for WY2023 include the following:

- The STA portion of the CERP IRL-S C-44 Reservoir and STA completed the first full year of operations.



Figure 8C-39. Current projects in the C-44 Basin.

Table 8C-19. Select Coordinating Agencies projects in the C-44 Basin including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr)	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
CERP Indian IRL-S – C-44 Reservoir and STA ^b	9,700	Construction (Operational Testing & Monitoring Period)	Project includes a 3,400-ac reservoir and 6,300-ac STA divided into 6 cells and operated in parallel.	63,505	9,370 ^c	23.0	2.4 ^c	77.0	51.9 ^c
Caulkins Water Farm Expansion	3,275	O&M	Northern Everglades Public Private Partnership project actively stores local stormwater runoff and Lake Okeechobee regulatory releases within a 3,275-ac aboveground impoundment located on privately-owned land along the C-44 Canal.	27,488 ^f	34,923	5.1 ^f	5.2	34.7 ^f	48.3
LOWRP C-44 Well Cluster	TBD ^d	Planning	This is supported through a partnership between the United States Army Corps of Engineers (USACE) and SFWMD to improve the quantity and timing of discharges to the SLE.	33,604	N/A ^e	N/A ^e	N/A ^e	N/A ^e	N/A ^e
C-44 Basin Totals				124,597	44,653	28.1	9.5	111.7	68.0

- a. Reflects the project status at the end of FY2023 (September 30, 2023).
- b. Actual WY2023 values presented here reflect STA operations only.
- c. Calculated as the WY2023 project inflow minus project outflow as reported in Appendix 2-6 of Volume III.
- d. TBD – to be determined. Project is planning/pre-design. Size and location are TBD.
- e. N/A – not applicable. Project was not operational during WY2023.
- f. Estimates revised to reflect the observed 5-year averages from project.

Table 8C-20. Project timeline for current SFWMD and select Coordinating Agencies projects in the C-44 Basin.

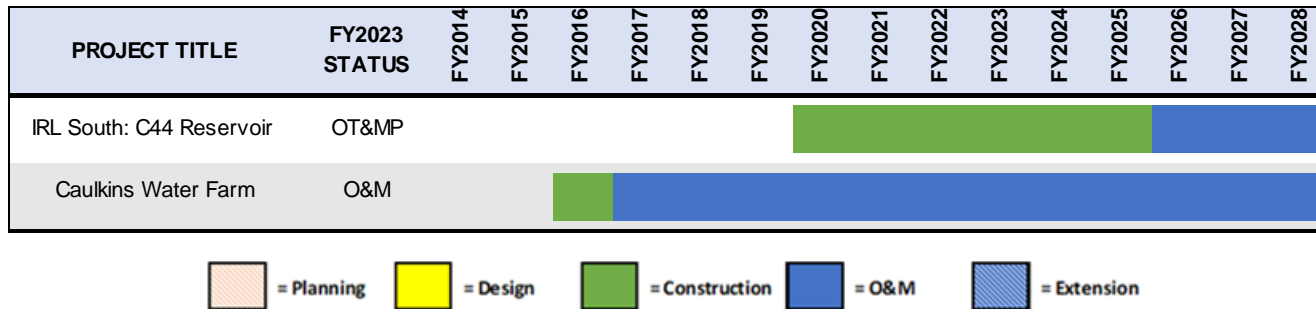


Table 8C-21. Project cost estimates for current SFWMD projects in the C-44 Basin. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
CERP Indian IRL-S – C-44 Reservoir and STA	State Appropriations/ SFWMD Ad Valorem/ Federal	\$67.8M	\$730.2M	\$5.1M	\$5.1M	\$5.1M	\$5.1M	\$5.0M
Caulkins Water Farm Expansion	State Appropriations	N/A ^d	\$42.4M	\$7.3M	\$7.0M	\$7.0M	\$7.0M	TBD ^e

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include land acquisition, design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Monitoring and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

e. TBD – To Be Determined.

Ten Mile Creek Basin

The Ten Mile Creek (TMC) Basin discharges to the North Fork Basin of the SLRW. Water releases are regulated through the Gordy Road structure, which is controlled by the North St. Lucie River Water Control District (NSLRWCD). Flow and water quality data from the Gordy Road structure were used to calculate the annual nutrient loads in runoff from the TMC Basin.

Projects impacting the TMC Basin are depicted in **Figure 8C-40** and listed in **Table 8C-22**. A timeline for each project and FY2023 project status is shown in **Table 8C-23**. Cost information is provided in **Table 8C-24**. There are three project components of the IRL-S project that will work in conjunction with the TMC, C-23, and C-24 basins. These components are the C-23/24 STA, C-23/24 North Reservoir, and C-23/24 South Reservoir. These project components were designed to treat and redirect C-23 and C-24 discharges to the headwaters of TMC to mimic the natural system. More information on these projects can be found in the *Regional Projects* subsection above.

Additional projects in the TMC Basin include the IRL Water Quality Improvement Project (IRL WQ Project), NSLRWCD Gordy Structure Retrofit, and TMC Water Preserve Area (WPA). The Gordy Structure is the main outfall for the western portion of the NSLRWCD. It is a gated spillway used to lower canal stages in the TMC during storm events. The gate retrofits are intended to reduce the release of sediments containing nutrients when the gates are lifted. The purpose of the TMC WPA, a federal critical project transferred to SFWMD in 2016, is to improve the quantity and timing of water discharged into the North Fork by capturing and storing stormwater runoff from the TMC Basin. The project consists of a 526-ac water storage area (reservoir) and a polishing cell with 132 ac of effective treatment area. In 2006, the United States Army Corps of Engineers (USACE) completed the reservoir and started the initial operational testing and monitoring period. Structural and operational concerns were identified during this period. Construction began in 2016 to rehabilitate the reservoir for use as a WPA. In 2017, the project was authorized for routine operation.

In addition, FDACS operates a hybrid wetland treatment technology (HWTT) facility in this basin that combines wetland and chemical treatment technologies and provides nutrient reduction.

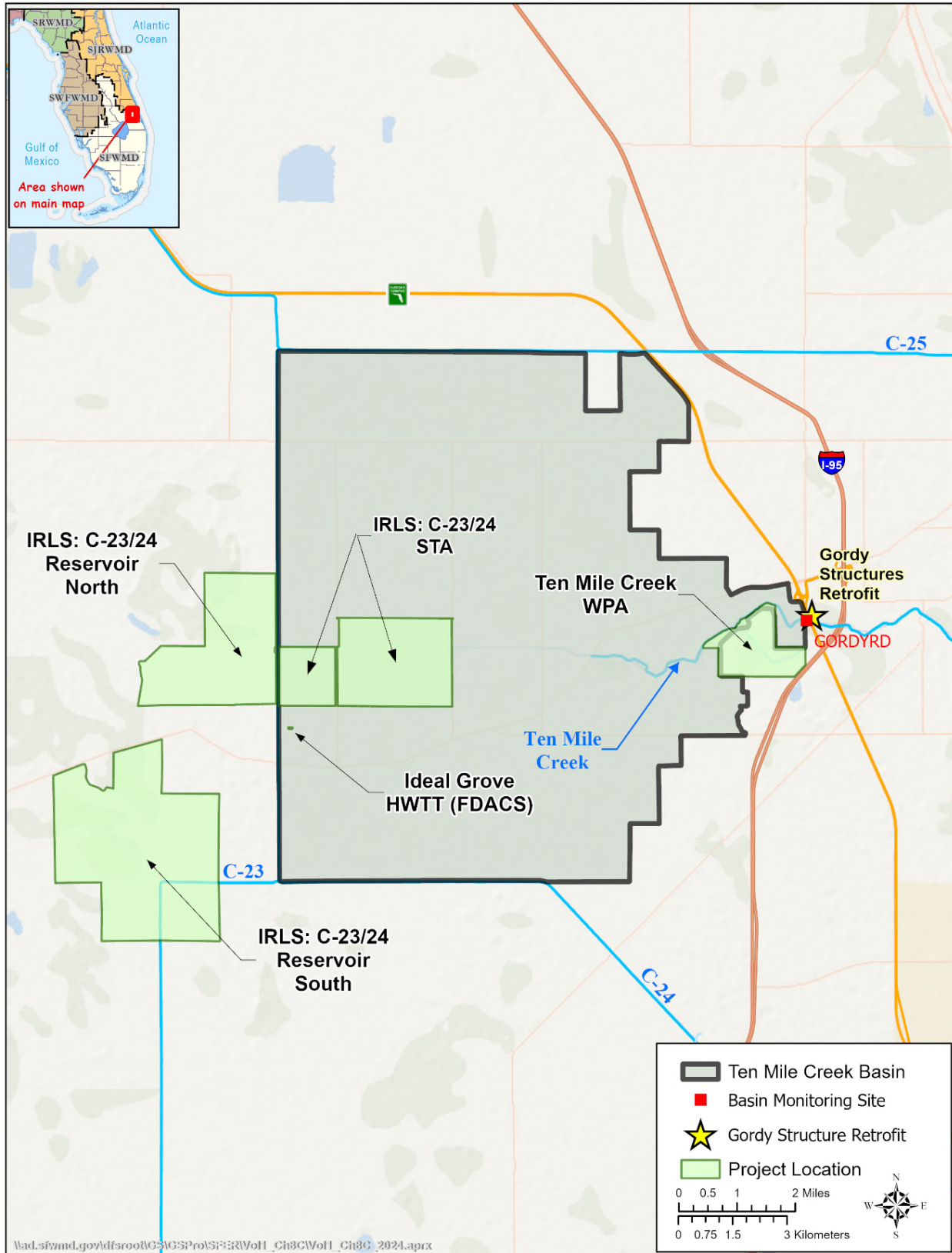


Figure 8C-40. Current projects in the TMC Basin.

Table 8C-22. Select Coordinating Agencies projects in the Ten Mile Creek Basin including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr) ^b	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
TMC WPA	658	O&M	The project improves the quantity and timing of discharges into the North Fork of the St. Lucie River by capturing and storing stormwater runoff from the TMC Basin.	2,302	3,451 ^b	4.0	1.7 ^b	TBD ^c	2.7 ^b
Ideal Grove HWTT (FDACS)	N/A ^d	O&M	HWTT combines attributes of treatment wetlands and chemical treatment systems. Ideal Grove HWTT is one of three operational HWTT systems in the SLRW and became operational in 2008. It has a treatment capacity of approximately 1.3 cubic feet per second (cfs) or 0.04 cubic meters per second or (m ³ /s),	N/A ^e	N/A ^e	0.1	0.02	0.1	0.03
Gordy Structure Retrofit (NSLRWCD)	N/A	O&M	The project intends to retrofit four gates at the Gordy Road structure to reduce sediment transport while maintaining structural functionality.	N/A ^e	N/A ^e	18.2	TBD ^c	44.8	TBD ^c
TMC Basin Totals				2,302	3,451	22.3	1.7	44.9	2.7

- a. Reflects the project status at the end of FY2023 (September 30, 2023).
- b. Calculated as the WY2023 project inflow minus project outflow as reported in Appendix 2-6 of Volume III.
- c. TBD – to be determined. Estimated project performance has not yet been established or is under development.
- d. N/A – information not available.
- e. N/A – not applicable. Storage or nutrient reduction is not associated with the project’s primary objective; however, actual performance may be calculated if data are available.

Table 8C-23. Project timeline for current SFWMD and select Coordinating Agencies projects in the TMC Basin.

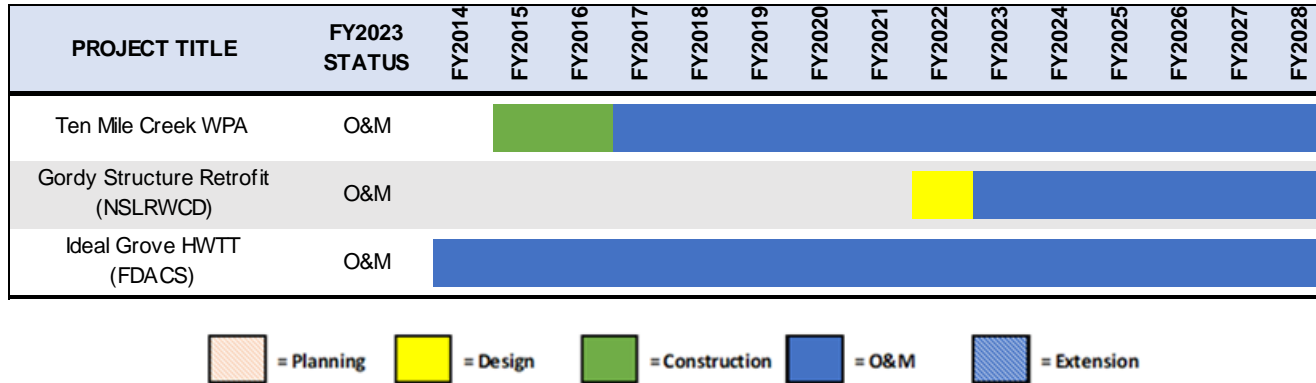


Table 8C-24. Project cost estimates for current SFWMD projects in the Ten Mile Creek Basin. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
TMC WPA	State Appropriations/ SFWMD Ad Valorem/ Federal	\$5.1M	\$53.0M	\$377K	\$349K	\$349K	\$349K	\$349K
Gordy Structure Retrofit (NSLRWCD)	State Grant	N/A ^d	\$500K	\$0	\$0	\$0	\$0	\$0

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include land acquisition, design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Monitoring and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

Tidal Basins

The SLRW Tidal Basins include a portion of the North Fork (excluding the TMC Basin); North Mid-Estuary; Basin 4,5,6; South Fork; South Mid-Estuary; and South Coastal basins. These basins are served by numerous tributaries known as St. Lucie Tributaries along the eastern portion of the SLRW. The Tidal Basins nutrient loads were calculated based on measured water quality concentrations collected at 29 upstream monitoring sites within the Tidal Basins, and on flows simulated by the SLE Tidal Basin Linear Reservoir (Lin Res) model calibrated to the SLE WaSh model (Wan and Konyha 2015).

Projects within the Tidal Basins are depicted in **Figure 8C-41** on the next page and listed in **Table 8C-25**. A timeline for each project and FY2023 project status are shown in **Table 8C-26**. Cost information is provided in **Table 8C-27**. There are two project components of the IRL-S project in the Tidal Basins. These components are the North Fork Floodplain Restoration and the South Fork portion of the Palmar NSWQTA.

Additional projects that reside in the Tidal Basins are the IRL WQ Project such the City of Port St. Lucie's (PSL's) Sagamore Basin STAs and baffle box projects; Martin County's Septic-to-Sewer Conversion Program; and the reclaimed water BMPs research project underway by the University of Florida (UF). Significant project milestone for WY2023 include the following:

- PSL Sagamore Basin STAs and baffle box projects completed construction and are now in operation.

In addition, FDACS operates two HWTT facilities in this basin that combine wetland and chemical treatment technologies and provide nutrient reduction.

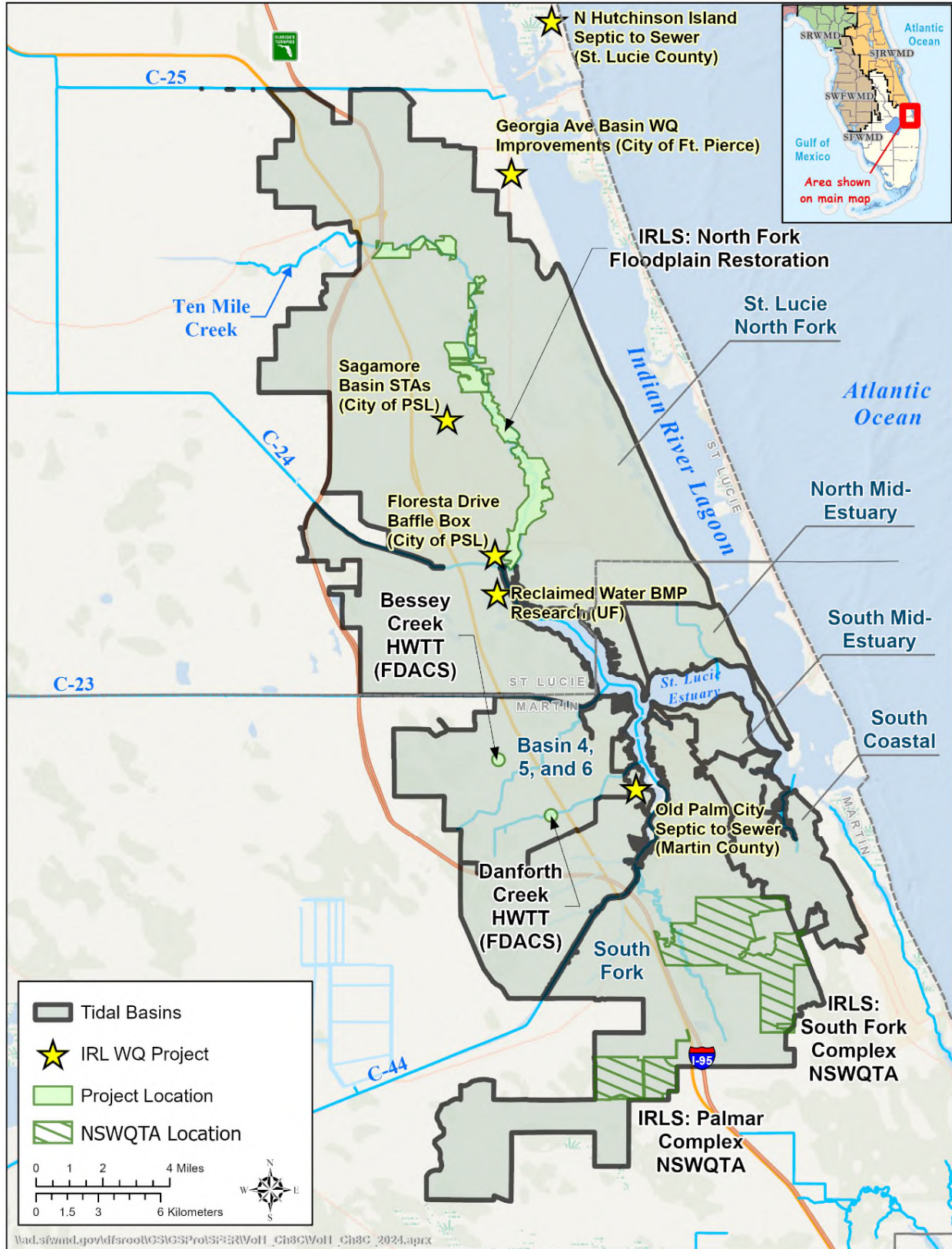


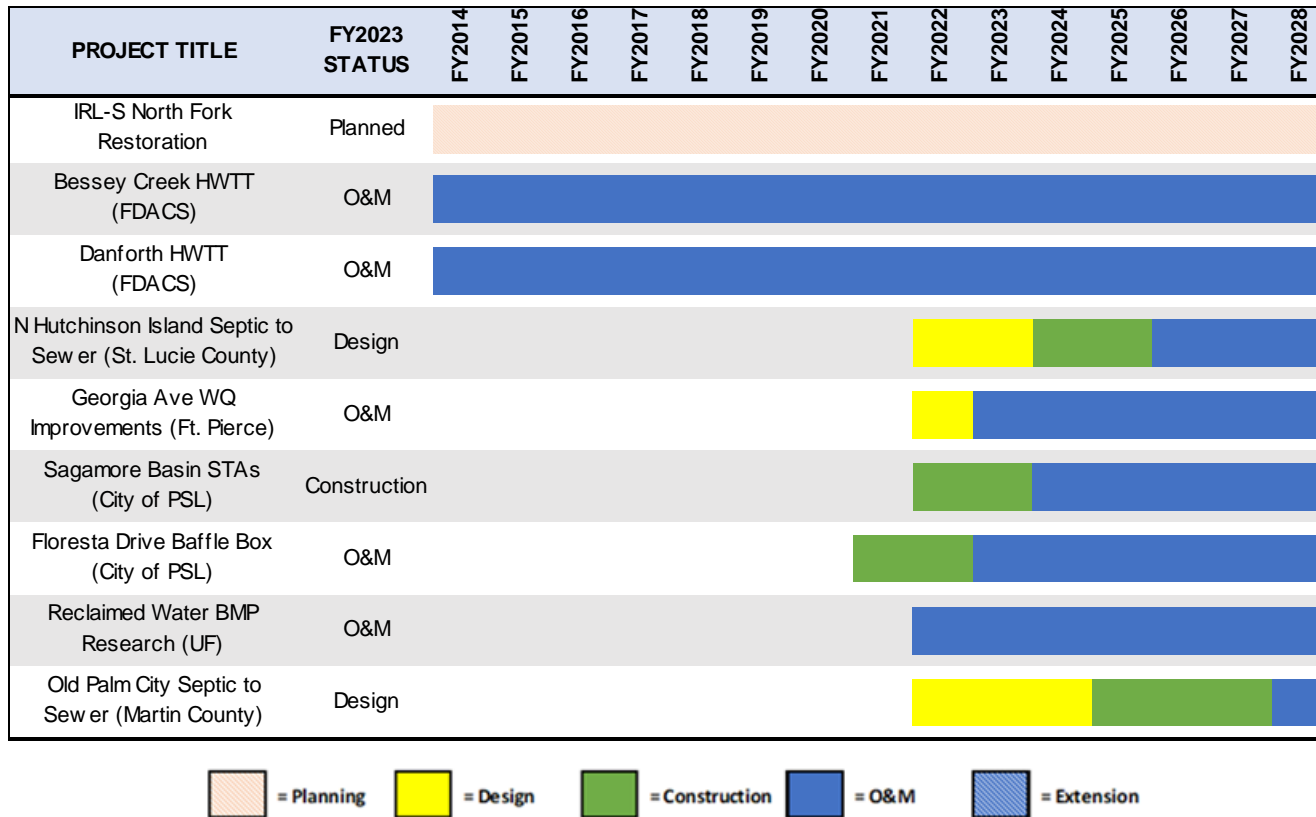
Figure 8C-41. Current projects in the Tidal Basins.
(Note: N – North and WQ – Water Quality.)

Table 8C-25. Select Coordinating Agencies projects in the Tidal Basins including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr)	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
CERP IRL-S North Fork Floodplain Restoration	3,100	Planning	Project includes acquisition and preservation of approximately 3,100 ac of floodplain and adjacent lands currently under significant development pressure. The project will provide significant environmental benefits to this portion of the St. Lucie River, such as reduced stormwater runoff, reduced turbidity, and improved management of exotic plants and animals.	TBD ^b	N/A ^c	TBD ^b	N/A ^c	TBD ^b	N/A ^c
Bessey Creek HWTT (FDACS)	N/A ^d	O&M	HWTT technology combines attributes of treatment wetlands and chemical treatment systems. This project is one of three operational HWTT systems in the SLRW. It became operational in 2015. It has a treatment capacity of approximately 20 cubic feet per second (cfs) or 0.57 cubic meters per second (m ³ /s).	N/A ^d	N/A ^d	0.4	0.3	1.7	1.0
Danforth Creek HWTT (FDACS)	N/A ^d	O&M	HWTT technology combines attributes of treatment wetlands and chemical treatment systems. This project is one of three operational HWTT systems in the SLRW. It became operational in 2016. It has a treatment capacity of approximately 25 cfs (0.71 m ³ /s).	N/A ^e	N/A ^e	0.7	0.4	1.8	1.1
North Hutchinson Island Septic to Sewer (St. Lucie County)	N/A	Design	Convert 31 septic systems to a centralized sewer system.	N/A ^e	N/A ^e	0.1	N/A ^e	0.3	N/A ^e
Georgia Ave Basin Water Quality Improvements (City of Fort Pierce)	235	O&M	Construct treatment trains at three inflow points to treat runoff prior to discharging into the IRL.	N/A ^e	N/A ^e	0.1	TBD ^b	0.3	TBD ^b
Sagamore Basin STAs (PSL)	9	O&M	Construct two STAs (5 and 4 ac) to reduce TN and TP in runoff from a 293-ac area.	N/A ^e	N/A ^e	0.6	N/A ^e	3.3	N/A ^e
Floresta Drive Baffle Box (PSL)	N/A	O&M	Install Type II baffle boxes to retrofit the surface water management system serving the Floresta Drive Drainage Basin.	N/A ^e	N/A ^e	0.1	N/A ^e	0.4	N/A ^e
Old Palm City Septic to Sewer (Martin County)	N/A	Design	Convert 1,075 septic systems to a centralized sanitary sewer vacuum system.	N/A ^e	N/A ^e	1.8	TBD ^b	12.4	TBD ^b
Tidal Basin Totals				TBD	N/A	3.8	0.7	20.2	2.1

- a. Reflects the project status at the end of FY2023 (September 30, 2023).
- b. TBD – to be determined. Estimated project performance has not yet been established or is under development.
- c. N/A – not applicable. Project was not operational during WY2023.
- d. N/A – information not available.
- e. Storage or nutrient reduction is not associated with the project’s primary objective; however, actual performance may be calculated if data are available

Table 8C-26. Project timeline for current SFWMD and select Coordinating Agencies projects in the Tidal Basins. ^a



a. N – North and WQ – Water Quality.

Table 8C-27. Project cost estimates for current SFWMD projects in the Tidal Basins. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
North Hutchinson Island Septic to Sewer (St. Lucie County)	State Grant	N/A ^d	N/A ^d	\$396K	\$179K	\$0	\$0	\$0
Georgia Ave Basin Water Quality Improvements (City of Fort Pierce)	State Grant	N/A ^d	\$648K	\$540K	\$0	\$0	\$0	\$0
Sagamore Basin STAs (PSL)	State Grant	N/A ^d	\$1.1M	\$0	\$0	\$0	\$0	\$0
Floresta Drive Baffle Box (PSL)	State Grant	N/A ^d	\$672K	\$0	\$0	\$0	\$0	\$0
Old Palm City Septic to Sewer (Martin County)	State Grant	N/A ^d	N/A ^d	\$0	\$1.3M	\$750K	\$500K	\$0

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include land acquisition, design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Monitoring and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

C-25 Basin

The C-25 Canal and C-25 Extension are the main drainage canals in the C-25 Basin. Discharges from the C-25 Basin are controlled by S-99 (a gated spillway that controls water surface elevations in the C-25 Canal and manages discharge toward the S-50 concrete weir and to tide). The G-81 structure (gated culvert) allows bi-directional flow between the C-25 and C-24 canals. The C-25 Basin is considered part of the SLRW when flow is directed through G-81 to the SLE. Overall drainage is from west to east, and the C-25 Canal discharges to the IRL near Fort Pierce. As a result, the C-25 Basin is not included in the St. Lucie River and Estuary BMAP (FDEP 2023a), and flow and water quality data were not compiled to quantify nutrient loads in runoff from the C-25 Basin. However, this information will be included in future WPP updates.

Projects within the C-25 Basin are depicted in **Figure 8C-42** on the next page. Projects are listed and described in **Table 8C-28**. A timeline for each project and FY2023 project status is shown in **Table 8C-29**. Cost information is provided in **Table 8C-30**.

Additionally, in November 2021, the SFWMD Governing Board approved the purchase of 1,583 ac in St. Lucie County needed to build the C-25 Reservoir and STA. The C-25 Reservoir and STA are major components of the IRL-S Project to support the health of the SLE and IRL. This project is currently in design, and construction is expected to begin in February 2024.

Additional projects that reside in the C-25 Basin are the Scott Water Farm and the Alderman-Deloney Ranch project. Significant project milestones for WY2023 include the following:

- The Scott Water Farm completed the first full year of operation and significantly exceeded long-term nutrient retention estimates.
- The Alderman-Deloney Ranch project was extended for an additional 10 years, under NEWWRNRLP.

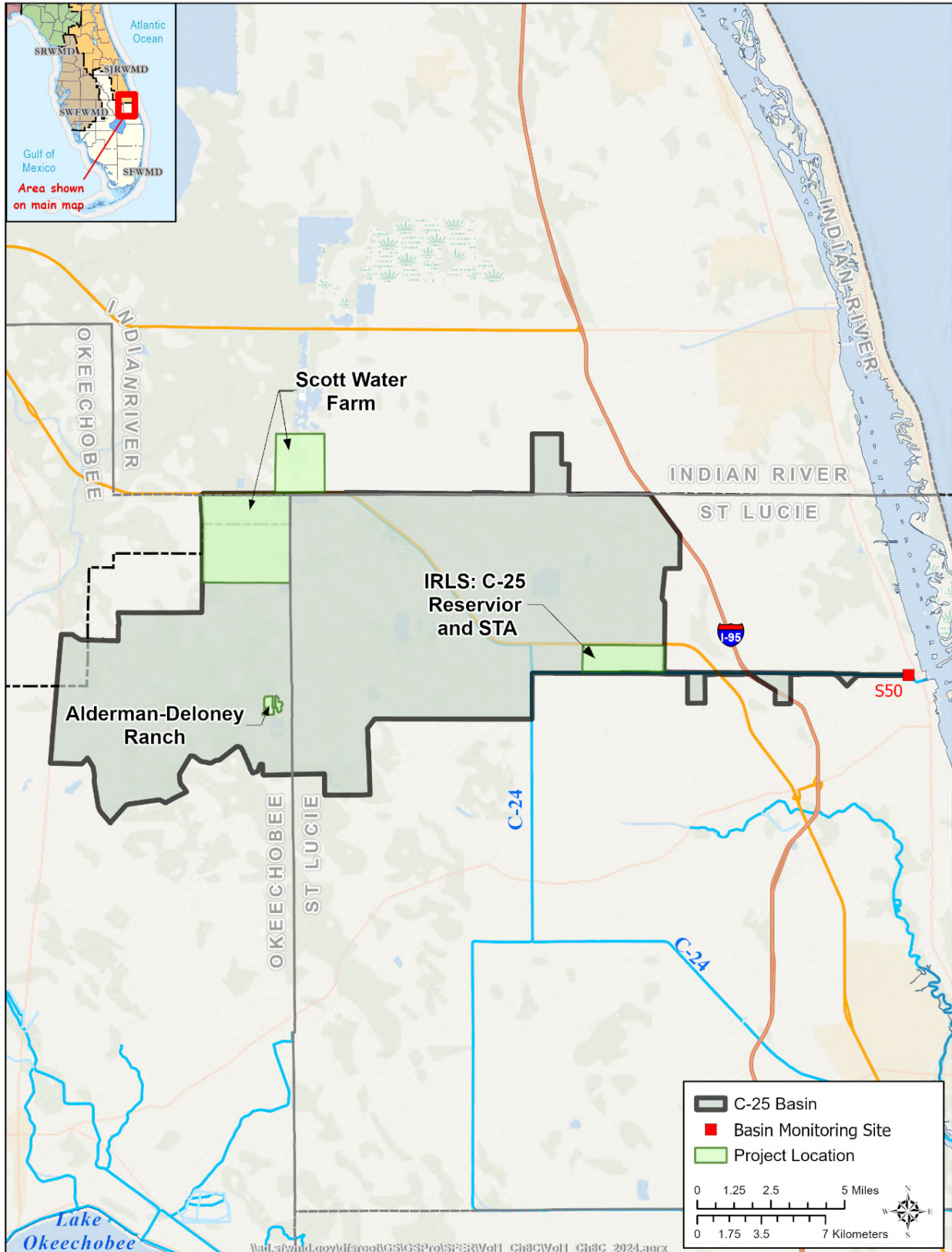


Figure 8C-42. Current projects in the C-25 Basin.

Table 8C-28. Select Coordinating Agencies projects in the C-25 Basin including long-term project estimates and WY2023 storage and nutrient retention.

Project Name	Project Area (ac)	Project Status FY2023 ^a	Description	Estimated Storage (ac-ft/yr)	WY2023 Actual Storage (ac-ft)	Estimated TP Removed (t/yr)	WY2023 Actual TP Removed (t)	Estimated TN Removed (t/yr)	WY2023 Actual TN Removed (t)
Alderman-Deloney Ranch	170	O&M	The existing project consists of 170 ac of WMAs (drained wetlands and fringe areas that have been rehydrated), which retain runoff via two fixed plate weir structures. The project was an original Florida Ranchlands Environmental Services Project and then transitioned into a Northern Everglades Payment for Environmental Services Project with higher weir elevations.	147	102	N/A ^b	0.0	N/A ^b	0.2
Scott Water Farm ^c	7,549	O&M	The Scott Water Farm Northern Everglades Public Private Partnership is located on two adjacent parcels named Scott 2000 (Indian River County) and Scott 6000 (Okeechobee County). Both parcels are used to retain stormwater so that it is not released to the C-25 Basin via the Turnpike Canal.	29,005	33,119	3.3	11.6	13.7	69.8
C-25 Reservoir & STA	1,276	Design	The C-25 Reservoir and STA will capture water from the C-25 Canal and reduce nutrient loads, suspended sediments, and extreme peaks of freshwater discharge to the SLE.	5,392	N/A ^d	8.9	N/A ^d	35.6	N/A ^d
C-25 Basin Totals				34,544	33,221	12.2	11.6	49.3	70.0

a. Reflects the project status at the end of FY2023 (September 30, 2023).

b. N/A – not applicable. Storage or nutrient reduction is not associated with the project’s primary objective; however, actual performance may be calculated if data are available.

c. Project completed construction November 2021 and, therefore, it was not operational for the full water year.

d. Project was not operational during WY2023.

Table 8C-29. Project timeline for current SFWMD and select Coordinating Agencies projects in the C-25 Basin.

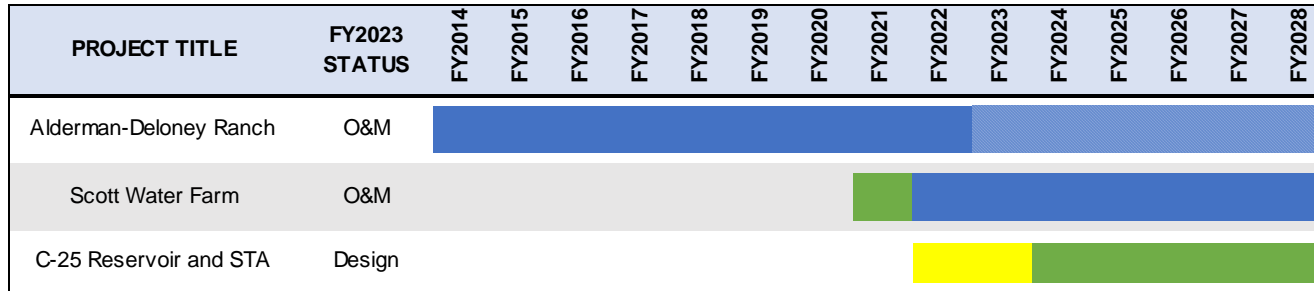


Table 8C-30. Project cost estimates for current SFWMD projects in the C-25 Basin. ^a

Project Name	Funding Source	Land Acquisition	Cost to Date ^b	FY2024 ^c	FY2025 ^c	FY2026 ^c	FY2027 ^c	FY2028 ^c
Alderman-Deloney Ranch	State Appropriations / District Ad Valorem	N/A ^d	\$25K	\$22K	\$22K	\$22K	\$22K	\$22K
Scott Water Farm	State Appropriations	N/A ^d	\$15.0M	\$7.7M	\$7.1M	\$7.1M	\$7.1M	\$7.1M
C-25 Reservoir & STA	State Appropriations	\$16.1M	\$18.0M	\$2.9M	\$68.0M	\$68.0M	\$68.0M	\$30.0M

a. A fiscal year begins on October 1 and continues until September 30 of the fiscal year indicated, e.g., FY2023 is October 1, 2022–September 30, 2023. K – thousand and M – million.

b. Cost to Date includes FY2023 and all previous years, where available. Costs include design, construction, operations, maintenance, and other contractual costs, where available. Costs for projects funded by state grants include construction eligible only. Land acquisition, monitoring, and other programmatic costs are not included.

c. Future cost estimates include planned capital/contractual expenses plus annual O&M cost estimates (FY2023 O&M costs). Future costs for projects funded by state grants include planned contractual expenses.

d. N/A – Not applicable.

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