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SARASOTA BAY ESTUARY PROGRAM

Comprehensive Conservation and Management Plan

Update 2021

Last Updated: June 2, 2021

ACKNOWLEDGEMENTS

The Sarasota Bay Estuary Program (SBEP) Comprehensive Conservation and Management Plan (CCMP) was first adopted in 1995, then updated in 2010 and 2014. It was developed in part with funds provided by the US Environmental Protection Agency, Region 4 through a cooperative agreement.

This 2021–2026 CCMP Update was developed under the direction of Darcy Young by SBEP staff, including Dr. David Tomasko, Mark Alderson, Dr. Jay Leverone, Darcy Young, Michael Dexter, and Christine Quigley, as well as the Management Conference. Strategic planning support, facilitation, research, writing, and mapping were provided by Shafer Consulting. Graphic design and document production was provided by Cross Ink. SBEP staff and members of SBEP's Technical Advisory Committee, Citizen Advisory Committee, Management Board, and Policy Board provided critical input and review. This Update greatly benefited from guidance and review by Felicia Burks, SBEP's Program Officer in EPA Region IV, Noemi Mercado, EPA Headquarters, Washington DC, and their colleagues. This Update was approved by SBEP's Policy Board in [Month 2021.

About the Sarasota Bay Estuary Program

The Sarasota Bay Estuary Program is dedicated to restoring our area's greatest and most important natural asset – Sarasota Bay. We strive to improve water quality, increase wildlife habitat, and enhance the natural resources of the area for use and enjoyment by the public. Sarasota Bay was named an "estuary of national significance" by the U.S. Congress in 1989, laying the groundwork for the Sarasota Bay National Estuary Program to join the National Estuary Program, now 28 strong.

SBEP is an intergovernmental partnership with a Management Conference that includes Manatee and Sarasota Counties, the Cities of Bradenton and Sarasota, the Town of Longboat Key, the Southwest Florida Water Management District (SWFWMD), the Florida Department of Environmental Protection (FDEP), and the United States Environmental Protection Agency (US EPA). In 2004, the partners signed an Interlocal Agreement that established the Sarasota Bay Estuary Program as an independent special district of the state of Florida and committed the partners to carrying out the Comprehensive Conservation and Management Plan for Sarasota Bay.

SBEP is governed by a Policy Board that consists of elected and appointed officials representing each partner in the Interlocal Agreement. The SBEP Management Board, consisting of upper-level administrators from each of the Interlocal Agreement partners and other regional agencies as well as the chairs of the Technical Advisory Committee and the Citizens Advisory Committee, makes recommendations to the Policy Board.

SBEP benefits from a Technical Advisory Committee of local scientists and managers and a Citizens Advisory Committee of local community stakeholders.

Sarasota Bay Estuary Program Management Conference Structure

SBEP staff gratefully acknowledge the service of all current and past Management Conference Members.

Note From The Executive Director

David Tomasko, Ph.D.

Greetings! For those of you who don't know me, joining the SBEP as the new Executive Director in 2020 was a sort of homecoming for me. Back in the early 1990s, I was the first scientist for the SBEP, after receiving the offer of employment from Mark Alderson, SBEP's Executive Director from 1989 to 2020. Sarasota Bay's initial recovery started under Mark's leadership, and we all owe him a debt of gratitude for his leadership and passion. The first large-scale habitat restoration projects were completed under his tenure, as well as the first diagnostic assessment of the health of the bay. Important efforts to replace problematic septic tanks and under-performing wastewater treatment plants occurred under his guidance and the bay's water quality and ecosystems started to slowly recover in response to those actions.

However, the health of the bay has slipped over the past few years due to a combination of factors, including population growth, aging infrastructure, and changes in rainfall patterns. As a result, the bay's water quality and ecological health have declined. The condition of the bay is not as good as it should be, and not as good as it could be. Nitrogen concentrations in the waters of Roberts, Little Sarasota and Blackburn Bays have been higher over the past five to seven years than the worst conditions seen over the prior fifteen years. This nutrient oversupply has increased the amount of algae in the water, which has reduced water clarity. Increases in the amount of macroalgae along the bay bottom have combined with the reduced water clarity to bring about a decline of seagrass coverage of several hundred acres in the part of the bay south of Siesta Key Drive. In the northern portions of the bay, two recent red tide episodes have brought about a decline of seagrass coverage in excess of 2,000 acres, far exceeding the losses in the southern part of the bay, further stressing the health of Sarasota Bay.

We must act quickly and decisively to restore water quality in the bay with renewed focus on nutrient management in the watershed. This will in turn require a coordinated and sustained effort to improve our stormwater and wastewater practices. Reducing our community's nutrient footprint will require government action, but much can be done by individuals as well. Combined with focused improvements to our aging infrastructure, we can bring about a second period of recovery in Sarasota Bay. The past thirty years of SBEP Management Conference leadership showed that Sarasota Bay's ecological health can recover with sufficient action, so let's get to it!

Watershed Segments

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MILESTONES of Sarasota-Area Bays

1000s BCE-1700s
Indigenous peoples inhabit Florida. Historic shell middens still shape many Southwest Florida estuary shorelines today.

1800s
Fishers from Cuba established fish camps, or ranchos, on the shores of Sarasota Bay, trading mainly in mullet and mullet roe.

Late 1800s
Dredging of the Intracoastal Waterway began in Sarasota Bay, leading to the creation of many small dredge-spoil islands.

Early to mid-1900s
Large-scale land reclamation projects drained thousands of acres of freshwater marsh across Florida and coastal development intensified.

1972
EPA Clean Water Act adopted.

1972
Florida's Wilson-Grizzle Act requires wastewater treatment plants discharging to southwest Florida estuaries, including Sarasota Bay, to upgrade to Advanced Wastewater Treatment (AWT) standards, or divert 100% to reclaimed use.

1982
Florida's statewide stormwater rule goes into effect, requiring municipal stormwater systems to manage nutrients.

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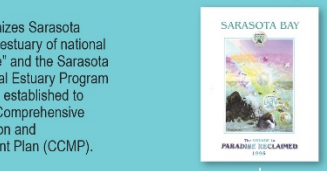
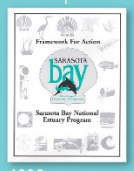
1989
EPA recognizes Sarasota Bay as an "estuary of national significance" and the Sarasota Bay National Estuary Program (SBNEP) is established to develop a Comprehensive Conservation and Management Plan (CCMP).



1995
SBEP's CCMP, approved by local partners, the Florida Governor, and the EPA Administrator, is published.



1992
SBNEP's Sarasota Bay: A Framework For Action, the first comprehensive technical study of Sarasota Bay, published.

1995
Sarasota Bay recognized as a Surface Water Improvement & Management (SWIM) Program priority water body by the Southwest Florida Water Management District.

2004
Federal, state, and local partners sign an Interlocal Agreement that establishes the Sarasota Bay Estuary Program as an Independent Special District of the state, institutes a funding schedule, and outlines priority issues and working groups.

2008
Seagrass acreage surpasses restoration target of 9,997 acres.

2009
FWC Fisheries Independent Monitoring (FIM) Program begins fisheries sampling in SBEP bays

2011
2011 – Estuarine Numeric Nutrient Criteria for SBEP-area bays established, setting regulatory limits to protect Sarasota-Manatee bays from nutrient over-enrichment.

2018
Last regular, permitted wastewater discharge to Sarasota Bay, the Siesta Key Water Reclamation Facility, is removed.

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INTRODUCTION

The Greater Sarasota Bay Estuarine System is a 50-mile-long coastal lagoon located on the southwest coast of Florida. Its interconnected Gulf waters, bays, and tidal creeks link together a rich mosaic of bay habitats, including seagrass meadows, hardbottom, oyster reefs, beaches, and saltwater and freshwater wetlands. These iconic Floridian habitats are animated with a great diversity of fish and wildlife that underpin ecosystem integrity and function and provide the foundational environmental services that drive the cultural identity and economies of our coastal communities.

> Callout box: Estuaries are partially enclosed coastal waterbodies where saltwater from the ocean mixes with freshwater from rivers and creeks. The land over which water collects and flows into a waterbody is called a watershed. Estuarine habitats are among the most productive on earth, providing food and critical habitat for 80 percent of fish and shellfish species. Together with their associated watershed habitats, estuaries provide important ecosystem services and support significant economic and recreational activities.

Historically, Sarasota Bay's alluring estuarine habitats teemed with abundant fish and wildlife – all dependent on a delicate balance of water quality and healthy interconnected habitats. The bay's iconic beauty, abundant fish and shellfish, and charismatic birds, dolphins, manatees, and sea turtles attracted and sustained residents from early indigenous peoples to Cuban fishers, to post-World War II couples and their Baby Boomer kids. Increasing population size (Figure 1) and associated development resulted in damage to and loss of natural habitats, which reduced their capacity to treat increasing pollutant loads. All of this took its toll on water and habitat quality.

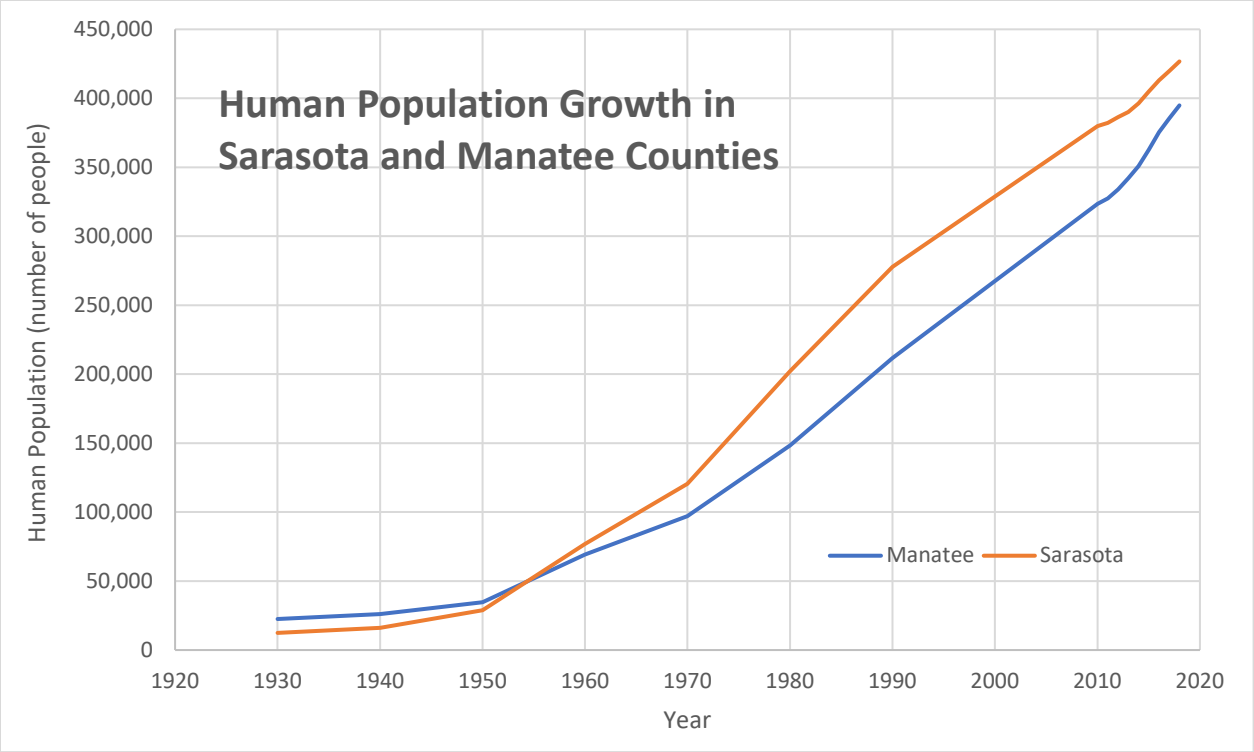

Figure 1. Population growth in Sarasota and Manatee Counties, Florida. Source: US Census estimates.

Today, the majority of the Greater Sarasota Bay Watershed has been altered by urban and agricultural development, leaving isolated and compromised natural areas with limited ecosystem function and services necessary to reduce heavy pollutant loads. Alteration of natural landscapes by changing land uses has interrupted the natural infiltration and historical volume, location, and timing of surface and groundwater flow, released pollutants and contaminants into the air and water, and increased nutrient and bacteria concentrations. These changes have negatively impacted aquatic systems and the services they provide to both natural and human populations.

Anthropogenic (human caused) stressors include land development and damage or loss of natural systems, high pollutant loads in wastewater and stormwater, agriculture, natural system and waterway alterations and disruptions, overharvesting, human intrusions and disturbance, and invasive and nuisance species. Increasing air and water temperatures, intensity of storms, and sea level rise associated with climate change will compound the negative effects of these stressors.

The Sarasota Bay Estuary Program (SBEP) and its partners have made great progress over the years in restoring and protecting the Sarasota Bay Estuarine System. Many challenges remain. Increasing population size and climate change will require new and reprioritized commitments to safeguard the community's vision of a healthy, resilient, productive bay to adaptively manage evolving threats.

Callout box: The community vision for Sarasota Bay is abundant seagrass meadows teeming with fish and shellfish, well-developed oyster reefs filtering water and providing essential habitat for fish and birds, living vegetated coastal wetlands and shorelines filtering runoff and protecting the coast, a mosaic of uplands, freshwater wetlands, and tidal creeks supporting natural waterflow and habitat for fish and wildlife, and unimpeded vegetated dunes and sandy shorelines along Gulf beaches.

About the Sarasota Bay Estuary and Watersheds

The Sarasota Bay Estuarine System is formed by a necklace of barrier islands to the west, the mainland of Manatee and Sarasota counties to the east, Anna Maria Sound to the north, and the Venice Inlet to the South (Figure 2). Circulation is primarily driven by tidal exchange with the Gulf of Mexico through inlets or passes, including Anna Maria Sound, Longboat Pass, New Pass, Big Sarasota Pass, and Venice Inlet. Big Sarasota Bay circulation is forced by the tides at Anna Maria Sound, Longboat Pass, New Pass, and Big Pass. Tidal circulation in Little Sarasota Bay is forced by tides at Venice Inlet and the Intracoastal Waterway running through the middle of the Bay. Numerous tidal creeks deliver freshwater to the eastern shoreline of the Bay, ranging in size from the largest (Phillippi Creek: drainage area of 36,417 acres) to the smallest (Palma Sola Creek: drainage area of 900 acres). The watershed is highly developed and consists of agricultural, residential, commercial, and light industrial land uses.

The Bay is comprised of one large bay segment (Sarasota Bay) and several smaller bay segments, including Palma Sola Bay to the north and Roberts Bay, Little Sarasota Bay, and Blackburn Bay to the south. Each bay segment is unique, differing in overall size, shape, water depth, habitat, sediment characterization, circulation, freshwater inputs, and pollutant delivery. SBEP and partners analyze and focus priority management actions for each bay independently, while recognizing their connectivity.

Palma Sola Bay

Palma Sola Bay is located in West Bradenton and opens up into Anna Maria Sound. It has a relatively stable seagrass coverage trend, but is connected to Perico Bayou, where substantial macroalgal blooms have been documented. Monitoring is required to determine the nutrient sources responsible for these blooms. The Bay has frequent exceedances of fecal coliform bacteria, for which it is currently impaired (FDEP 2020). Targeted research is needed to determine bacteria loads from humans, pets, wildlife, and horses.

Sarasota Bay

Sarasota Bay is located between Longboat Key, Bradenton Beach, and Lido Key to the west, and Bradenton and Sarasota to the east. It is well flushed by Longboat Pass, New Pass, and Big Pass and is the largest and deepest bay between Tampa Bay and Charlotte Harbor. Freshwater runoff from highly urbanized watersheds via Whitaker Bayou, Hudson Bayou, and Bowlees Creek greatly exceeds historical freshwater input. Sarasota Bay is an Outstanding Florida Water, and includes an area that is conditionally approved for shellfish harvesting—though it has been closed for decades due to elevated bacterial pollution, for which Sarasota Bay is impaired (FDEP 2020). Seagrass acreage declined significantly in Sarasota Bay between 2018–2020 and its potential for recovery needs to be assessed. Sarasota Bay suffered serious impacts due to red tide in 2018–2019, more so than any other bay segment. Potential for increased nutrient loading from ongoing shoreline and watershed development in Manatee County needs to be minimized or offset. Opportunities exist for canal restoration and wastewater treatment plant upgrades to improve water quality.

> Callout box: Water tends to be clearer in Sarasota Bay than the smaller bay segments to the south. Bays with a higher ratio of watershed area to open water can have proportionally more freshwater inflow and pollutant loading than systems with lower ratios. Sarasota Bay has a 3:1 watershed-to-waterbody ratio compared to a 13:4 ratio for Roberts Bay, Little Sarasota Bay and Blackburn Bay (Tomasko and Raulerson 2007). Sarasota Bay also has significant saltwater flushing from the Gulf of Mexico. Closing Midnight Pass in 1983 contributed to reduced flushing in southern bay segments.

Roberts Bay

Roberts Bay is located between Siesta Key and mainland Sarasota County. It receives freshwater from the large, highly urbanized Phillippi Creek watershed and saltwater from the Gulf through Big Pass. Roberts Bay is impaired for total nitrogen (FDEP 2020) and experiences persistent impairments for phytoplankton (chlorophyll-a). Drift macroalgae also appear to be increasing. There is an opportunity to document the benefit of planned upgrades to treatment, storage, and disposal of wastewater from the Bee Ridge Wastewater Treatment Plant and treatment upgrades related to septic to sewer conversions. Phillippi Creek is approximately seven miles of natural creek and over 100 miles of manmade canals. Many opportunities exist to reduce nutrient loading to Roberts Bay and increase fish and wildlife habitat by naturalizing these canals.

Little Sarasota Bay

Little Sarasota Bay receives freshwater from five tidal tributaries, including Elligraw Bayou, Holiday Bayou, Clower Creek, Catfish Creek, and North Creek, as well as direct runoff from coastal areas. Midnight Pass, which once separated Siesta Key and Casey Key, historically connected Little Sarasota Bay to Gulf waters, but it was intentionally closed in 1983. Little Sarasota Bay experienced significant seagrass loss between 2014–2018, but losses leveled off between 2018-2020. It has persistent impairments for phytoplankton (chlorophyll-a) and increasing concentrations of drift and attached macroalgae. Ongoing development in the watershed and use of reclaimed wastewater for irrigation create a need to determine the capacity of the watershed to assimilate nutrient loads from use of reclaimed water from non-Advanced Wastewater Treatment Plants.

Blackburn Bay

Blackburn Bay is a long narrow bay between Casey Key and the mainland communities of Osprey, Laurel, and Nokomis. The bay receives saltwater through the Venice Inlet and freshwater from a canal and South Creek. Blackburn Bay is impaired for total nitrogen and South Creek is impaired for fecal coliform bacteria (FDEP 2020). The Bay suffered significant seagrass loss between 2014–2018, while 2020 data indicate a leveling off of the decline. There is increasing drift and attached macroalgae in the bay and it experiences persistent issues with high concentrations of phytoplankton (chlorophyll-a). There is a priority management need to determine the capacity of the watershed to assimilate nutrient loads from reclaimed water from non-AWT WWTPs.

History of the Sarasota Bay Estuary

Formation of the offshore keys that define the Gulf of Mexico boundary of modern Sarasota Bay occurred about 5,000 years ago, during a period of rising seas (Estevez 1992). During the past few million years, sea level has fluctuated substantially. Geologically, sea level in the present-day Sarasota Bay area has ranged from as much as 330 feet below to perhaps as much as 100 feet above present levels. In fact, as recently as 17,000 years ago, the shoreline of the Gulf of Mexico was approximately 60 miles to the west.

Sarasota Bay served as a primary waterway for the Tocobaga, Timucuan, and Calusa, and other indigenous peoples during the 1500s. They created massive shell mounds, called middens, some of which are still visible today. Cuban fishers established fish camps, or rancheros, on the shore of the Bay from 1700 to the mid-1800s. Mullet and mullet roe were the principal products traded with Havana then, although drum, turtle, and trout were also salted and shipped south. Seminole Indians, newly arrived in the Sarasota Bay area, also roamed the bay and coastal region hunting, fishing, and farming. European explorers used Sarasota Bay as a sheltered water link between Charlotte Harbor and Tampa Bay.

An early homesteader to the region was Josiah Gates, who arrived in the Manatee River area in 1842. A year later, William Whitaker sailed to the high yellow bluffs on the mainland further south and staked his claim to what is now much of the northwest portion of the City of Sarasota.

Beginning in 1920, large scale drainage projects were constructed to eventually drain 100,000 acres of freshwater sawgrass marsh. These marshes extended east of the coastal ridge to Myakka and from Tampa Bay to Charlotte Harbor. The marshes were initially drained for farming, which gave way to residential and commercial development. The slow trickle of settlers became a stream, and then a flood after World War II.

Although fewer than 100,000 people lived in the Sarasota Bay area 50 years ago, that early settler population has now swelled to more than 500,000, with continued growth projected. Coastal and Bay development intensified from the late 1950s to 1970, as hundreds of acres of bay bottom were dredged to produce waterfront lots. Canals were dredged and the spoil was used to create subdivisions. The drained saltwater marshes were converted to residential neighborhoods.

Bird Key, located between the City of Sarasota mainland and St. Armands Key, was once the location of one of the largest seagrass beds in Sarasota Bay. The Bird Key development was bulkheaded with seawalls, dredges filled the area behind the seawalls with material from the bay bottom, and the newly expanded island was subdivided into single-family home sites. During this same development cycle, the Intracoastal Waterway was dredged to provide a deep, protected channel running the length of the bay and beyond. Dredge spoil islands were created throughout the bay during construction of the Intracoastal Waterway, covering seagrass beds and permanently changing water circulation patterns.

The natural shoreline was gradually replaced by seawalls to retain dredge-and fill material for homesites. Natural landscapes were replaced by nonporous parking lots, roads, and rooftops. Seagrass coverage was reduced as water quality declined.

Sarasota Bay was a very different place in 1989 from what native residents remember. Seagrass beds had diminished, and remaining seagrass flats were scarred by the tracks of boat propellers. Scallop, oyster, and clam harvests were reduced, and anglers' catches were generally reduced as well. Miles of natural shoreline habitats had been replaced by seawalls, and once abundant mangrove wetlands were depleted. Intense residential and commercial development throughout the Bay area increased stormwater runoff, wastewater pollution, sediment, and chemical contaminants in the bay.

In 1989, a new vision was established by the citizens of Sarasota Bay to reclaim water quality and its biological integrity. This vision was brought into focus by the creation of the Sarasota Bay Estuary Program.

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ESTUARY PROGRAM

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Leffis Key Park - #4
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- Sarasota Bay Watershed
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- Blackburn Bay Watershed
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- Artificial Reefs
- Oyster Habitat Enhancements
- Seagrass Habitat

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Little Sarasota Bay Watershed Habitat Restoration
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Blackburn Bay Watershed Habitat Restoration
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White Beach Oyster Habitat - #4

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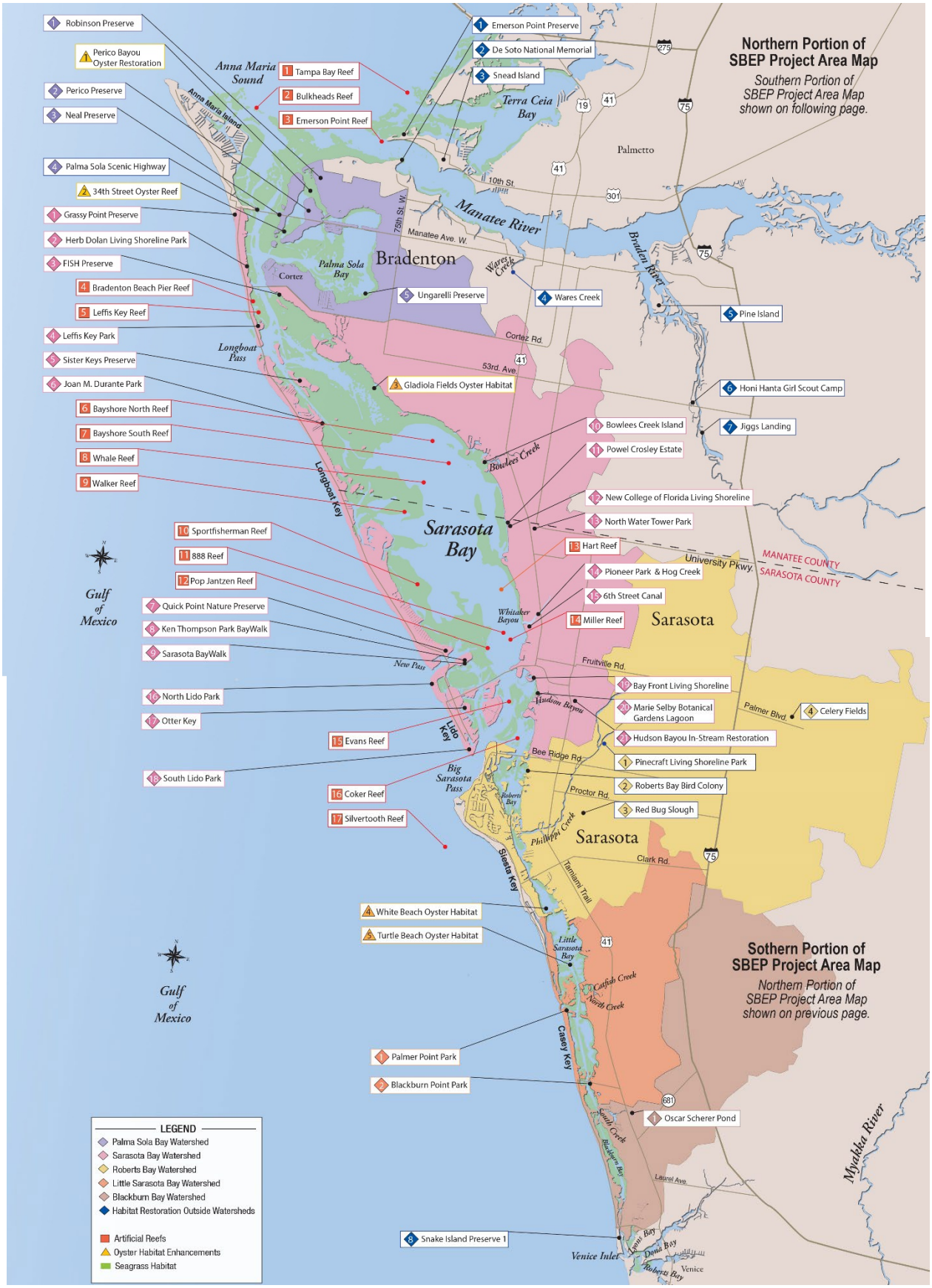
Northern Portion of SBEP Project Area Map
Southern Portion of SBEP Project Area Map shown on following page.
Sothern Portion of SBEP Project Area Map
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Robinson Preserve
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Oscar Scherer Pond
Anna Maria Sound
Anna Maria Island
Terra Ceia Bay
Palmetto
Manatee River
Braden River
Bradenton
Palma Sola Bay
Cortez
Longboat Pass
Longboat Key
Sarasota Bay
Gulf of Mexico
Bowlees Creek
Whitaker Bayou
New Pass
Lido Key
Big Sarasota Pass
Roberts Bay
Hudson Bayou
Phillippi Creek
Sarasota
Siesta Key
Little Sarasota Bay
Catfish Creek
North Creek
Casey Key
Blackburn Bay
Venice Inlet
Venice
Myakka River
MANATEE COUNTY
SARASOTA COUNTY
10th St.
75th St. W.
Manatee Ave. W.
Cortez Rd.
53rd. Ave.
University Pkwy.
Fruitville Rd.
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About This CCMP Update

Purpose and Focus of Update

This 2021 Update to Sarasota Bay Estuary Program's 2014 Comprehensive Conservation and Management Plan (CCMP) is a science-based, community-driven strategic blueprint to advance progress in protecting and restoring the water quality and ecological integrity of Sarasota Bay. The CCMP, which is updated every five years, is a living document that reflects the community's evolving understanding of the bay and its watersheds. It sets priorities, focuses resources, and ensures that SBEP staff, Management Conference members, protection and restoration partners, and other stakeholders are working toward common goals and objectives through coordinated, collaborative planning and action.

This Update was developed over 28 months through a facilitated strategic planning process. Over 100 scientists, engineers, resource managers, resource users, volunteers, community members, and elected officials contributed knowledge, insights, and opinions during the Update process. Each Action Plan was developed sequentially and reviewed by SBEP's Technical Advisory Committee or Citizen Advisory Committee, and Management Board. The SBEP Policy Board, composed of elected and appointed officials and high-level environmental administrators from SBEP partner governments and agencies, discussed and approved each Action Plan and formally adopted the full CCMP. Additional public input was solicited and collected during a three-month period when the draft CCMP was available for download and review from the SBEP website. Longstanding SBEP goals and objectives for protection and restoration of Sarasota Bay were reaffirmed and reenergized and new objectives and priorities emerged throughout this community-driven process.

Changes in the 2021 CCMP Update

The seven chapters, 35 objectives, and 104 actions of the 2014 CCMP were updated, consolidated, moved, restated, or retired. The 2021 CCMP features four Action Plans with 21 objectives and 57 activities (See Appendix 1: Action Plans at a Glance). The specific status of each Action in the 2014 CCMP has been cross-walked to the 2021 CCMP to illustrate continuity and progress (See Appendix 2: 2014 to 2021 CCMP Crosswalk). The 2021 CCMP was reorganized under the framework of a more formal strategic plan to improve focus and decision-making, highlight priorities, and track progress (See Description of Action Plans at a Glance).

Notable changes in the 2021 CCMP Update include:

- Support for comprehensive and coordinated surface water and groundwater quality monitoring, assessment, and reporting was prioritized as a new objective (See WQQ-1).
- Improving and managing hydrology for a more natural pattern of timing, quantity, and distribution of surface water flows was prioritized as its own objective with two activities (See WQQ-3).

- Encouragement for regular inspection and maintenance of septic systems, including installation of supplemental and advanced septic system technologies was identified to be an important activity in coastal areas with impaired waters (WQ-5.2).
- Evaluation and management of the impacts of reclaimed wastewater storage, distribution, and use on nutrient loading and hydrology was prioritized as an activity, due to increased use of reclaimed water for irrigation (WQQ-6.2).
- Encouragement of proactive inspection, maintenance, fats, oils, and grease avoidance, and replacement of failing or underperforming sewer infrastructure to prevent inflow and infiltration, overflows, and spills was identified to be an important activity (WQQ-6.3).
- Improving understandings of pollutant loading from atmospheric deposition was introduced as a priority knowledge gap (WQQ-7).
- Improving understanding, monitoring, reporting, and response to recover from, mitigate, and reduce harmful algal blooms was prioritized as a new objective (WQQ-8).
- Protecting, enhancing, and restoring beaches and dunes for wildlife and resiliency was prioritized as a new objective (WH-6).
- Monitoring and protecting threatened, endangered, and vulnerable wildlife with an emphasis on birds, dolphins, manatees, and sea turtles was prioritized as a new objective (FW-3).
- Outreach to new groups, especially those that have traditionally been underserved or underrepresented, has been prioritized to engage a broader, more diverse audience for protection, restoration, and education activities, and for expanding access and recreational opportunities to them (See Growing SBEP's Reach to Underserved and Underrepresented Stakeholders).
- Threats due to climate change and the importance of mitigation and adaption were addressed in each Action Plan (See Climate Ready Estuary).

Growing SBEP's Reach to Underserved and Underrepresented Stakeholders

SBEP strives for the fair and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development and implementation of environmental priorities, programs, and opportunities. SBEP recognizes the importance of local knowledge and cultural diversity when developing and implementing priorities to protect and restore the bay. SBEP seeks to broaden its services and base of public support for bay protection and restoration to groups that have been traditionally underserved or underrepresented in educational outreach and protection and restoration activities, including environmental justice communities. It also seeks to broaden bay access, recreational opportunities, field trips, and Bay Partners Grants to underrepresented groups and those disconnected from the bay for reasons of location, opportunity, and resources. Priority groups include African American and Hispanic/Latino residents, those with physical or mental disabilities, traditional waterfront workers like commercial fishers in Cortez, and seasonal and older residents with time and interest in contributing to the community. Tactics to address inclusive and accessible programming are described in the SBEP Communications Plan (SBEP 2019).

Climate Ready Estuary

Climate change threatens Sarasota Bay's natural systems, already under stress from humans. The US EPA set a goal for all National Estuary Programs to assess climate change vulnerabilities, develop and implement adaptation strategies, and engage and educate stakeholders. SBEP conducted a climate vulnerability analysis to assess impacts due to sea level rise, changes in precipitation, warmer air and water temperatures, and ocean acidification (SBEP and Shafer 2017). The analysis identified 54 threats that present a range of challenges to achieve CCMP goals, including impacts to water and habitat quality, fish and wildlife, and human use and enjoyment of the bay. Examples of impacts include:

- Changes in the growth rates and survival of algae, bacteria, and viruses
- Failure of low-lying wastewater infrastructure due to flooding or groundwater saturation
- Emergency releases of partially treated wastewater from treatment facilities overloaded by inflow and infiltration during intensifying storm events
- Increase or decrease in episodic volume and velocity of freshwater to tidal creeks and the bay
- Loss of shallow intertidal habitat, including mangroves, salt marsh, and beaches due to upland barriers to migration
- Changes in species composition and zonation and spread of invasive species
- Decreases in juvenile fish, shellfish, and bird feeding, breeding, and refuge habitat due to loss of coastal wetlands and natural shorelines
- Changes in seagrass cover and epiphytes due to changes in water clarity, temperature, depth, and pH
- Reduced or restricted public access to beaches, coastal parks, and natural areas

Results of the Climate Vulnerability Analysis were used to inform development of this 2021 CCMP Update.

Scientific knowledge and understanding of climate change and how it may impact natural and built environments continues to grow, and so do conservation, restoration, mitigation, and adaptation management tools to address impacts. As both fields evolve, SBEP and partners will remain adaptive to new information and management tools to ensure continued success in protecting and restoring a resilient Sarasota Bay.

About the Action Plan Strategy

Definition of terms

The CCMP strategy is composed of four Action Plans, including Water Quality and Quantity (WQQ), Watershed Habitats (WH), Fish and Wildlife (FW), and Community Engagement (CE). Each Action Plan has a high-level goal that is supported by quantifiable Objectives, that are supported by

specific Activities. Each Objective is assigned five-year performance metrics, benefits, and location. Each Activity is assigned a timeframe, list of collaborators, and estimated five-year costs and potential funding sources. These elements are presented within each Chapter and all together in Appendix 1: Action Plans At A Glance.

SBEP's role in implementing the CCMP is clearly defined for each Activity.

SBEP Role Definitions for CCMP Matrices

SBEP Actions	SBEP Engagement	SBEP Staff Time	SBEP (320) Project Funds
Support	Encourage actions that support CCMP implementation.	Yes	No
Coordinate	Convene partnering entities, ensure open communication, and maximize efficiencies.	Yes	Yes, for some meetings
Collaborate	Invest funding and staff time as a partner, but not as the lead agency.	Yes	Yes
Conduct	Invest funding and staff time as the lead agency.	Yes	Yes

Key to costs

Estimated five-year cost ranges for each CCMP activity are provided in the Action Plan Strategy using the following ranges:

$ <$25K
$$ $25K–99K
$$$ $10K–499K
$$$$ $500K–1 M
$$$$$ >$1 M

Supporting documents

Specific strategies, tactics, and information for CCMP implementation are detailed in supporting documents, including:

- **Monitoring Strategy** (to be adopted by 2024) will outline strategies and methodologies for tracking CCMP performance measures.
- **Finance Strategy** (to be adopted by 2024) will outline the strategy for long-term financial support to implement the CCMP.
- **Communications Strategy** (2019, to be updated by 2024) describes principles and tactics for implementing the Public Engagement Action Plan (SBEP 2019).

- **Habitat Restoration Plan** (to be adopted by 2024) analyzes and makes recommendations for habitat restoration priorities, especially with regard to climate change stressors, to implement the Watershed Habitats Action Plan.
- **SBEP Climate Vulnerability Analysis** (2017) analyzes climate related risks to implementing the CCMP. Findings from this analysis helped guide development of this 2021–2026 CCMP Update (SBEP and Shafer 2017).

WATER QUALITY AND QUANTITY ACTION PLAN

GOAL: Improve water quality and the timing, quantity, and distribution of freshwater flow to the estuary

Introduction

Sarasota Bay Estuary Program (SBEP) bays are celebrated for their alluring beauty, abundant fish and wildlife, recreational activities, and economic opportunities — all directly dependent on a delicate balance of water temperature, nutrients, pH, oxygen, and clarity. SBEP bays are a shallow coastal lagoon system with historically less freshwater input than present. Alteration of natural landscapes by residential, commercial, agricultural, and industrial land uses has interrupted the natural infiltration and historical volume, location, and timing of surface and groundwater flow, released pollutants and contaminants into the air and water, and increased nutrient and bacteria concentrations, reduced dissolved oxygen concentrations in the early morning hours, as well as other aspects of water quality and quantity. These changes have negatively impacted aquatic systems and the services they provide to both natural and human populations.

SBEP and its partners have achieved many successes in protecting and restoring water quality. As last quantified six years ago, nitrogen loading to SBEP Bays has been reduced 64% since 1989 due to considerable capital investments in wastewater and stormwater treatment infrastructure (SBEP 2014). These gains, which may have been offset to some degree after 2013, were achieved over a period of decades by conversion of septic systems to central sewer service, consolidation of small private wastewater treatment plants, improvements in the nutrient removal processes used by wastewater treatment plants for the Cities of Bradenton and Sarasota, the eventual elimination of direct wastewater discharge to the bays, and treatment of stormwater with regional stormwater treatment systems and innovative onsite treatment techniques. As population growth and development continue, and climate change magnifies existing challenges, regional partnerships are even more critical for monitoring, evaluating, and responding to water quality threats. Multiple ongoing threats to water quality include excess nutrient loadings, harmful algal blooms, high bacteria counts, low dissolved oxygen concentrations, increased sediment loads from excess runoff, toxins, microplastics, and alteration of natural hydrology.

[Callout box / 2-page spread: threats to water quality]

Excess Nutrients

Living things require nutrients to survive, grow, and reproduce. However, excess nutrients, including nitrogen and phosphorus, can feed harmful algal blooms, which can deplete dissolved oxygen, reduce water clarity, and create toxins harmful to aquatic life and human health. Nitrogen is the limiting nutrient for phytoplankton in SBEP waters, although it is possible that macroalgae may be limited by phosphorus loads to local waters. Excess nutrients in urban runoff from

fertilizer, animal waste, septic systems (WQQ-5), wastewater spills and overflows (WQQ-6), reuse irrigation (WQQ-6), and atmospheric deposition (WQQ-7) are leading threats to water quality.

Bacteria

Bacterial contamination affects the Sarasota-Manatee community's ability to use water for recreation and shellfish harvesting. It comes from a variety of sources, but of most concern is fecal waste from humans and other animals. Sources of fecal bacteria include septic systems, centralized wastewater collection system overflows, backups, and leaks, and wastes from pets, small hobby farms, and ranchettes. In sub-tropical systems such as Southwest Florida, "fecal indicator bacteria" can also arise from non-fecal sources, such as decomposing seaweed and even grass clippings that are blown into stormwater conveyance systems. After heavy rainfalls, stormwater carries bacteria as well as nutrients from these sources to waterways and bays.

Low Dissolved Oxygen

Dissolved oxygen (DO) is an important indicator of water quality. Dissolved oxygen is generated during aquatic photosynthesis and wind-driven surface air mixing. Oxygen is consumed by animal, plant, and microbial respiration and decomposition. Low DO conditions can occur naturally in wetlands and tidal creeks, where organic decomposition rates are high. Low DO can also occur in shallow estuarine waters during the rainy season when large volumes of freshwater runoff can create a freshwater lens that reduces mixing of oxygen into deeper water. Excess nutrients in runoff can cause algal blooms, which can deplete DO when algae die and decompose, and also in the early morning after hours with insufficient light for photosynthesis. Nutrient-stimulated algal growth and bacteria can also stimulate oxygen demand, leading to low DO. Suspended sediments and other particulate matter can also limit the availability of sunlight, which can decrease oxygen production by photosynthetic organisms such as seagrass meadows.

Sediment

Sediment and other particles in stormwater runoff can reduce water clarity and the penetration of sunlight, which limits photosynthesis and the area of suitable bottom habitat available to support seagrass. When suspended sediments settle, they can smother bay bottom habitats, which is especially harmful if the sediments carry bacteria and toxins from land-based sources.

Toxins

Aquatic environments are the ultimate reservoirs for many toxic manmade chemicals. Stormwater can carry oil, heavy metals, herbicides, pesticides, and chemical waste into waterbodies. Endocrine disrupting compounds are emerging pollutants of concern for environmental and human health and come from a variety of household products including flame retardants, plastics, personal care products, and pharmaceuticals. These constituents are linked to adverse endocrine or reproductive effects in animals, whose tissues can accumulate toxins, making shellfish and fish harmful to humans. Toxins from pharmaceuticals and personal care products can pass through septic systems and wastewater treatment facilities and are present in treated wastewater discharges, including reuse.

Plastics

Microplastics are an emerging pollutant of concern. These particles, defined as plastics less than 5mm diameter, are derived from the disintegration of larger plastic debris, manufactured microbeads from cleansers and cosmetics, and microfibers from laundering synthetic clothing. Microplastics can pass untreated through septic systems and wastewater treatment facilities and contaminate the environment. Microplastics are highly resistant to breaking down through decomposition. For the most part, they only continue to break apart into smaller pieces. They can also absorb chemical contaminants and become incorporated into sediments and embedded in the tissue of living things. Ongoing research aims to better understand the impacts microplastics have on human and aquatic life.

Hydrologic Alteration

Human activities have substantially altered SBEP watersheds, waterways, and bays and profoundly impacted hydrology. Hydrologic alteration, defined as "the manmade or man-induced alteration of the chemical, physical, biological, and radiological integrity of water" (Clean Water Act Section 502(19)), is characterized as "pollution" under the Clean Water Act (Novak *et al.* 2016). The historical seasonally fluctuating volume, velocity, timing, and location of fresh surface water and groundwater flows have been redirected, impeded, or accelerated to drain water from the landscape (Wood 2019). Wetlands have been drained and filled, creeks have been dammed, straightened, widened, deepened, and also connected to hundreds of miles of new canals. Pervious natural habitats were replaced with impervious manmade surfaces. Isolated waterbodies were connected with canals and drained into different receiving waters, and bays were dredged deeper in some places and filled in others.

Today, freshwater flows more quickly off the landscape, in much higher volumes, carrying pollutants, sediment, and other contaminants into creeks and bays. These changes interact with and alter nutrient and bacteria concentrations, dissolved oxygen, sediment loads, salinity, and other aspects of water quality, negatively impacting biological aquatic systems.

Action Plan Strategy

In this CCMP update, the SBEP Management Conference commits to eight major objectives for the goal of improving water quality and the timing, quantity, and distribution of freshwater flow to SBEP estuaries.

- **Objective 1**: Support comprehensive and coordinated surface water and groundwater quality monitoring, assessment, and reporting
- **Objective 2**: Develop improvement plans to maintain, attain, or surpass state water quality standards
- **Objective 3**: Improve and manage hydrology for a more natural pattern of timing, quantity, and distribution of surface water flows
- **Objective 4**: Reduce pollutant loading from stormwater

- **Objective 5**: Reduce pollutant loading from septic and other onsite sewage treatment and disposal systems
- **Objective 6**: Reduce pollutant loading from centralized wastewater collection, treatment and disposal systems, including reuse
- **Objective 7**: Improve understanding of pollutant loading from atmospheric nitrogen deposition
- **Objective 8**: Support measures to better understand, monitor, report, respond to, recover from, and reduce harmful algal blooms

WQQ Objective 1: Support comprehensive and coordinated surface water and groundwater quality monitoring, assessment, and reporting.

Activity 1.1	*Continue support of long-term, coordinated, and timely collection, archiving, analysis, reporting, and quality assurance/quality control of water quality data. Support and enhance timely public communication of water quality monitoring data.*
Activity 1.2	*Review and evaluate monitoring programs, increase efficiencies, fill water and air quality monitoring gaps, reevaluate estuary circulation models, identify sources of pollution, and update pollutant sources in pollutant load models.*

Background

Long-term standardized water quality monitoring of bays, tidal creeks, and beaches produces data to track water quality improvements or impairments over time (Figure 1). Data collection, quality assurance/quality control, archiving, analysis, and reporting support the development of management actions for continuously improving water quality against ongoing human impacts.

The ongoing long-term standardized water quality monitoring of SBEP tidal creeks and estuaries is largely driven by the regulatory requirements of municipal stormwater permits required under the federal Clean Water Act and administered by the Florida Department of Environmental Protection (FDEP). National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) stormwater permits held by county and municipal governments require ongoing water quality monitoring to demonstrate that stormwater discharges do not contribute to the deterioration of the area's receiving water bodies.

Coordination among a variety of agencies conducting environmental water quality sampling in Southwest Florida estuaries occurs through the Regional Ambient Monitoring Program (RAMP) with standardized field sampling and laboratory analysis protocols that results in consistent data collection methods used by all parties (Table 1). This ensures that water quality data meet stringent State quality assurance standards before being submitted to the Watershed Information Network (WIN), a statewide public database maintained by FDEP.

Status

Manatee County Parks and Natural Resources Department samples northern SBEP bays including Big Sarasota Bay from Anna Maria Sound south to the county line, and Palma Sola Bay. Each of the

24 total sampling areas (hexagons) has 24 sampling stations. Eight of these stations are sampled monthly so that all 24 stations in an area are sampled each quarter[1].

Sarasota County Public Works monitors 30 sampling areas (polygons) across six SBEP estuary segments from Big Sarasota Bay to Blackburn Bay. Each area has 12 sampling stations. One station is sampled in each area each month so that all 12 stations are sampled each year[2].

The counties also collect monthly water quality samples at fixed stations in a dozen tidal creeks flowing into SBEP bays. Florida Department of Health also samples bi-weekly for bacteria and red tide at 12 Gulf beach locations plus the Palma Sola Bay Causeway and Bird Key Park. In addition, biological indicators of water quality such as seagrass, oysters, and scallops are routinely monitored by counties and other agencies (see WH-5).

Other watershed data, such as stream flow and surface water and groundwater levels, are collected by a network of gauges maintained by SWFWMD in cooperation with USGS. High resolution rainfall data is collected throughout the region by automated monitoring gauges maintained by USGS, SWFWMD, and the counties.

[1] Manatee County: 24 areas x 24 stations/area = 576 stations; Stations sampled 1 x per quarter = 2304 samples annually

[2] Sarasota County: 6 segments x 5 areas/segment x 12 stations/area = 360 stations; Stations sampled 1 x per year = 360 samples annually

Figure 1. Water quality monitoring stations in the Sarasota Bay estuary and watersheds with sample data maintained in the Watershed Information Network (WIN).

Table 1. Field and laboratory estuary and tidal creek monitoring program parameters collected monthly by Manatee and Sarasota Counties.

Parameter	Estuaries		Tidal Creeks	
	Manatee	Sarasota	Manatee	Sarasota
Field				
Depth	X	X	X	X
pH	X	X	X	X
Temperature	X	X	X	X
Dissolved Oxygen (mg/l and % Sat)	X	X	X	X
Salinity	X	X	X	X
Conductivity	X	X	X	X
Transparency (Secchi disk depth)	X	X	X	X
Light Attenuation (PAR)	X	X		
Total Dissolved Solids			X	
Laboratory				
Color	X	X	X	X
Turbidity	X	X	X	X
Total Suspended Solids	X		X	X
Biochemical Oxygen Demand		X		X
Chlorophyll-a	X	X	X	X
Pheophytin				X
Total Kjeldahl Nitrogen	X	X	X	X
Ammonia + Ammonium as N	X	X	X	X
Nitrite + Nitrate	X	X	X	X
Nitrate	X		X	
Total Phosphorous	X	X	X	X
Orthophosphate		X	X	X
Bacteria (Fecal Coliform and/or Enterococci)			X	X

The USF Water Atlas provides continuous access to water quality data and other technical information for area scientists, resource managers and users, elected officials, and the public. Managed by the University of South Florida in Tampa, the Water Atlas is a user-friendly, web-based data management system that imports WIN data and uses geographic information systems and analysis tools to relay, analyze, and display a massive amount of data — making trends easier to visualize and understand.

Priorities

Analysis of water quality status and trends is essential to identify major sources of pollutants, provide accurate measures of pollutant load limits, develop a basis for management plans, and evaluate effectiveness of management practices (WQQ-2). Since its initiation in 1995, long-term coordinated water quality monitoring throughout the region has provided a quantitative basis for determining water quality impairments, estimates of water quality thresholds to maintain seagrass coverage, and identification of numeric nutrient criteria for evaluating estuarine water quality, among other uses.

SBEP will continue to support the long-term, coordinated and standardized collection, quality assurance/quality control, archiving, analysis, and reporting of water quality data that is fundamental to the work of protecting and restoring the estuary. Further, SBEP will collaborate with partners to review and evaluate water and air quality monitoring programs for continuous improvement, especially to fill monitoring gaps. Additional data are needed about nutrient loading from atmospheric deposition, groundwater seepage, sediment flux, and reuse irrigation to update pollutant loading models. Quantifying spatial and temporal macroalgae biomass trends in the bay is important for understanding the fate of nutrients and the implications of biological storage and release for bay water quality. Estuary circulation models should be reevaluated, especially for Gulf passes where beach replenishment operations occur and for the southern bays where water quality and seagrass do not meet targets. In addition, understanding the effects of climate change on estuary pH through ocean acidification and the mitigating role of seagrass requires further study. Monitoring carbonate chemistry parameters, including total alkalinity and dissolved inorganic carbon can help managers better understand coastal and estuarine acidification. As water temperatures continue to rise in Sarasota Bay, the impacts of increased temperatures, both direct and indirect, should be considered for additional study.

Strategy

Activity 1.1 — Continue support of long-term, coordinated, and timely collection, archiving, analysis, reporting, and quality assurance/quality control of water quality data. Support and enhance timely public communication of water quality monitoring data.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments; FDOH; FDEP; FWC; SWFWMD; USGS; USF
Projected 5-Year Costs and Funding Sources: $$$/SBEP (CWA 320); County & Municipal Governments
Location: SBEP waterbodies and watersheds

Activity 1.2 — Review and evaluate monitoring programs, increase efficiencies, fill water and air quality monitoring gaps, reevaluate estuary circulation models,

identify sources of pollution, and update pollutant sources in pollutant load models.

Timeframe: Monitoring Strategy complete in [202X
Collaborators: SBEP (Collaborate); Water Quality Consortium; County Governments; Mote Marine Laboratory; FDEP; FDOH; USF; USGS
Projected 5-Year Costs and Funding Sources: $$$/SBEP (CWA 320); County & Municipal Governments; SWFWMD; FDEP
Location: SBEP bays and watersheds

Benefits

Long-term, standardized water quality data that is regularly analyzed and publicly accessible supports identification of waterbody improvements or impairments and management actions to improve water quality.

5-Year Performance Metrics

- Completion of CCMP Monitoring Strategy
- Creation of a water quality status and trends communication piece

WQQ Objective 2: Develop improvement plans to maintain, attain, or surpass state water quality standards.

Activity 2.1	*Revise and implement watershed management plans and prioritized projects. Include hydrologic improvement planning in watershed management plans.*
Activity 2.2	*Convene a Sarasota Bay Water Quality Consortium and produce a report detailing water quality indicators and a pathway to remediation.*

Background

SBEP and its partners support the long-standing goal to improve and maintain environmental water quality necessary to support and sustain natural communities and human enjoyment of the bay. Efforts to improve water quality are carried out under the regulatory guidance of the federal Clean Water Act (CWA) cooperatively administered by the USEPA and FDEP. Under the CWA, FDEP classifies waters by degree of highest designated beneficial use — including Class 1 for drinking water, Class 2 for shellfish harvest, and Class 3 for fishing, recreation, and support of healthy fish and wildlife — and develops water quality standards supportive of each designated use. Most Florida and SBEP waters are designated Class 3, though a large part of Big Sarasota Bay is designated Class 2, but closed to shellfish harvest since 2004 due to bacteria impairment. The Sarasota Bay Estuarine System from Anna Maria Island to Venice is designated by FDEP as an area of "Special Waters - Outstanding Florida Waters". This designation recognizes the outstanding natural attributes of Sarasota Bay and affords it special protections. From a regulatory standpoint, this means that projects regulated by FDEP or SWFWMD that are proposed within the Sarasota Bay system must not lower water quality as determined at the time of designation, or the year prior to permit request, whichever water quality is better. Exceptions for projects deemed to be "clearly in the public interest" apply (FDEP 2017a).

Water Quality Indicators

The State's numeric water quality standards set maximum thresholds for nutrient pollution in waterbodies, which if not exceeded support the designated waterbody use and protect aquatic life and human health. Recognizing that inland waters have different water chemistry and aquatic life than estuarine waters, the three Southwest Florida NEPs proactively developed estuary-specific numeric nutrient criteria (NNC) (Janicki Environmental, Inc 2010), which were subsequently approved by USEPA and adopted by FDEP (Table 2). Some of these NNC have recently been determined to be unreliable for Sarasota Bay, and a revised approach to develop NNC criteria was developed, resulting in a proposed new NNC criteria for total nitrogen (Janicki Environmental, Inc 2018). Although the revised criterion improves upon the original criteria, it is not normalized for salinity (rainfall), and may result in false positive conclusions of anthropogenic nutrient impairment in wetter than normal years and false negatives in drier than normal years (Tomasko and Keenan 2019). In addition, in Roberts, Little Sarasota, and Blackburn Bays, existing NNC for Total Nitrogen

appear to be too high and are not aligned with other metrics of ecosystem health. Efforts are underway to reevaluate existing NNC criteria.

Table 2. Existing and potential updated numeric nutrient criteria (NNC) thresholds for SBEP estuary segments. Potential updates to NNC are based on the highest annual geometric mean—the worst year with respect to water quality—recorded during the 15-year period of 1998–2012.

Estuary Segment	Existing Estuarine NNC			Potential Updated NNC
	Total P Threshold[1]	Total N Threshold[1,3]	Chlorophyll a Threshold[2]	Total N Threshold[1,3]
1. Palma Sola Bay	0.26 mg/L	0.93 mg/L	11.8 µg/L	no change
2. Sarasota Bay	0.19 mg/L	0.82 mg/L[3]	6.1 µg/L	no change
3. Roberts Bay	0.23 mg/L	0.54 mg/L	11.0 µg/L	0.49 mg/L
4. Little Sarasota Bay	0.21 mg/L	0.60 mg/L	10.4 µg/L	0.54 mg/L
5. Blackburn Bay	0.21 mg/L	0.43 mg/L	8.2 µg/L	0.37 mg/L

[1] annual geometric mean not to be exceeded more than once in a three-year period

[2] annual arithmetic mean not to be exceeded more than once in a three-year period

[3] annual geometric mean is calculated from monthly arithmetic mean of color by region and season

The prime indicators of nutrient pollution in estuaries are excess nitrogen, phosphorous, and chlorophyll-*a*. The nutrient thresholds are intended to correlate with chlorophyll-*a* thresholds that meet water clarity targets necessary to sustain seagrass at or above management targets (Janicki *et al.* 2008) (WH-5).

To better understand, manage, and report water quality characteristics that produce water clarity supportive of seagrass targets, SBEP developed a water clarity conditions reporting tool (Dixon and Wessel 2017). Directly measuring the amount of light passing through water in shallow estuarine waters is difficult and error prone. Instead, the major contributors to water clarity (water color, chlorophyll, and turbidity) are easily and routinely measured and can be modeled to predict water clarity.

Actual concentrations of nutrients and chlorophyll measured at monitoring stations can vary substantially with annual rainfall and land use patterns in the watershed, so the NNC are defined as annual means for each bay with both recommended targets (an acceptable cautionary level) and regulatory thresholds (a level not to be exceeded). Because of the area's unique geology containing naturally occurring phosphorous in the soils, aquatic primary productivity is limited by and highly responsive to increases in nitrogen, but less so to phosphorous. However, the role of phosphorus in stimulating macroalgae, which is not quantified in a water sample, needs to be assessed.

Tidal creeks are significant sources of freshwater to estuaries and provide critical fisheries habitat (WH-3) but have water chemistry different from estuaries. Early findings suggest that current FDEP narrative water quality criteria for tidal creeks based on dissolved oxygen (DO) and chlorophyll-a may be inaccurate and inadequate as indicators of the health of tidal creeks. Specifically, researchers observed no adverse effects on fish communities in creeks with low DO and high chlorophyll (Janicki and Mote 2016). Water quality in tidal creeks is often quite similar to that of wetlands, except nutrients can enter from both upstream land-based and downstream estuarine sources. A tidal creeks nutrient Report Card and additional indicators of creek condition have been developed to assist in efforts to identify and prioritize creeks for further evaluation and management response based on their nutrient conditions (Janicki and Mote 2019).

Bioindicators such as algal blooms, seagrass, and oysters also provide insight into the health of the estuary and are an important part of the water quality monitoring strategy (WQQ-1, WH-5). Algal blooms can indicate excess nutrient supply. Oysters can accumulate and concentrate trace metals over time and require specific ranges of salinity to survive. Because seagrasses require adequate light for photosynthesis, their presence or absence in a location can be used as an indicator of water clarity, which can be diminished by suspended sediments, particles, and nutrient fueled algal blooms.

Status

Water Quality Status

In Sarasota Bay, a central focus of water quality management is to reduce nitrogen availability to microalgae, primarily photosynthetic microalgae called phytoplankton, to achieve water clarity supportive of seagrass meadows. Water quality indicators that track the status of water clarity include total nitrogen, chlorophyll (a measure of phytoplankton), and seagrass coverage.

The Sarasota Bay Estuarine Nutrient Region (ENR) extends from the Manatee Avenue Bridge in Manatee County to the Siesta Key Bridge in Sarasota County, and was used to develop NNC for Sarasota Bay. Annual geometric mean total nitrogen concentrations have increased in the Sarasota County portion of the ENR from about 0.2 mg/L in the late 1990s to about 0.4 mg/L in 2015, while chlorophyll concentrations have been relatively stable (Janicki Environmental, Inc. 2019). Over that time, annual geometric mean total nitrogen in the Manatee County portion of the ENR has decreased from about 0.7 mg/L to about 4 mg/L, while chlorophyll concentrations have slightly decreased. Areal extent of seagrass coverage has increased in the ENR over the same time period.

In 2019, SBEP noted the likelihood of upcoming impairments in several Bay segments and commissioned a report to investigate whether increasing nitrogen concentrations in SBEP southern bay segments could be explained by changes in rainfall and stormwater runoff, or whether other drivers were responsible (Tomasko and Keenan 2019). Researchers found that increases in total nitrogen (TN) in northern Sarasota Bay areas from New Pass to Palma Sola Bay were consistent with those predicted from increased rainfall/runoff. In Bay segments south of New Pass, including areas east of New Pass and Big Pass, Roberts Bay, Little Sarasota Bay, and Blackburn Bay, increases

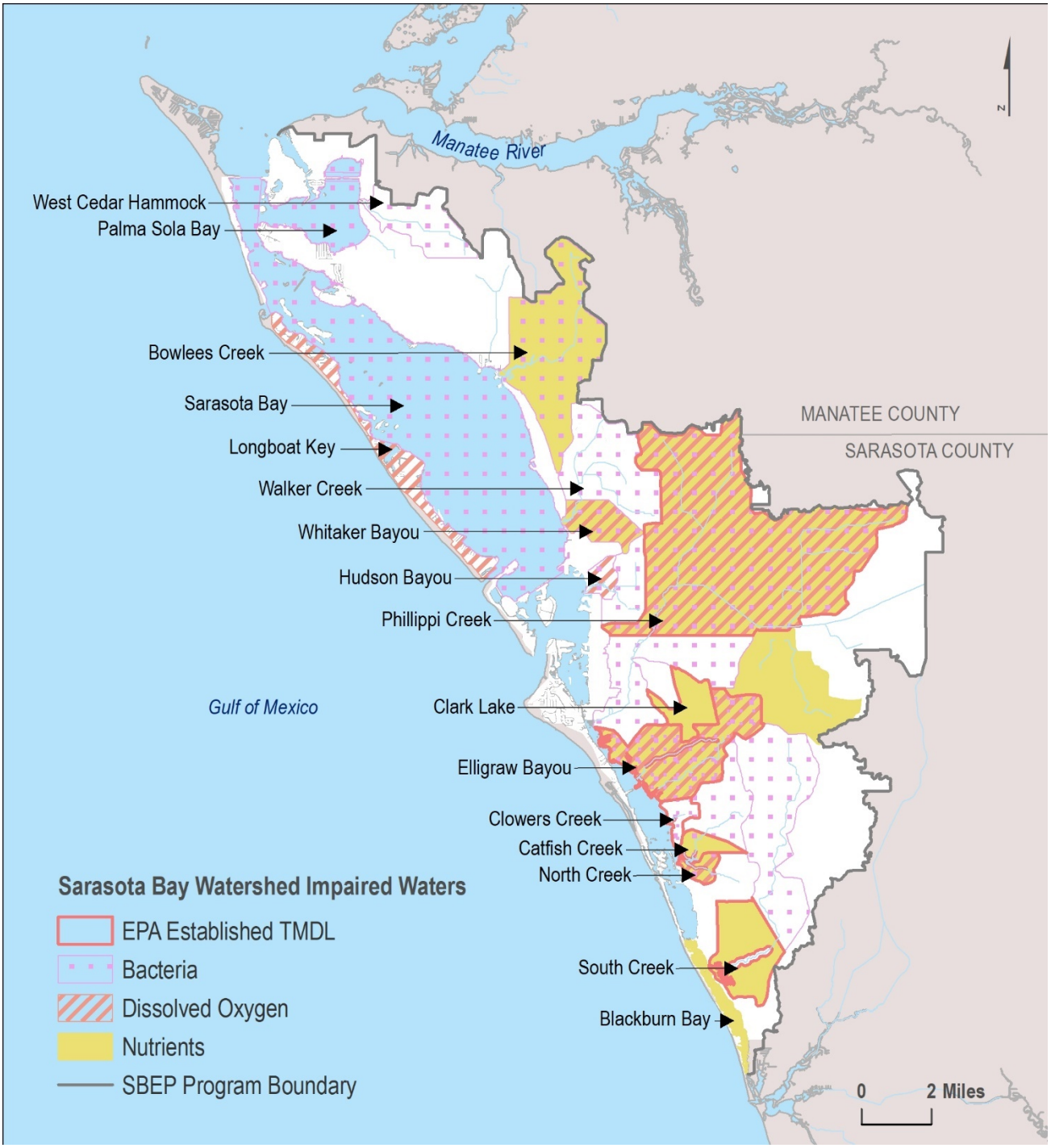
in TN were found to be above and beyond those which can be explained by changes in rainfall and its effect on salinity and nitrogen. This suggests for these bay segments, increased nutrient loads from sources with nitrogen concentrations higher than stormwater runoff, such as those associated with wastewater, may be responsible.

Water Quality Impairments and Improvement Plans

Under the CWA, FDEP evaluates all waterbodies in Florida on a rotating basis every 5 years and reviews water quality standards every three years. The most recent FDEP assessment of SBEP waterbodies was completed in August 2020. Waterbodies that do not meet water quality standards and have no reasonable plan for improvement are verified and listed as “impaired” for the particular pollutants of concern—nutrients, bacteria, metals, etc. FDEP then prioritizes verified impaired waters for Total Maximum Daily Load (TMDL) development. TMDL is a scientific determination of the maximum amount of a pollutant a waterbody can assimilate from all sources and still meet water quality standards. It is a restoration target that allocates “allowable” pollutant loads from the TMDL budget to particular sources of pollution discharging into waterbodies. Once the TMDL is established, specific activities to eliminate “non-allowable” pollutant loads must be implemented.

There are over 1,700 FDEP verified listed impairments to Florida waterbodies. High priority for TMDL development is given to waters with impairments affecting drinking water sources, human health, and threatened or endangered species — about 10% of the total. SBEP waterbodies have 32 FDEP verified listed impairments for bacteria, nutrients, DO, and metals in 16 creeks and bays (Figure 2, Table 3). US EPA approved TMDLs have already been developed for six tidal creeks flowing into the southern bay segments, including Phillippi Creek, Sarasota’s largest source of freshwater flow. No TMDL development has been required for SBEP bays.

Figure 2. Bays and creeks verified impaired for water quality by FDEP using data collected up to 2015. Source: FDEP Verified Impaired List published August 2020.



Basin Management Action Plans (BMAPs) are enforceable comprehensive pollutant cleanup plans developed by FDEP to implement TMDLs that coordinate stakeholders and consolidate efforts, setting a course for restoration of water quality. In a similar process, community stakeholders can voluntarily develop a Reasonable Assurance Plan ("4B Plan") for water bodies not meeting water quality standards, and thereby pre-empt FDEP's regulatory steps to list the waterbody as impaired and develop a TMDL and BMAP.

Table 3. FDEP verified list of impaired waters in SBEP bays and watersheds using monitoring data up to 2015. Source: FDEP Verified Impaired List published August 2020.

Water Segment Name	WBID	County	Water-body Class[1]	Parameters Assessed Using the Impaired Waters Rule (IWR)	Dissolved Oxygen/Biology Pollutant of Concern	FDEP Priority for TMDL Development[2]
Blackburn Bay	1968F	Sarasota	3M	Nutrients (Total Nitrogen)		Medium
Bowlees Creek	1896	Manatee	3M	Fecal Coliform		Medium
Bowlees Creek	1896	Manatee	3M	Nutrients (Chlorophyll-a)		Medium
Catfish Creek	1984AA	Sarasota	3F	Fecal Coliform		Low
Catfish Creek (Tidal)	1984	Sarasota	3M	Fecal Coliform		Low
Clowers Creek Estuary	1975A	Sarasota	3M	Fecal Coliform		High
Clowers Creek Estuary	1975A	Sarasota	3M	Copper		Medium
Clowers Creek Estuary	1975A	Sarasota	3M	Iron		Medium
Hudson Bayou Drain	1953A	Sarasota	3F	Fecal Coliform		Low
Elligraw Bayou	1975	Sarasota	3M	Fecal Coliform		Low
Elligraw Bayou	1975	Sarasota	3M	Nutrients (Chlorophyll-a)		Medium
Hudson Bayou Tidal	1953	Sarasota	3M	Dissolved Oxygen	Biochemical Oxygen Demand	Medium
Hudson Bayou Tidal	1953	Sarasota	3M	Fecal Coliform		Low
Longboat Key	1916	Manatee, Sarasota	3M	Dissolved Oxygen	Biochemical Oxygen Demand	Medium
Matheny Creek	1975B	Sarasota	3F	Fecal Coliform		Low
North Creek (Tidal)	1984A	Sarasota	3M	Dissolved Oxygen	Total Nitrogen, Total Phosphorus, Biochemical Oxygen Demand	Medium
North Creek (Tidal)	1984A	Sarasota	3M	Iron		Medium

North Creek (Tidal)	1984A	Sarasota	3M	Nutrients (Chlorophyll-a)		High
North Creek (Tidal)	1984A	Sarasota	3M	Fecal Coliform		Low
Palma Sola Bay	1883	Manatee	2	Fecal Coliform		Low
Palma Sola North	1883B	Manatee	3M	Bacteria (Beach Advisories)		Medium
Palma Sola South	1883C	Manatee	3M	Bacteria (Beach Advisories)		Medium
Philippe Creek Tributary	1966	Sarasota	3F	Nutrients (Macrophytes)		Medium
Philippi Creek	1937	Sarasota	3F	Fecal Coliform		Medium
Philippi Creek (Tidal)	1947	Sarasota	3M	Fecal Coliform		Low
Sarasota Bay	1968B	Manatee, Sarasota	2	Bacteria (in Shellfish)		Low
South Creek	1982	Sarasota	3F	Fecal Coliform		Low
Walker Creek	1936A	Manatee, Sarasota	3F	Fecal Coliform		Low
West Cedar Hammock	1885A	Manatee	3M	Fecal Coliform		Low
Whitaker Bayou (Tidal)	1936	Sarasota	3M	Dissolved Oxygen	Total Nitrogen, Total Phosphorus, Biochemical Oxygen Demand	High
Whitaker Bayou (Tidal)	1936	Sarasota	3M	Fecal Coliform		Low
Whitaker Bayou (Tidal)	1936	Sarasota	3M	Nutrients (Chlorophyll-a)		High

[1] Florida's has five waterbody classifications, including Class 2 – shellfish propagation or harvesting and Class 3 – recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife in (M) marine or (F) freshwater.

[2] Where a parameter was identified as impaired under the Impaired Waters Rule, a priority of "medium" was assigned by FDEP. Exceptions are waters where the impairment poses a threat to potable water or human health, which have been assigned a "high" priority, and fecal coliform impairments, which have been assigned a "low" priority. All other listings are prioritized by FDEP based on the following: listings with a "High" priority should be addressed within the next 5 years, listings with a "Medium" priority should be addressed within 5-10 years as resources allow, and listings with a "Low" priority should be addressed within the next 10 years.

Priorities

SBEP and partners have developed water quality management plans for Sarasota Bay (JEA 2012a), Little Sarasota Bay (JEA 2012b) and Roberts Bay (JEA 2010) to evaluate existing water quality characteristics as compared to regulatory thresholds and management targets, estimate current and future pollutant loading, and identify activities and projects for water quality improvement and protection. More than 80 water quality improvement projects are identified for SBEP waterbodies.

Sarasota County is in the process of updating the Sarasota Bay Water Quality Plan in with an updated pollutant load model and list of projects.

Manatee County is working with SWFWMD to leverage RESTORE Act funds to develop watershed management plans for priority tidal tributaries, including Bowlees Creek and Cedar Hammock Drain in SBEP watersheds. These creeks flow from watersheds characterized by older development lacking modern stormwater management systems and have verified listed impairments. The completed watershed plans will include hydrologic/hydraulic modeling, an inventory of existing stormwater infrastructure, and prioritized projects to address water quality and flooding problems using green infrastructure solutions (see WQQ-4) where possible.

The Southwest Florida Water Management District (SWFWMD) classifies Sarasota Bay as a priority water body for protection and restoration through its Surface Water Improvement and Management (SWIM) program, which develops watershed management plans to evaluate priority waterbodies and identify improvement projects. SWFWMD works with SBEP, FDEP, and local governments to implement projects from the Sarasota Bay SWIM Plan (SWFWMD 2002) that improve coastal and wetland habitat quality and reduce water pollution through installation of stormwater BMPs. An update to the SWIM Plan is expected in 2021 or later.

There is an urgent need to reduce pollutants and contaminants, avoid impairments, and increase estuary resilience to unpredictable stressors such as hurricanes, HABs, and climate change. SBEP will continue to participate in developing and updating water quality management plans and implement water quality and habitat improvement projects (see WH-1), especially for older developments in coastal areas lacking modern stormwater management systems. There is also a need to develop or reevaluate water quality indicators and targets, fill data gaps (see WQQ-1), and update pollutant loading models to achieve a more holistic and robust assessment of impairments, and the required actions to restore water quality to degraded waters.

In 2021, SBEP convened a Water Quality Consortium of a broad group of stakeholders in response to several Bays receiving impairments (Table 3). The Water Quality Consortium was established in the 2004 SBEP Interlocal Agreement with the mandate to “develop an Action Plan […] to address the goals for cumulative water quality improvement in bay segments verified by FDEP as impaired.” The Water Quality Consortium [is working to develop an Action Plan to build community capacity to reduce nutrient inputs.

Strategy

Activity 2.1	Revise and implement watershed management plans and prioritized projects. Include hydrologic improvement planning in watershed management plans. ***Timeframe***: Update Sarasota Bay Watershed Management Plan in [2021; Update Bowlees Creek Watershed Management Plan in 2020

Collaborators: SBEP (Collaborate); County & Municipal Governments; SWFWMD
Projected 5-Year Costs and Funding Sources: $$$$/County & Municipal Governments; SWFWMD
Location: SBEP waterbodies and watersheds

Activity 2.2 Convene a Sarasota Bay Water Quality Consortium and produce a report detailing water quality indicators and a pathway to remediation.

Timeframe: Convene Water Quality Consortium in 2021.
Collaborators: SBEP (Conduct); County & Municipal Governments; FDEP
Projected 5-Year Costs and Funding Sources: $$/SBEP (CWA 320); Sarasota County, Manatee County, Town of Longboat Key, City of Bradenton, FDEP, SWFWMD
Location: SBEP waterbodies and watersheds

Benefits

Watershed management plans and projects developed from accurate nutrient pollutant loading models and science-based criteria for water quality indicators, targets, and thresholds result in measurable water quality improvements.

5-Year Performance Metrics

- Establishment of a Water Quality Consortium
- Creation of a report detailing water quality indicators and a pathway to remediation
- Creation of a prioritized list of water quality projects

WQQ Objective 3: Improve and manage hydrology for a more natural pattern of timing, quantity, and distribution of surface water flows.

Activity 3.1	*Understand historic, current, and projected hydrologic regimes, accounting for projected climate change and the role of beneficial reuse; identify and prioritize hydrologic improvement projects.*
Activity 3.2	*Support floodplain management that benefits resiliency to flooding and climate change, stormwater quality and quantity improvement, nutrient reduction, and flowway and floodplain restoration to mimic natural system function.*

Background

Human activities have profoundly altered the natural hydrology of all SBEP watersheds. Historically, the slow-draining Southwest Florida landscape was dotted with chains of wetlands, linked by shallow, meandering creeks. Beginning in the 1920s, spasms of development, systematically reengineered water flow through watersheds. Natural areas were hardened with rooftops and roads, natural creeks were channelized straighter and deeper, wetlands were ditched, and floodplains were connected via canals and pipes into large drainage networks. Freshwater flows, volumes, and timing were redirected, impeded, or accelerated, vastly increasing the rate and volume of freshwater reaching the estuary, bringing with it high levels of contaminated and polluted runoff.

Call Out Box of Hydrologic Alteration in the SBEP watershed

- Draining and filling wetlands;
- Damming, straightening, widening, and deepening creeks;
- Hardening natural pervious areas;
- Connecting isolated waterbodies with canals; and
- Dredging and filling the estuary.

Variability in the timing, volume, velocity, and location of freshwater flows can regulate the suitability of a habitat to sustain salinity-sensitive biological communities (Estevez *et al.* 1991, Morrison and Greening 2011). When streamflow volume is chronically reduced so that tidal saltwater replaces the historical freshwater regime, freshwater biological communities may be displaced. Similarly, if too much freshwater chronically floods a traditionally high-salinity habitat, biological communities requiring saline waters may be displaced. Some species can tolerate physiological stress related to suboptimum salinity regimes for limited durations; however, if the alteration becomes chronic or permanent, they too will be displaced.

Climate change is expected to impact natural hydrology in SBEP waterbodies and watersheds due to rising seas and changing precipitation patterns (SBEP and Shafer 2017). Rainfall intensities are projected to increase during the wet season and more days without rain are expected during the dry season (Easterling 2017). Increased flooding during more intense rainfall events may flood natural areas and overwhelm infrastructure designed to manage stormwater. Changes in freshwater input into creeks and bays will likely alter their chemical, physical, and ecological characteristics, further disrupting salinity regimes that are important in their role as nursery and forage areas for aquatic life.

Climate change impacts will be compounded by continued development pressure and increased demands for further alteration and drainage to reduce impacts of increased flooding (Twilley 2001). The community's priority response to these changes may be to build more protective structures and barriers to prevent flooding and water intrusion into built environments, while abandoning infrastructure that becomes obsolete. Remaining natural floodplains and flowways require attention in order to remain unaltered by future development projects. Retrofitting and restoring important ecosystem services lost due to development can be costly. It is more cost-effective to protect natural areas during development planning than to try to restore them post-impact, which is one reason why the conservation of natural floodplains and flowways is an ongoing SBEP priority (see WH-2 and WH-4).

Hydrologic restoration considers the complex interaction of surface water and groundwater flow in order to integrate and balance natural system preservation, water supply, water quality, and flood protection under different climatic and hydrologic conditions. Effective planning determines how much water an ecosystem needs, where water is located, how it can be safely distributed to those areas of need, and how water quality can be protected and improved in the process.

Status

The largest hydrologic restoration project in SBEP watersheds is the Celery Fields Regional Stormwater Facility. Its 440 acres of created wetlands and ponds store stormwater and release it slowly to Phillippi Creek, preventing flooding in downstream neighborhoods. The project was so successful in restoring wetlands that the Celery Fields have become a world-renowned birding and recreation area. Further downstream, the Pinecraft levee project helps manage flow volume to prevent flooding. Phillippi Creek, which drains SBEP's largest watershed, itself is a highly altered network of over 100 miles of manmade canals flowing into seven miles of tidal creek. Large-scale canal construction began in the 1920s and expanded the size of the Phillippi Creek watershed from 28 to 56 square miles.

In natural meandering creeks, sediments are often shaped into point bars and natural levees, increasing the creek's geomorphic and biological diversity (Wood 2019). Pools, pockets of vegetation, wood substrates, and leaf packs in natural creeks increase the diversity and abundance of creek life. In contrast, deep straight canals provide little water quality improvement and habitat value. They also require frequent and costly maintenance, including mowing, application of

herbicides, removal of debris, dredging, and repairing eroded banks. In 2015, Sarasota County spent $6.6 million maintaining Phillippi Creek canals, with some canals requiring significantly more maintenance than other. For example, from 2008–2015, less than 30% of the canals were responsible for 90% of the costs — with just 14 canals responsible for half the costs.

Priorities

Sarasota County is developing a Phillippi Creek restoration strategy that involves retrofitting man-made canals to mimic the natural function of the original creek (Wood 2019). Canals can be reengineered to incorporate shallow, broad, vegetated, and serpentine stream-like components that create variable patterns of flows and eddies. This nature-based design improves water quality and creates fish habitat and can be done without compromising flood protection. Wood (2019) prioritized areas within the Phillippi Creek drainage network that were most subject to erosion and repetitive high maintenance costs. These corridors include Bobby Jones Golf Course along Canal Main B, Lower Canal Main A west of Interstate I-75, Celery Fields along Canal Main C, and Upper Canal Main A east of I-75. Considering scale and continuity, priority areas can be grouped to accomplish multiple benefits in addition to flood prevention, such as water quality improvement, fish corridors, or recreational aquatic watercraft trails (blueways) and terrestrial pedestrian or bicycle trails (greenways).

The partial dam on Phillippi Creek near the Southgate Community Center no longer serves a functional purpose and has been evaluated for removal. With removal of obsolete dams, waterways can realize significant gains in water quality, flood control, recreational opportunities, habitat improvement, and public safety (USEPA 2016b).

In many areas of the developed watershed, it is not feasible to return altered waterways to their original natural state. Nevertheless, there are many opportunities for hydrologic improvements that provide multiple benefits of flood protection, wetland restoration, increased recreational opportunities, and improved water quality. Over 80 such projects are detailed in watershed management plans for Sarasota Bay (JEA 2012a, update 2021), Little Sarasota Bay (JEA 2012b), Roberts Bay (JEA 2010), and Bowlees Creek ([in progress) as well as the County Floodplain Management Plans and SWFWMD's Sarasota Bay Surface Water Improvement Management Plan (SWFWMD 2002). SBEP continues to prioritize hydrologic protection and restoration by reestablishing landscape scale floodplains, protecting wetlands, and protecting tidal tributary isohaline zones to support critical habitat migration and improve resilience of natural systems (see Watershed Habitats Action Plan). Projects in the SBEP Five-Year Habitat Restoration Plan (see WH-1) are scored for their potential to restore natural floodplain function. Projects with significant potential to retain or slow stormwater flow are awarded more points than projects without hydrologic restoration potential.

In 2021, SBEP and Manatee County will complete 60% plans and apply for construction permits for a priority creek restoration project at GT Bray Park in Bradenton. The project will restore tidal creek habitat in a heavily altered system and provide educational opportunities for park visitors.

Ongoing and future comprehensive watershed management planning and project design must consider projected climate change impacts on water availability and flow regimes. They should also consider the cost-benefits of capture and beneficial reuse of stormwater (APA 2010), both as a water conservation measure and to reduce excess flow to the estuary. Increasingly, urban stormwater runoff is recognized to be as a valuable water resource that could be captured and used for irrigation, flushing, cleaning, construction, etc. where potable water quality is not required.

Strategy

Activity 3.1 Understand historic, current, and projected hydrologic regimes, accounting for projected climate change and the role of beneficial reuse; identify and prioritize hydrologic improvement projects.

Timeframe: Update Sarasota Bay Watershed Management Plan in 2021–2022.
Collaborators: SBEP (Collaborate); County & Municipal Governments; SWFWMD; USGS
Projected 5-Year Costs and Funding Sources: $$$/County & Municipal Governments; SWFWMD
Location: SBEP priority hydrologic alteration areas.

Activity 3.2 Support floodplain management that benefits resiliency to flooding and climate change, stormwater quality and quantity improvement, nutrient reduction, and flowway and floodplain restoration to mimic natural system function.

Timeframe: Ongoing
Collaborators: SBEP (Coordinate); County & Municipal Governments; SWFWMD; FEMA
Projected 5-Year Costs and Funding Sources: $$$$$/County & Municipal Governments; SWFWMD
Location: SBEP priority hydrologic alteration areas.

Benefits

Improving hydrology to a more natural state provides multiple benefits for water quality, recreation, habitat, and flood protection.

5-Year Performance Metrics

- Completion of an inventory of prioritized (funded) projects for hydrologic restoration.

WQQ Objective 4: Reduce pollutant loading from stormwater.

Activity 4.1	*Support development and adoption of green infrastructure and smart growth standards in comprehensive land-use plans and land development regulations (stormwater rules and design manuals) to reduce stormwater quantity and pollutant loading.*
Activity 4.2	*Install green infrastructure projects to improve stormwater management for efficient pollution reduction and flood control.*
Activity 4.3	*Establish a stormwater utility in Manatee County and consider utilizing stormwater utility funding for water quality improvement projects, especially green infrastructure.*
Activity 4.4	*Evaluate nutrient removal performance and cost-benefits of nutrient removal BMPs. Support development of a homeowner/HOA BMP manual and a model vendor contract supportive of water quality.*

Background

One of Florida's most abundant natural resources is rainwater. SBEP watersheds typically receive 45 inches or more of rainfall on an annual basis. In natural areas, rainfall is intercepted by tree canopies, evaporates, filters into soil, and/or flows slowly over land to collect in waterbodies — nourishing wetlands and wildlife. Development to support human population growth commonly converts pervious natural habitats to impervious rooftops, roads, and parking lots, causing rainfall to accumulate into increased quantities of stormwater runoff and/or cause flooding. Historically, stormwater management in Florida focused on collecting and rapidly moving stormwater away from development for flood protection. As it flows across developed land, stormwater accumulates pollutants and contaminants from human activities, causing water quality problems for collecting waterbodies. Urban stormwater is the primary pathway of pollutant loading to SBEP waters.

Stormwater management in SBEP watersheds will become more challenging with projected changes in rainfall patterns due to climate change (SBEP and Shafer 2017). Increased water vapor due to warming air and water temperatures is expected to increase the frequency and intensity of precipitation extremes (Easterling 2017). Stormwater created by the first rain after prolonged dry periods will likely have higher concentrations of nutrients and possibly bacteria, and increased storm intensity will likely increase erosion and sediment loads in stormwater. Heavier rain events or longer droughts with warmer temperatures may affect the biological and mechanical functions of stormwater treatment systems such as vegetated swales and stormwater detention ponds, which could compromise their ability to filter sediment, toxins, trash, and nutrients from stormwater and to modulate the flow of freshwater to the estuary. Rising sea levels will interfere with the function of gravity-fed pipes and outfall systems in areas directly along the coastline, creating more nuisance flooding. Impacts will be more severe in older coastal neighborhoods

where little or no stormwater treatment infrastructure exists and where stormwater flows untreated directly into natural waterbodies.

Sources of nutrient pollution to stormwater include excessive application of fertilizers, animal waste, septic systems (WQQ-5), wastewater spills and overflows (WQQ-6), reuse irrigation (WQQ-6), and atmospheric emissions from engines and powerplants that fall back to the watershed through both wet and dry deposition (WQQ-7). The type and concentration of stormwater pollution varies based on amount of rainfall and land use. Typical urban stormwater runoff contains about 2.0–2.4 mg/L total nitrogen and 0.3–0.5 mg/L total phosphorous, about twice the state threshold for ambient water quality in estuaries (WQQ-2) (Sarasota County 2015).

Status

The most effective way to reduce polluted stormwater runoff is to reduce the availability of pollutants and contaminants to stormwater. Fertilizer ordinances prohibiting nitrogen and phosphorus-based application in the summer wet season continue to be implemented in all jurisdictions throughout SBEP watersheds. SBEP participates in fertilizer and pet waste education and supports UF IFAS's Florida Friendly Landscaping™ program. Street sweeping is also an effective strategy to reduce pollutant and contaminant availability. For example, in 2018 the City of Sarasota swept 8,208 miles of streets to remove 1,547 tons of sediment, 66.67 tons of litter, 1,742 pounds of nitrogen, and 1,117 pounds of phosphorous.

Modern stormwater management systems work to replicate the function of natural systems, allowing pollutants and contaminants to be removed by soils and plants, and water to percolate into the ground. Stormwater treatment projects identified in regional water quality management plans have been constructed in Phillippi Creek, Hudson Bayou, and Catfish Creek watersheds and initiated in the Whitaker Bayou watershed. Manatee County is developing projects for Bowlees Creek and aims to establish a county-wide stormwater utility to fund more water quality projects. Coastal stormwater treatment retrofits were installed in the City of Bradenton Beach and City of Sarasota. Various treatment techniques are strategically designed and located to work together to treat urban stormwater drainage over hundreds of acres. Techniques employed in SBEP watersheds include bioswale enhancement, exotic plant removal, bay friendly plantings, sediment removal, wetland creation, stream bank re-sloping and restoration, baffle boxes, infiltration basins, weirs, and erosion control matting.

Priorities

In the urbanized SBEP watershed, especially in older developments where large projects are impractical or too expensive, a series of smaller green infrastructure practices can be linked together to form an effective treatment train. Green infrastructure practices, also known as Low Impact Development or Low Impact Design (LID), work with natural elements to reduce and treat stormwater at its source, minimizing the volume of water and pollution emanating from the constructed environment.

Examples of green infrastructure practices include:

- *Canopy trees and green roofs* to intercept rainfall before it hits the ground
- *Rainwater harvesting systems,* such as rain barrels and cisterns, to capture rainfall and store it for later use
- *Vegetative buffers and littoral zones around shorelines, ponds, and waterways* to filter pollutants and litter from runoff before it enters a waterbody
- *Pervious surfaces for parking areas, walkways, and drives — like pavers, bricks, or gravel,* to reduce runoff after light rainfalls, allowing gradual infiltration of rainfall into underlying soils
- *Rain gardens, vegetated swales, and recessed tree islands* to capture runoff and allow it to evaporate, percolate into the ground, or be used by vegetation
- *Stormwater parks* to combine recreational opportunities, public amenities, wildlife habitat, flood protection, and stormwater storage and treatment into one area

Most stormwater treatment opportunities are on privately owned property. Barriers to implementing green infrastructure include limited education and training opportunities, Homeowner Association rules and deed restrictions, and conflicting language in comprehensive plans and development codes. A widely distributed comprehensive guide for homeowners, analogous to the detailed guidance provided to farmers and golf course managers, would improve the public's understanding and capacity to identify and reduce their nutrient pollution footprint through recommended practices and do-it-yourself DIY green infrastructure projects around the home and neighborhood.

Sarasota County's Low Impact Development (LID) Guidance Document provides technical support to professionals seeking to implement LID-integrated stormwater management practices in their project (Sarasota County 2015). The document provides county-specific technical guidance and design specifications on the design, construction, operations, and maintenance specifications for LID practices, including shallow bioretention, pervious pavements, stormwater harvesting, green roof stormwater treatment systems, rainwater harvesting, and detention with biofiltration. It also provides permitting guidance for meeting Environmental Resource Permit Basis for Review and Sarasota County Land Development Regulation. Increased outreach and education to professionals engaged in planning, designing, constructing, operating, and maintaining building and development projects in Sarasota County about LID and how to use the Guidance Document may expand the use of LID in SBEP watersheds.

SBEP supports development and adoption of green infrastructure and smart growth standards in comprehensive land-use plans and land development regulations.

FDEP created a revised draft Statewide Stormwater Treatment Rule in 2010. If adopted, it would be the first update since the original 1982 rule. Current regulations require new development to install approved best management practices (BMPs) with minimum stormwater treatment efficiency of 80% pollutant removal for Class III waters and 95% removal for Outstanding Florida Waters like

SBEP Bays. But while stormwater BMPs have improved retention and treatment of sediments and metals, wet detention ponds (the most common stormwater treatment systems used in the SBEP watershed) reduce nitrogen loads by 30 to 40% and reduce phosphorus loads by an average of 65%, both of which fall short of the "80% pollutant removal" value cited in the original stormwater guidance from FDEP (Harper 1999). The draft rule from 2010 proposes to increase the level of nutrient removal required from new stormwater treatment systems to 100%, such that post-development nutrient loads would not exceed loads from comparable natural, undeveloped areas. However, in areas with a high water table, it is unclear if such systems can be designed and/or constructed (Harper and Baker 2007).

The draft rule also aims to create a unified statewide standard supporting the underlying objectives of LID. In 2019, Florida's Governor directed FDEP to adopt stormwater rules that reflect the most up-to-date science on BMP efficiency. Data are needed on nutrient removal efficiencies of living shorelines, oyster reefs, and seagrasses to see if they can be assigned credits as BMPs. Reevaluation of stormwater requirements should also consider additional retention and treatment capacity to accommodate projected climate change scenarios, such as rising seas. Since stormwater design rules apply to new developments, performance of existing stormwater ponds could potentially be improved with a five-year recertification requirement.

Strategy

Activity 4.1 Support development and adoption of green infrastructure and smart growth standards in comprehensive land-use plans and land development regulations (stormwater rules and design manuals) to reduce stormwater quantity and pollutant loading.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments
Projected 5-Year Costs and Funding Sources: $/County & Municipal Governments
Location: SBEP watersheds

Activity 4.2 Install green infrastructure projects to improve stormwater management for efficient pollution reduction and flood control.

Timeframe: Ongoing
Collaborators: SBEP (Coordinate/ Collaborate); County & Municipal Governments; SWFWMD; FDEP; FDOT
Projected 5-Year Costs and Funding Sources: $$$$/SWFWMD; FDEP; County & Municipal Governments; FDOT; MPO
Location: SBEP watersheds

Activity 4.3 Establish a stormwater utility in Manatee County and consider utilizing stormwater utility funding for water quality improvement projects, especially green infrastructure.

Timeframe: 2020
Collaborators: SBEP (Support); Manatee County
Projected 5-Year Costs and Funding Sources: $/Manatee County
Location: Manatee County

Activity 4.4 Evaluate nutrient removal performance and cost-benefits of nutrient removal BMPs. Support development of a homeowner/HOA BMP manual and a model vendor contract supportive of water quality.

Timeframe:
Collaborators: SBEP (Collaborate); UF/IFAS Extension; FDEP
Projected 5-Year Costs and Funding Sources: $$/SBEP (320); UF/IFAS Extension; USEPA
Location: SBEP watersheds

Benefits

Reduced pollutant loading from stormwater improves water quality necessary for human uses and healthy aquatic systems.

5-Year Performance Metrics

- Establishment of a stormwater utility in Manatee County.
- Creation of an HOA/homeowner BMP manual (or convene a workshop to design a manual)

WQQ Objective 5: Reduce pollutant loading from septic and other onsite sewage treatment and disposal systems.

Activity 5.1	*Continue conversion of septic systems to centralized sewer systems and consolidation of small wastewater treatment plants, prioritized in coastal areas.*
Activity 5.2	*Encourage regular inspection and maintenance of septic systems and installation of supplemental and advanced septic system technologies, prioritized in coastal areas.*
Activity 5.3	*Improve inventory and mapping of septic and other onsite sewage treatment and disposal systems and increase understanding about septic system capacity to treat nutrient pollution and pathogens under different site conditions, including climate change.*

Background

Untreated or partially treated sewage contains nutrients, bacteria, chemicals, microplastics, and pharmaceuticals harmful to the environment and public health. Commercial and residential properties not serviced by modern wastewater treatment facilities, commonly use onsite sewage treatment and disposal systems (OSTDS) like septic systems to treat sewage on their property. Conventional septic systems are primarily designed to treat bacteria and other pathogens, though do provide some nutrient treatment. They provide little to no treatment of pharmaceuticals and no treatment of microplastics.

Septic systems can be a significant source of pollution in Florida surface and groundwaters. For example, high concentrations of nitrogen and bacteria were found down gradient from septic systems in Charlotte Harbor (Lapointe *et al.* 2016). Stable nitrogen isotope ratios in macroalgae, which could be an indicator of sewage as a nitrogen source, was found in areas served primarily by septic tank systems (Lapointe *et al.* 2016). However, similar patterns of nitrogen isotopes could be produced by cycling of nitrogen from other sources, such as fertilizer. We need to better understand nutrient and bacteria loading from septic systems in SBEP watersheds, especially near priority and impaired waterbodies.

From a water quality management perspective, nitrogen is the primary nutrient pollutant of concern in sewage. Even when properly sited, operated, and maintained, conventional septic tanks and drainfields only remove 30 to 40% of nitrogen (Toor *et al.* 2011). However, substantial reductions of nitrogen can also occur via denitrification in soils when conditions are favorable. When septic systems are improperly sited, operated, or maintained, they can be even less effective. Understanding the inherent limitations of conventional septic systems to convert organic nitrogen into harmless nitrogen gas is important to prioritizing management strategies to reduce nitrogen loading from them.

In the low oxygen environment of the septic tank, organic nitrogen is converted to nitrogen-containing ammonium. In the upper, oxygenated soil layer of the drainfield, nitrifying bacteria convert ammonium to nitrate. In deeper soils with low or no oxygen, but with a sufficient carbon source, denitrifying bacteria convert nitrate to nitrogen gas, which then escapes harmlessly into the atmosphere. If the upper soil layer becomes saturated with rainfall or groundwater, conversion of ammonium to nitrate can be interrupted, allowing ammonium to pass through lower soil layers and into groundwater. It can then be transported to and pollute surface waters. If nitrate is not denitrified before reaching groundwater, it can still be denitrified if it encounters enough carbon and has enough time or travel distance to surface water. If not, it can be transported to and pollute surface waters.

As a result, design and siting septic systems in appropriate locations is important to managing their potential impacts. For example, drainfields sited in areas with poor soil types and shallow water tables or in areas prone to saturation during rainstorms will have diminished treatment capacity.

Safeguarding adequate depth between the bottom of the drainfield and groundwater is important to reducing nitrogen loading to waterbodies. Since 1983, Florida has required at least a two-foot separation between the bottom of the drainfield and the seasonal high-water table. Both Manatee County and Sarasota County Governments require a depth of three feet. Before 1983, only one foot was required. Because many coastal areas in SBEP watersheds were developed before 1983, protective distances between drainfields and groundwater may not occur in older neighborhoods with pre-1983 septic systems. Climate change is expected to increase rainfall intensity and sea levels in SBEP waters and watersheds (SBEP and Shafer 2017). These stressors may increase flooding and soil saturation, raise groundwater levels, and further reduce the treatment effectiveness of septic system drainfields, if those systems are not elevated in some manner (Cooper 2016, M-DCDR&ER 2018).

Ensuring adequate distance between the drainfield and surface waters is also important for preventing nitrogen loading to waterbodies. Florida requires a minimum 75-foot setback between a septic drainfield and bays, rivers, streams, canals, lakes, or ponds. Since June 15, 1983, Sarasota County Government requires a 100-foot minimum setback. On lots platted before June 15, 1983, Sarasota County requires a 50-foot minimum setback. Manatee County requires a 75-foot minimum setback or a 50-foot setback on lots platted before January 1, 1972.

Improper use and maintenance of septic systems can also lead to reduced treatment performance or failure. Tanks and drainfields of septic systems deteriorate over time. Although conventional systems have a functional lifespan of about 25 years, many systems in SBEP watersheds are older. Solids and scum that cannot be digested in the tank accumulate and must be physically removed every 3–5 years to avoid backups or damage to the drainfield. Soils can be compacted over drainfields or roots of shrubs and trees can interfere with proper drainfield operation. Disposing harmful chemicals or undigestible items into septic systems reduces the effectiveness of bacteria and can clog and damage systems.

Status

Management of pollutant loading from septic systems in SBEP watersheds has focused on research to inventory the location of septic systems, outreach and education to encourage owners to properly use and maintain systems, and capital projects to convert septic systems to central sewer service in priority areas.

Inventory and Status

Understanding the location and status of septic systems operating in SBEP watersheds is fundamental to assessing and managing their environmental impacts. Currently, the inventory of septic systems in SBEP watersheds is unverified, inaccurate, and missing key data on system build and status.

FDOH's statewide Florida Water Management Inventory (FLWMI, FDOH 2016) estimates that there are 26,646 "known", "likely", or "somewhat likely" parcels using septic systems in SBEP watersheds Table 4). Most exist in older, coastal communities near Outstanding Florida Waters, including Anna Maria, Holmes Beach, Palma Sola Bay, Bayshore Gardens, Whitfield, Vamo, Casey Key, neighborhoods adjacent to Dona Bay, South Venice, and Manasota Key.

Table 4. Number of parcels using septic systems in SBEP watersheds in Sarasota and Manatee Counties from the Florida Department of Health's Florida Water Management Inventory (FLWMI), including known, likely, and somewhat likely identifications and an independent inventory of known and likely parcels using septic systems conducted by Sarasota County (2019).

SBEP Watershed Areas by County	FDOH Estimate				County Estimate
	Known	Likely	SW Likely	TOTAL	Known and Likely
Sarasota	2,356	5,000	735	8,091	13,342
Manatee	81	18,473	1	18,555	N/A
Total	2,437	23,473	736	26,646	

Sarasota County Government conducted its own septic system inventory in 2019, finding 13,342 parcels either "known" or "likely" to use septic systems in the Sarasota County portion of SBEP watersheds — 5,251 parcels more than the FLWMI estimate (Table 4).

Many data on septic system locations are unverified and there are significant inconsistencies between FDOH and Sarasota County data. To address these shortcomings, local legislators filed bills in the State House and Senate in 2019 (HB 85 and SB 214) requiring FDOH to identify and map all septic systems in the state. Both bills failed to make it out of committee.

Use and Maintenance

There are no operation or maintenance requirements for septic systems in SBEP watersheds and no data exist to quantify how many systems are properly used and maintained. The only management tool currently available to encourage best practices is outreach and education. SBEP, Science and Environment Council, Sarasota County Government, University of Florida Institute of Food and Agricultural Science (UF/IFAS), and the USEPA provide limited outreach and education about septic system use and maintenance (see Community Engagement Action Plan).

In 2010, Florida recognized that voluntary maintenance of septic systems was not enough to ensure septic systems were operating in ways that protected public health and the environment. In response, the state adopted a statewide mandatory septic system evaluation and maintenance requirement. However, the state legislature repealed the law in 2012, arguing that it was an undue burden for septic system owners to ensure their systems were not threatening public health or the environment. In 2019, following severe episodes of blue-green algal blooms, macroalgal blooms, and red tide, local legislators introduced State House Bill 85 and Senate Bill 214 to require statewide septic system maintenance every five years, but both bills failed to make it out of committee. Later in the year, the State's Blue-Green Algae Task Force recommended that Florida develop and implement a septic system inspection and monitoring program to identify improperly functioning or failing systems (BGATF 2019).

Advanced Septic Systems and Conversion of Septic to Central Sewer Service

In areas near priority waterbodies or where groundwater levels no longer support proper drainfield treatment, septic systems can be upgraded with advanced nutrient-removal technologies or converted to central sewer service.

Advanced nutrient treatment technologies are now available for new system installations or retrofits of older systems. Technologies approved for use in Florida include in-ground nitrogen-reducing biofilters, nitrogen-reducing aerobic treatment units, or nitrogen-reducing Performance-Based Treatment Systems (FDOH May 2019). Florida now prohibits installation of new septic systems on lots of one acre or less in priority focus areas within Outstanding Florida Springs watersheds, unless they include advanced nutrient treatment. Although SBEP watersheds do not have Outstanding Florida Springs, SBEP Bays from Anna Maria Island to the Venice Inlet are classified as Special Outstanding Florida Waters. In 2019, Florida's Blue-Green Algae Task Force recommended extending the springs rule to include other vulnerable areas across the state. Until Outstanding Florida Waters are afforded the same protections as Outstanding Florida Springs, advanced nutrient-treatment upgrades to conventional septic systems in SBEP watershed remain voluntary. Outreach and education are important tools to promote these opportunities to property owners in areas where septic systems are underperforming or failing and where future central sewer service is unplanned (see Community Engagement Action Plan).

Converting underperforming or failing septic systems to central sewer is an effective strategy to reduce nutrient pollution from septic systems. In 2001, Sarasota County began the phased

conversion of septic to sewer service for about 14,000 parcels in the Phillippi Creek Watershed (Figure 3). Phillippi Creek is the largest tidal creek entering SBEP Bays – with seven miles of creek and over 100 miles of canals draining mostly residential and commercial development. As of December 2019, about 10,000 parcels have been converted. In 2019, Florida's Blue-Green Algae Task Force recommended legislation and funding for cost-effective septic to sewer programs (BGATF 2019). One caveat to septic to central sewer conversion is that if Advanced Wastewater Treatment is not used, the fate and impacts of high-nutrient reuse water must be considered.

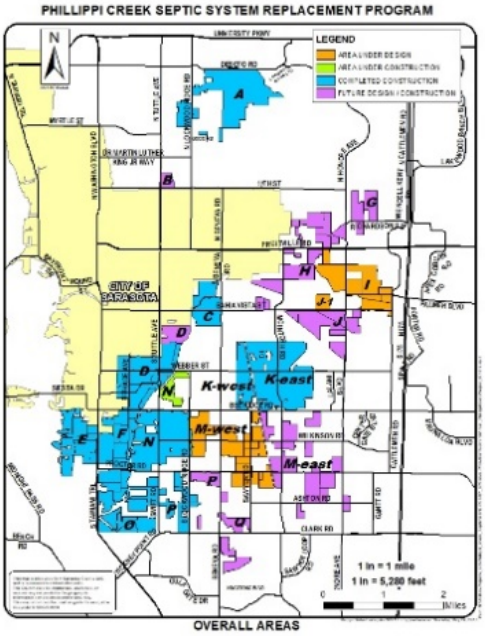


Figure 3. Phillippi Creek Septic Replacement Program is converting 14,000 parcels in the Phillippi Creek Watershed from septic to sewer service.

Priorities

SBEP and its partners recognize that conventional septic systems can be a source of nutrient pollution in coastal areas. We need to improve our understanding about the capacity of septic systems to treat nutrient pollution and pathogens under different site conditions, including potential impacts due to climate change. Existing septic systems should be inventoried and mapped. Regular inspection and maintenance of septic systems should be encouraged and those found to be underperforming or failing should be repaired or replaced. In priority areas, especially near SBEP Outstanding Florida Waters, septic systems should be converted to centralized sewer systems and small wastewater treatment plants should be consolidated. Where central sewer is unlikely to become available, conventional systems can be upgraded with advanced nutrient removal technologies.

1227 Strategy

Activity 5.1 Continue conversion of septic systems to centralized sewer systems and consolidation of small wastewater treatment plants, prioritized in coastal areas.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments; private utilities
Projected 5-Year Costs and Funding Sources: $$$$$/County & Municipal Governments
Location: SBEP priority watersheds and coastal areas

Activity 5.2 Encourage regular inspection and maintenance of septic systems and installation of supplemental and advanced septic system technologies, prioritized in coastal areas.

Timeframe: Ongoing
Collaborators: SBEP (Support); FDOH; FDEP
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP priority watersheds and coastal areas

Activity 5.3 Improve inventory and mapping of septic and other onsite sewage treatment and disposal systems and increase understanding about septic system capacity to treat nutrient pollution and pathogens under different site conditions, including climate change.

Timeframe: Ongoing; CCMP Monitoring Strategy complete in 202X
Collaborators: SBEP (Collaborate); FDOH; County & Municipal Governments
Projected 5-Year Costs and Funding Sources: $/County & Municipal Governments
Location: SBEP priority watersheds and coastal areas

1228

1229 Benefits

1230 Improving understanding and management of pollutant loading from septic systems and converting
1231 parcels from septic to sewer service will reduce pollutant loading from septic systems.

1232 5-Year Performance Metrics

1233 • Improved inventory of onsite sewage treatment and disposal systems.

1234 • Creation of a prioritized list of future septic to sewer service conversions.

WQQ Objective 6: Reduce pollutant loading from centralized wastewater collection, treatment, and disposal systems, including reuse.

Activity 6.1	*Support advanced wastewater treatment or better throughout SBEP watersheds, considering population growth, climate change, and opportunities for beneficial reuse.*
Activity 6.2	*Evaluate and manage impact of reuse storage and distribution on nutrient loading and hydrology, including reuse irrigation in population growth centers and siting of reuse ponds relative to bays and creeks. Develop management plans and BMPs to avoid overflows, releases, and excess nutrient loading.*
Activity 6.3	*Encourage proactive inspection, maintenance, and replacement of failing or underperforming sanitary sewer infrastructure to prevent inflow and infiltration, overflows, and spills. Support improved quantitative public reporting requirements for accidental and emergency sewage discharges.*
Activity 6.4	*Review detection and treatment methods for emerging contaminants and pollutants in wastewater such as endocrine disrupters, pharmaceuticals, and plastic microfibers.*

Background

Effective wastewater treatment is critical to ensure area waters meet their designated uses. In centralized wastewater treatment systems, wastewater is collected at its source and conveyed to a wastewater treatment facility (WWTF), treated, then disposed. Failure during any stage can release untreated or partially treated sewage containing bacteria, viruses, nutrients, pharmaceuticals, and other harmful pollutants and contaminants into the environment.

Wastewater Collection

Sanitary sewer systems collect sewage from its source and transport it through a series of gravity-fed pipelines, electrical lift stations, and force mains to a WWTF. Backups, spills, and overflows of untreated sewage can result from a variety of causes.

- Incursions of tree roots and disposal of improper items into drains or toilets, like diapers, wipes, dental floss, fats, oils, and grease can clog pipes and cause overflows.
- Rapid population growth, septic to sewer service conversion, or closing WWTFs and transporting wastewater to another WWTF can exceed original system capacity to treat and/or dispose of wastewater.
- Aging infrastructure deteriorates and eventually fails, resulting in spills and overflows.
- Construction activities can break or dislodge pipes, leading to spills.
- Groundwater and stormwater can enter the system by infiltration through defective, permeable, or broken pipes or by inflow through unauthorized connections. This excess

volume can overwhelm system capacity and cause backups, overflows, and emergency discharges, especially during heavy rainfall events.

- Storms and flooding can cause electrical failures at lift stations unequipped with battery backup devices, resulting in overflows.

Wastewater Treatment

WTTFs can utilize several treatment levels.

- **Primary treatment** mechanically removes solids, grease, and oils.
- **Secondary treatment** uses microbes to reduce soluble organic matter, then disinfects the remaining water.
- **Tertiary, or Advanced wastewater treatment (AWT)** further reduces impurities, including nutrients like nitrogen and phosphorus. AWT treatment techniques can include biological treatment, filtration, carbon absorption, distillation, and reverse osmosis.

Additional technologies are being developed elsewhere to remove pharmaceuticals, endocrine disruptors, or other harmful chemicals that can survive primary, secondary, and advanced treatment. The suitability of these technologies should be evaluated for WWTFs operating in or providing reuse water to SBEP watersheds.

Nutrient concentrations in treated wastewater are regulated by the state according to treatment level (Table 5). Florida requires a minimum of secondary treatment before disposal. To protect select waterbodies, Florida requires wastewater to be treated to AWT standards before it can be discharged into Sarasota Bay, Little Sarasota Bay, Roberts Bay, or "...into any river, stream, channel, canal, bay, bayou, sound, or other water tributary thereto..." as well as other waterbodies in Southwest Florida (Grizzle-Figg Act 1987, F.S. 403.086). Further, the Act requires that discharges, even of AWT effluent will not by itself cause considerable impacts to Outstanding Florida Waters or to other waters, substantially impact an approved shellfish harvesting area or water used as a domestic water supply, or seriously alter the natural fresh-salt water balance of the receiving water after reasonable opportunity for mixing.

Table 5. State of Florida standards for total nitrogen (TN), total phosphorus (TP), biological oxygen demand (BOD), and total suspended solids (TSS) in treated wastewater effluent, according to treatment level. Standards are annual averages and are regulated by Florida Statute F.S. 403-086. (https://www.flsenate.gov/laws/statutes/2012/403.086)

	Wastewater Treatment Level	
Contaminant	Advanced	Secondary
TN	3 mg/L	N/A

TP	1 mg/L	N/A
BOD	5 mg/L	20 mg/L
TSS	5 mg/L	20 mg/L

Disposal of Treated Biosolids and Wastewater

End products of wastewater treatment include treated biosolids and wastewater effluent. Subject to regulation, biosolids can be used as a fertilizer or soil amendment on farms and ranches, forest lands, public parks, or land reclamation projects, though none are applied to lands in SBEP watersheds. Depending on treatment level, effluent can be discharged into surface waters, injected into underground wells and aquifers, released to infiltration basins and spray fields, or reclaimed for beneficial reuse.

Emerging Contaminants and Pollutants of Concern

Endocrine disrupters, pharmaceuticals, and microplastics can negatively impact living things. Many of these contaminants and pollutants persist through treatment in WWTFs and pollute the environment following disposal (Murphy *et al.* 2016, Kostich *et al.* 2013, Sunn *et al.* 2019, Conley *et al.* 2019, Estahbanati and Fahrenfeld 2016). More research is needed to improve detection and treatment methods for these emerging contaminants and pollutants, and to better understand their environmental and human impacts (Barber *et al.* 2012).

Climate Change Vulnerabilities

SBEP completed a climate vulnerability analysis of its CCMP goals in 2017, concluding that climate stressors will further strain aging wastewater infrastructure in SBEP watersheds (SBEP and Shafer 2017). Projected increases in storm intensity will likely increase capacity challenges for sanitary sewer infrastructure, resulting in additional backups, overflows of untreated or partially treated wastewater, or emergency discharges at WWTFs. More intense rainfall events will present further challenges to reuse storage ponds that already regularly exceed capacity during the summer rainy season. Rising sea levels will likely elevate groundwater levels and increase infiltration into wastewater conveyance pipes, corrode infrastructure, and alter the effectiveness of wastewater treatment. Impacts due to increased loading of harmful nutrients, bacteria, and viruses in wastewater will be compounded by warmer temperatures (Lovett 2010). Due to these vulnerabilities and others, climate stressors must be considered when planning new or retrofitting existing wastewater infrastructure.

Status

Under Florida's Public Notice of Pollution Act (effective July 1, 2017) all reportable pollution release events require public notice within 24-hours of the incident. Between July 1, 2017 and November 11, 2019, 292 releases were reported in Sarasota and Manatee Counties — more than one every

three days. The public notice database can be improved by creating specific fields for details like number of gallons spilled and recovered, spill quality (raw, partially treated, or reuse quality), and estimates of the unrecovered pollution load of bacteria, nitrogen, and phosphorus.

SBEP partners have adopted deep-well injection, along with increased wet weather storage ponds, as a strategy for eliminating discharges of treated wastewater to surface waterbodies. This technology uses injection wells to transfer treated wastewater effluent into deep geologic formations that are confined vertically by impermeable layers. The impermeable layers prevent migration of pollutants or contaminants into potable water supplies. For example, in 2015, the City of Sarasota built a $6 million deep-well injection facility to divert regular surface water discharges of treated wastewater into Hog Creek and Whitaker Bayou.

[CALLOUT BOX: Wastewater Treatment and Storage Upgrades in SBEP Watersheds]

- Manatee County upgraded its advanced-secondary treatment Southwest Regional Water Reclamation Facility (SWRWRF) in 2017 to include a modified process that reduces TN levels below an average 8.5 mg/l – about a 40% reduction. The process removes biological oxygen demand, ammonia, and nitrate plus nitrite.
- Manatee County completed construction of a 15-million-gallon recharge well at SWRWRF that provides additional wet weather disposal capacity in the reuse system.
- Manatee County added another 10-million-gallon reuse water storage tank and a high service pump station in support of the Manatee County Agricultural Reuse System (MARS). The system connects the County's three regional WWTFs and is designed to supply up to 30 million gallons per day of reuse water for agricultural, residential, and residential users.
- Sarasota County, with matching funding from SWFWMD, built supporting infrastructure for an Aquifer Storage and Recovery (ASR) well at the Central County Water Reclamation Facility, which allows for underground storage of reuse water during periods of wet weather when irrigation demand is low.
- Sarasota County eliminated its last regular surface water discharge of treated wastewater in 2018 when it decommissioned the Siesta Key advanced WWTF. Collection infrastructure, including eight miles of force main, a master pump station, and a booster pump station, was built to transfer wastewater from the island to the larger Bee Ridge advanced-secondary WWTF on the mainland.
- Sarasota County is obligated to improve its Bee Ridge WWTF to AWT levels by 2025.
- The City of Sarasota improved treatment performance at its AWT WWTP to achieve 1.65 mg/L total nitrogen and 0.42 mg/L total phosphorus in its reuse water, exceeding requirements for AWT and meeting Florida's numeric nutrient criteria for freshwater streams. The City of Sarasota eliminated regular surface water discharges of treated wastewater into Whitaker Bayou, resulting in about a 20% reduction in TN loading to Big Sarasota Bay. The City is also constructing a large lift station in Lukewood Park to service one third of the city's wastewater.

Priorities

Addressing causes of wastewater spills and overflows through regular inspection and maintenance, capital improvement projects, education, and enforcement are management priorities in SBEP watersheds.

The City of Sarasota adopted a Climate Vulnerability Analysis of 34 city-owned wastewater assets and identified seven as being most vulnerable to future climate conditions. The plan, which is the first climate vulnerability assessment of infrastructure in SBEP watersheds, identified high-level strategies for protecting and preserving those assets. SBEP supports conducting similar climate vulnerability analyses for all wastewater assets in Sarasota and Manatee County that are potentially vulnerable to future climate conditions.

Since 2013, Sarasota County's Bee Ridge WWTF has periodically discharged treated wastewater containing up to 20 mg/L of TN into Phillippi Creek, a protected tributary of Roberts Bay. These discharges have exceeded 760 million gallons of non-AWT effluent (Stantec 2019). The County is obligated to upgrade the facility to AWT by 2025, which will improve options for treated wastewater disposal, decrease nitrogen loading in watersheds where reuse is applied, and reduce loading to Phillippi Creek in the event emergency discharges are required. In the short term, the County is

- Evaluating and implementing wastewater collection system improvements to divert wastewater flows from the Bee Ridge facility to the Central County WWTF.
- Evaluating and implementing improvements to transfer excess reclaimed water from the Bee Ridge facility to an existing deep injection well at the Central County WWTF.
- Enhancing efforts to reduce infiltration and inflow of groundwater and stormwater into the treatment system.
- Planning to construct two 18-million-gallon per day aquifer recharge wells at the site.

Because beneficial reuse of treated wastewater for irrigation can reduce demand on surface water and groundwater sources, SWFWMD, Sarasota and Manatee Counties, and local municipalities promote reuse for water conservation. However, since most WWTFs that affect SBEP watersheds only accomplish secondary treatment, there is a need to assess the quantity and fate of nutrients in non-AWT reuse irrigation water and their consequences for water quality. For example, communities and golf courses are generally unaware of the need to offset their fertilizer use with the nutrient content of reuse water irrigation. Moreover, use of non-AWT reuse water for irrigation during the summer may diminish the effectiveness of local fertilizer ordinances, which prohibit the summer application of fertilizers containing nitrogen and phosphorus. During periods of heavy rainfall, demand for reuse water declines, causing storage challenges at wastewater reclamation facilities and emergency releases of high nutrient reuse water (especially from non-AWT WWTFs).

Whether direct from emergency release and overflows or indirect from irrigation, non-AWT reuse water can result in significant nutrient loading to waterbodies. One solution is to upgrade all

WWTFs to AWT. WWTFs operating both inside and outside of SBEP watershed boundaries can impact SBEP bays if they are connected to reuse water distribution systems that cross watershed boundaries (insert Map of reuse water lines and facilities from SWFWMD). The largest WWTFs that can supply reuse water to SBEP watersheds by local or regional reuse distribution systems include the Manatee SW, Manatee County SE, City of Bradenton, City of Sarasota, Bee Ridge, and Sarasota County Central WWTFs. Of these, only the City of Sarasota and City of Bradenton WWTFs produce reuse water equal to or better than AWT.

Since its first CCMP, SBEP has asserted that all wastewater in Sarasota Bay watersheds should be treated to AWT standards before effluent reaches bays or tributaries (SBEP 1995), consistent with the intent of the Grizzle-Figg Act (FS 403.086). This remains a top management priority.

Strategy

Activity 6.1 Support advanced wastewater treatment or better throughout SBEP watersheds, considering population growth, climate change, and opportunities for beneficial reuse.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments
Projected 5-Year Costs and Funding Sources: $/SBEP (320); $$$$$/County & Municipal Governments
Location: SBEP watersheds

Activity 6.2 Evaluate and manage impact of reuse storage and distribution on nutrient loading and hydrology, including reuse irrigation in population growth centers and siting of reuse ponds relative to bays and creeks. Develop management plans and BMPs to avoid overflows, releases, and excess nutrient loading.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate); County & Municipal Governments; FDEP
Projected 5-Year Costs and Funding Sources: $$$/County & Municipal Governments; FDEP
Location: SBEP watersheds

Activity 6.3 Encourage proactive inspection, maintenance, and replacement of failing or underperforming sanitary sewer infrastructure to prevent inflow and infiltration, overflows, and spills. Support improved quantitative public reporting requirements for accidental and emergency sewage discharges.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments; FDOH; FDEP

Projected 5-Year Costs and Funding Sources: $/SBEP (320); $$$/County & Municipal Governments; FDOH; FDEP
Location: SBEP watersheds

Activity 6.4 Review detection and treatment methods for emerging contaminants and pollutants in wastewater such as endocrine disrupters, pharmaceuticals, and plastic microfibers.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate/ Conduct); FDEP, FDOH; Universities; USEPA
Projected 5-Year Costs and Funding Sources: $$/FDEP, FDOH; Universities; NOAA
Location: SBEP watersheds

Benefits

Reducing spills and overflows from failing or underperforming centralized wastewater infrastructure, converting WWTPs to advanced treatment, and improving detection and treatment methods for emerging contaminants will reduce pollutant loading from centralized wastewater collection, treatment, and disposal systems, including reuse.

5-Year Performance Metrics

Updated pollutant loading model for SBEP bays

WQQ Objective 7: Improve understanding of pollutant loading from atmospheric nitrogen deposition.

Activity 7.1	*Evaluate air quality monitoring network and programs to quantify sources, pathways, and contribution of direct and indirect atmospheric deposition to area waters.*
Activity 7.2	*Support initiatives to reduce emissions from vehicles, landscape maintenance equipment, and other mobile sources.*

Background

Airborne nitrogen compounds in the form of nitrogen oxides and ammonia are a significant source of nutrient pollution to watersheds and bays. Atmospheric nitrogen can be deposited directly onto waterbodies or indirectly by deposition on the watershed and conveyed to waterbodies by stormwater or groundwater. It can be deposited as gas and dust (dry deposition) or rain (wet deposition). Natural sources of reactive atmospheric nitrogen include emissions from wild animal waste, lightning, forest fires, and soils; anthropogenic sources include emissions from fertilizer application, human and livestock waste, and fossil fuel combustion by power plants, vehicles, and outdoor power equipment. Mobile sources of nitrogen oxides like cars and landscape machinery create emissions close to the ground, which can contribute four times more nitrogen deposition to the local watershed than regional power plants that release nitrogen from tall stacks (Poor *et al.* 2013b).

Total CO_2 emissions from driving in the Sarasota-Bradenton metro area are up 61% since 1990 (Gately *et al.* 2019). Boat engines and gas-powered outdoor equipment emit even more pollution per use than automobiles. For example, operating a gas-powered leaf blower for thirty minutes creates the equivalent nitrogen emission of driving a Ford F-150 truck more than 68 miles (Kavanagh 2011). Florida has the highest per capita emissions from gas-powered outdoor equipment compared to California, Illinois, New York, and Texas (Banks 2015). Moreover, Florida has been called the “boating capital” of the United States, with 44,000 registered vessels in Manatee and Sarasota Counties generating emissions at the water’s surface.

The proportion of nitrogen loading due to atmospheric deposition varies widely among locales, with estimates as high as 75% of total nitrogen loading for bays in the northeastern US (Howarth 2008) although estimates from Tampa Bay are that atmospheric deposition comprises between 20 to 32% of nitrogen loads to that well-studied system (TBEP 2003). Atmospheric deposition’s portion of nitrogen loads to Tampa Bay have declined over time, perhaps related to recent improvements in air quality, as indicated below for Sarasota Bay.

Status

Monitoring atmospheric nitrogen deposition is fundamental to estimating atmospheric nitrogen loading to area waters. The existing air quality monitoring network in Sarasota and Manatee Counties was predominately designed to monitor air quality for protecting human health. As a result, existing monitoring stations are not optimally sited for monitoring nitrogen deposition on watersheds of priority waterbodies or deposition directly on the waterbodies themselves.

Two monitoring networks have air quality monitoring stations in Sarasota and Manatee Counties. The *National Atmospheric Deposition Program* is a cooperative among federal, tribal, state, and local government agencies, educational institutions, private sector, and non-governmental agencies that monitors rainfall chemistry. The Program includes one station located at the Verna Wellfields in northeastern Sarasota County, where records of nitrate concentration, equivalents, wet deposition, and other pollutants have been maintained since 1983. The station is located in a remote area of the County away from heavy traffic, where data indicate that annual weighted mean atmospheric nitrate concentration has been generally declining since the 1980s (Figure 4). Wet nitrogen deposition peaked during the early to mid-90s, declined until 2012, then began rising again (Figure 5), perhaps due to the finding that precipitation at the station has increased since around 2006. Because Verna Wellfields is located in a remote area of the County away from heavy urbanization and outside of SBEP watersheds, it is not an ideal indicator of atmospheric deposition onto SBEP watersheds or bays.

Figure 4. Annual weighted mean atmospheric nitrate concentration at the Verna Wellfields station in Northeast Sarasota County. Trend line represents a three-year moving average with a one-year time step. Graph source: http://nadp.slh.wisc.edu/data/ntn/plots/ntntrends.html?siteID=FL41

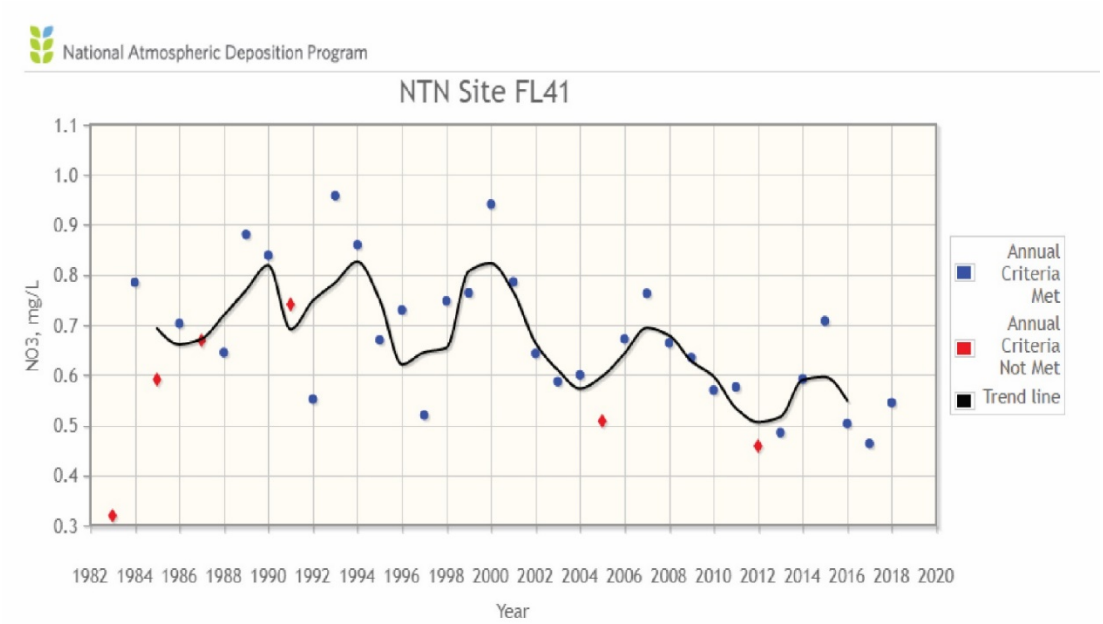
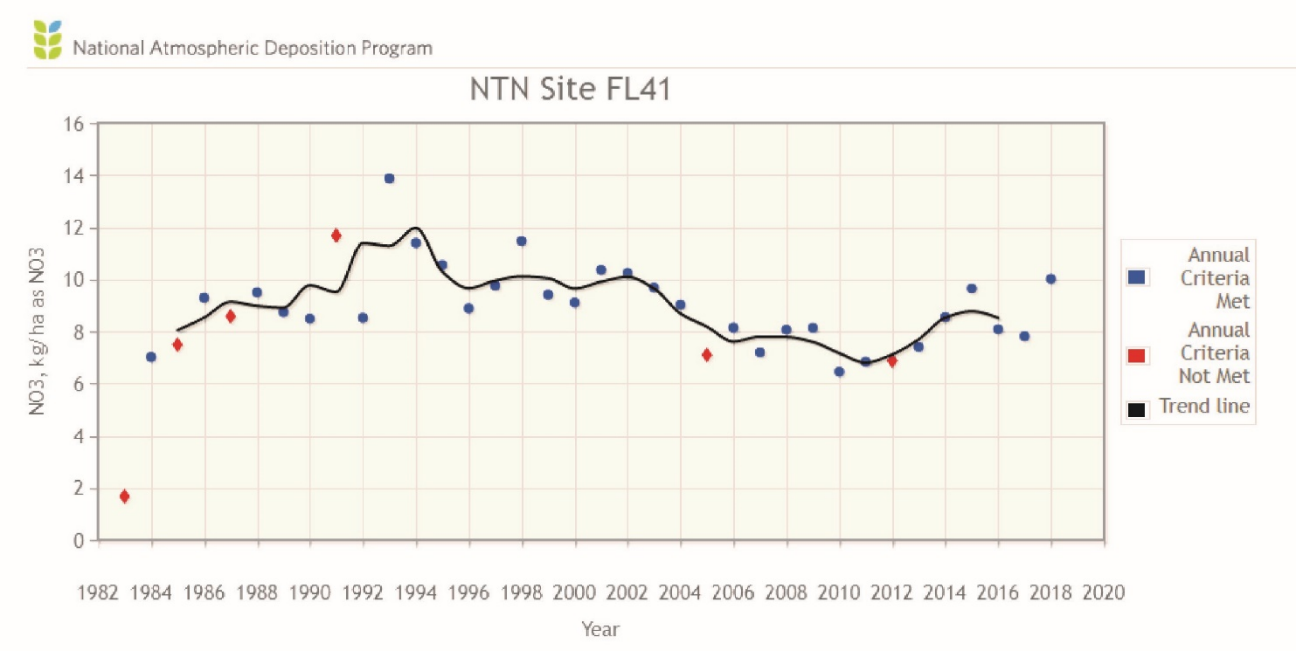


Figure 5. Annual weighted mean atmospheric nitrate deposition at the Verna Wellfields in Northeast Sarasota County. Trend line represents a three-year moving average with a one-year time step. Graph source: http://nadp.slh.wisc.edu/data/ntn/plots/ntntrends.html?siteID=FL41



Florida's Ambient Air Quality Monitoring Program is coordinated by FDEP. The Program includes 100 monitoring sites across the state to assess progress in maintaining and improving air quality, understand temporal variations in air pollutants, and evaluate pollution exposure by individuals and the environment (FDEP 2019). The Program includes four air quality stations in Sarasota County (Paw Park on 17th Street in Sarasota, Lido Park, Bee Ridge Park, and Jackson Road in Venice) and four in Manatee County (G.T. Bray Park, 39th Street Park in Bradenton, and two at Port Manatee). None currently monitor nitrogen oxide concentrations or deposition. Monitoring of atmospheric nitrogen concentration was terminated at the Paw Park site in summer 2019.

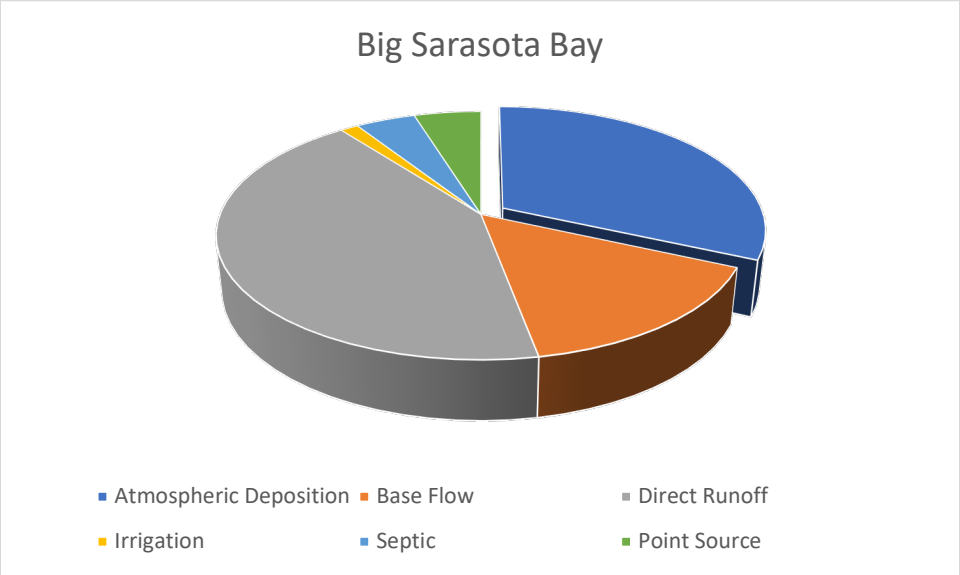
Understanding atmospheric nitrogen loading to SBEP bays is limited by lack of an air quality monitoring program dedicated to that goal. Janicki (2010) calculated direct wet and dry nitrogen deposition onto SBEP bay segments using atmospheric nitrogen wet deposition data from Verna Wellfields, together with a dry:wet ratio calculated for Tampa Bay (Poor et al 2000, Pribble *et al.* 2001) and local rainfall estimates. The relative contribution of direct atmospheric nitrogen deposition, compared to other sources or conveyances, varied significantly among SBEP bay segments (Table 6). The relative contributions of direct and indirect deposition on bays are dependent, in part, on the proportional surface area of the bay compared to its watershed. For Big Sarasota Bay, direct nitrogen deposition to the bay accounted for almost 32% of nitrogen loading. This analysis underestimates nitrogen loading due to total atmospheric deposition because it only

measures direct deposition and excludes measures of indirect deposition, where nitrogen is deposited onto the watershed and conveyed to bays via stormwater. In the analysis, indirect atmospheric nitrogen deposition is aggregated with other sources of nitrogen loading measured as direct runoff. Considering this, total contributions of atmospheric nitrogen deposition to SBEP bays can be significant.

Table 6: Relative contribution (%) of each nitrogen load type to the 2008 loads to each SBEP bay segment. Source: Janicki *et al.* 2010.

Load Type	Blackburn Bay	Little Sarasota Bay	Palma Sola Bay	Roberts Bay	Big Sarasota Bay
Atmospheric Deposition	4	15.6	20.4	2.3	31.7
Base Flow	21.9	25	19.4	27.6	15.3
Direct Runoff	59.8	56	49.5	59.2	42.5
Irrigation	1.7	2.3	2.3	2.5	1.3
Septic	12.6	1.1	8.4	4.1	4.3
Point Source	0	0	0	4.3	4.8

Figure 5: Relative contribution (%) of direct atmospheric nitrogen deposition to the 2008 nitrogen loads for Big Sarasota Bay. Nitrogen loading due to indirect atmospheric nitrogen deposition on the watershed of Big Sarasota Bay is aggregated with other nitrogen loading sources in the direct runoff category. Data source: Janicki *et al.* 2010.



Priorities

Establishing an air quality monitoring program to track nitrogen deposition in SBEP watersheds and bays would be an important investment for understanding and monitoring the contribution of nitrogen loading in SBEP waters.

SBEP supports initiatives to reduce emissions from vehicles, landscape maintenance equipment, and other mobile sources to reduce atmospheric nitrogen deposition on its watersheds and bays. Education and outreach about the relationship between fossil fuel combustion and water quality would be an important tool for reducing locally generated nitrogen emissions from mobile sources. There are also co-benefits to reducing fossil fuel emissions for public health, especially around vulnerable populations, and for climate change mitigation.

Strategy

Activity 7.1 Evaluate air quality monitoring network and programs to quantify sources, pathways, and contribution of direct and indirect atmospheric deposition to area waters.

Timeframe: CCMP Monitoring Strategy in 202X
Collaborators: SBEP (Coordinate); County & Municipal Governments; FDOH, FDEP
Projected 5-Year Costs and Funding Sources: $$/SBEP (320); FDEP
Location: SBEP waterbodies and watersheds

Activity 7.2 Support initiatives to reduce emissions from vehicles, landscape maintenance equipment, and other mobile sources.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments; FDEP
Projected 5-Year Costs and Funding Sources: $/SBEP (320); County & Municipal Governments; FDEP
Location: SBEP waterbodies and watersheds

Benefits

Improving understanding of pollutant loading from atmospheric deposition will improve management of water quality in SBEP watersheds and bays.

5-Year Performance Metrics

Literature review/analysis of atmospheric nitrogen deposition

WQQ Objective 8: Support measures to better understand, monitor, report, respond to, recover from, mitigate, and reduce harmful algal blooms.

Activity 8.1	*Support development of coordinated, standardized tools for monitoring and reporting on HABs, evaluating their impact on the environment, economy, and human health, and improving capacity to prepare for, respond to, and recover from them.*
Activity 8.2	*Support research and monitoring to better understand the taxonomic composition, toxicity, severity, extent, and duration of HABs, and the role nutrient sources and climate change play in bloom initiation, growth, maintenance, and termination.*

Background

Algae are an informal, diverse group of unicellular (microalgae) and multicellular (macroalgae) organisms. They can live in fresh, salt, or brackish waters and derive energy through photosynthesis, though some can use external energy sources. Algae are a critical part of the estuarine food web that produce oxygen and provide habitat and forage area for numerous organisms. Under favorable conditions, including high temperature, light, pH, and availability of nutrients like nitrogen and phosphorus, algae can multiply quickly and form blooms. Harmful algal blooms (HABs), defined as those algal blooms with measurably detrimental effects to humans and ecosystems, can reduce available sunlight for seagrasses, smother aquatic vegetation and hardbottom habitats, degrade water quality, and kill aquatic invertebrates, fish, seabirds, turtles, and marine mammals (Zanchett and Oliveira-Fiho 2013). When blooms die and decay, oxygen can be depleted in surrounding waters, causing additional mortality and adding nutrients to sustain the bloom. In addition to environmental impacts, HABs can impact human recreation, economic activity, and health. These impacts threaten coastal ecosystems and communities throughout Southwest Florida.

HABs have increased in frequency, extent, and duration throughout the world's waters, often in response to increased temperatures due to climate change and anthropogenic (human-caused) nutrient pollution (Gilbert 2020). Climate change is expected to further increase their impacts due to reduced oxygen solubility, increased water column stratification, variable salinity, increased acidity, and more intense precipitation events washing nutrients into waterways (O'Brien *et al.* 2016, SBEP and Shafer 2017).

SBEP waterbodies are impacted by red tide and blooms of cyanobacteria and macroalgae.

Red Tide

Florida red tide, formed by the dinoflagellate *Karenia brevis,* is a common saltwater HAB in Southwest Florida. *K. brevis* typically exists in low concentrations throughout the Gulf of Mexico, grows slowly, and can utilize low concentrations of a broad range of organic and inorganic nutrients (Geesey and Tester 1993). *K. brevis* blooms are believed to initiate in low-nutrient deep-water environments 10–40 miles offshore, where blooms can be sustained by recycling or regenerating nutrients. Blooms can be transported inshore by currents and winds and maintained or intensified by nutrients, including those from land-based runoff and decomposing marine life. *K. brevis* produces neurotoxins called brevetoxins that can bioaccumulate and kill fish, seabirds, turtles, and marine mammals. In humans, aerosols of the toxin can cause eye, nose, and throat irritation and more serious consequences for people with existing respiratory issues, like asthma (Kirkpatrick *et al.* 2004). Eating shellfish impacted by *K. brevis* can also result in neurotoxic shellfish poisoning. The 2017–2019 west Florida red tide bloom lasted 15 months and decimated marine life. By January 2019, Manatee and Sarasota Counties had removed a total of 571 tons of dead sea life from their beaches and waterways. Throughout West Florida, FWC and NOAA reported that over 589 sea turtles, 213 manatees, and 127 bottlenose dolphins were killed during the bloom. Impacts to beachgoers, boaters, charters, and fishers were significant with Visit Sarasota County reporting declines in hotel occupancy of 11.3 percent during the last three months of 2018 — the largest decline during that period since the September 11, 2001 terrorist attacks. Photographs and reports of dead and rotting sea life from SBEP Bays were featured in national news across the country, including the New York Times, Washington Post, USA Today, CNN, Fox News, and National Geographic.

Although red tide has historically impacted Florida's west coast, Brand and Compton (2007) analyzed a HAB database compiled by FWC (Haverkamp *et al.* 2004), reporting that *K. brevis* was 13 to 18 times more abundant in the 1994–2003 time period than it was in 1954–1963, and that it was approximately 20 times more abundant within 5 km of the shoreline than 20-30 km offshore. They attributed the increase to human population growth and associated nutrient pollution. FWC has cautioned that limitations in their database (reviewed in Alcock 2007) make it inappropriate for determining if red tide has increased in frequency or severity over the past 60 years. However, recent research by Medina *et al.* (2020) concluded that "...anthropogenic nitrogen runoff facilitated the growth of *K. brevis* blooms near Charlotte Harbor and suggest that bloom events would be mitigated by nitrogen source and transport controls..."

Others have advised that singling out one unique cause may be oversimplified, citing complex bloom dynamics, multiple nutrient sources, and the importance of regenerated nitrogen in supporting red tide (Heil *et al.* 2014). Current understanding of red tide suggests that it may be impossible to altogether eliminate its periodic recurrence in Southwest Florida, though the successful nutrient management efforts could potentially decrease the intensity and duration of blooms once they start by reducing the availability of anthropogenic nutrient pollution in nearshore waters (*i.e.*, Alcock 2007, Paerl *et al.* 2008, Heil *et al.* 2014).

Cyanobacteria Blooms

Both freshwater and saltwater species of cyanobacteria (blue-green algae) generate HABs in Florida and about 20 species in the genera *Microcystis*, *Cylindrospermopsis*, *Anabaena*, *Aphanizomenon*, *Lyngbya*, and *Planktothrix* can produce toxins (Rastogi *et al.* 2015).

Lyngbya majuscula is a common saltwater filamentous cyanobacteria in SBEP bays that can create dense mats along the bay bottom, smothering oyster reefs and seagrasses. Sometimes mats can produce so much oxygen during photosynthesis that they dislodge, float to the surface, and wash ashore. Rotting *Lyngbya* blooms degrade water and shoreline habitat quality, diminish dissolved oxygen, and impact human shoreline uses. Impacts to human health include dermatitis and respiratory distress. *Lyngbya* blooms usually occur in spring and summer in SBEP bays when waters are warmer, light input is more intense, and rains wash nutrient pollution off the watershed into the bay. Blooms of Lyngbya may be increasing in Florida (Paerl *et al.* 2008, Arthur *et al.* 2009). A prominent *Lyngbya* HAB in the spring of 2019 garnered significant attention by the community.

Lyngbya blooms are stimulated by over-enrichment of nitrogen and phosphorus, and in the presence of iron can also convert inert atmospheric nitrogen into a bioavailable form (Arthur *et al.* 2009, Paerl *et al.* 2008). Reducing the availability of inshore anthropogenic nutrient pollution is likely the best strategy for reducing *Lyngbya* HABS in SBEP bays (Paerl *et al.* 2008).

Microcystis is a genus of freshwater cyanobacteria that release toxins called microcystins. Released upon cell death, these toxins can persist in the water for weeks to months and negatively impact all aquatic trophic levels. The toxins can also bioaccumulate in animals and be transferred to humans (Smith and Haney 2006, Zanchett and Oliveira-Filho 2013). Pathways of human exposure include consuming fish and shellfish with high concentrations of microcystin in tissues, swallowing, skin contact, and inhalation of contaminated water. Microcystins can cause acute abdominal pain, headache, nausea, and vomiting and serious damage to liver, intestines, brain, kidney, lung, heart, and reproductive tissues (Massey *et al.* 2018). Microcystins are listed on the USEPA's third drinking water Candidate Contaminant list (USEPA 2014). The International Agency for Research on Cancer has classified Microcystin-LR as a possible human carcinogen.

Macroalgae Blooms

Nuisance blooms of macroalgae impact aquatic ecosystems by diminishing sunlight to seagrasses, depleting dissolved oxygen when they die and rot, and smothering benthic habitat. Macroalgae also contributes to beach wrack, which in excessive amounts can decay and increase bacteria loads in nearby waters. Nutrient pollution is a primary cause for macroalgal blooms in SBEP Bays.

SBEP commissioned a study of macroalgae at 11 sites in SBEP bays between 2009-2011 (LaPointe 2012). Benthic macroalgae were analyzed for nitrogen isotopes and carbon to nitrogen ratios to identify potential nitrogen sources feeding blooms. Study results pointed to sewage-derived nitrogen and rainfall as drivers of development of blooms of two common genera of macroalgae, *Gracilaria* and *Ulva*.

Seagrass Epiphytes

A multitude of sessile species settle and live on seagrass blades. Seagrass epiphytes include algae, bacteria, sponges, bryzoans, tunicates, crustaceans, and mollusks. Increased nutrient availability has been shown to increase epiphyte loading on seagrass (Jensen and Gibson 1986, Tomasko and Lapointe 1991, Nelson 2017), which can reduce light availability for photosynthesis and degrade seagrass health. Epiphyte loads in Sarasota Bay appear to be steadily increasing since 2013 (Sarasota County 2018; [insert Figure 5 from report).

Status

Monitoring

Florida's DEP tracks cyanobacteria blooms, reviews citizen reports of algal blooms, and coordinates sampling among other agencies. FWC tracks red tide events, provides status reports, and coordinates routine and event-response monitoring with state agencies, local governments, Mote Marine Laboratory, and private citizens.

Complementary efforts include:

- *Collaboration for Prediction of Red Tides:* FWC provides red tide data to the USF College of Marine Sciences, which forecasts red tide movement using the West Florida Shelf Regional Ocean Modeling System.
- *USF Optical Oceanography Laboratory:* USF processes NASA and NOAA data to provide bloom maps to FWC to assist them in directing sampling efforts and bloom assessments.
- *Harmful Algal Bloom Observing System (HABSOS)*: FWC provides data to NOAA's HABSOS, a system used to visualize blooms and changes in environmental conditions.
- *Beach Conditions Reporting System*: Mote Marine Laboratory reports information about red tide-related respiratory irritation and dead fish at local beaches.
- *Harmful Algal Bloom Operational Forecast System*: FWC provides data to NOAA's Harmful Algal Blooms Operational Forecast System (HAB-OFS), which publishes information bulletins.

SBEP has hired an intern to lead the citizen science Eyes on Seagrass Project, which will monitor seagrass coverage in SBEP bays.

Policy Initiatives

The 2016–2019 occurrence of prolonged and highly destructive blue-green HABs and red tide throughout Florida sparked public concern and support for improved nutrient management throughout the state. In response, Florida Governor Ron DeSantis issued Executive Order 12-12 in January of 2019 calling for expedited action to protect and restore waterbodies of the state. The governor's new budget prioritized increased research and a focus on science. The State created the Blue-Green Algae Task Force to provide guidance and science-based recommendations for improving and restoring Florida's water bodies that have been adversely affected by blue-green HABs and reactivated the state's Harmful Algal Bloom/Red Tide Task Force, which will help

determine strategies to research, monitor, control, and mitigate rede tide and other HABs in Florida waters. The governor also signed SB 1552 launching the Florida Red Tide Mitigation and Technology Development Initiative as a partnership between FWC and Mote Marine Laboratory to develop technologies and approaches to control and mitigate red tide and its impacts.

The 2021 Florida Macroalgae Workshop, an initiative of the Florida Estuaries Alliance, the Southwest Florida Water Management District, Florida Sea Grant, the St. Johns River Water Management District, and Harbor Branch Oceanographic Institute, convened stakeholders in March and April 2021 to discuss the state of current knowledge about macroalgae blooms in Florida estuaries. Participants identified priority research and data gaps. The workshop steering committee is now working to develop a workshop synthesis report containing recommended next steps for macroalgae monitoring, research, and management in Florida estuaries.

Priorities

SBEP will continue to work with partners to reduce HAB impacts by reducing nutrient pollution in its watersheds (see WQQ Objectives 4–6) and delivering educational information about HABs through its website and other outreach efforts (see Community Engagement Action Plan). SBEP supports research and monitoring to better understand the species composition of blooms and to better track and forecast their severity, extent, and duration. In addition, SBEP recognizes the need to understand the role that various nutrient sources play through time and space in bloom initiation, growth, maintenance, and termination, especially for red tide.

There is a critical need to continue monitoring macroalgae in SBEP bays to track species population dynamics, and to quantify the nutrient load tied up in macroalgae biomass. There is also a need to monitor freshwater and marine cyanobacteria in priority SBEP waters. Microcystins should be monitored in freshwaters approved for recreation.

In 2020, a Community Red Tide Impact and Response Assessment study was completed to improve understanding of red tide impacts and responses to future impacts (Shafer 2020a and Shafer 2020b). The study, conducted by the Science and Environment Council, developed a regionally-standardized Red Tide Community Impact Assessment Framework, identified data gaps, and applied that tool to document and report on select environmental, social, and economic impacts of the historic 2017–2019 Florida red tide event in TBEP and SBEP waterbodies and watersheds. The study also examined red tide response efforts by County and Municipal Governments and other agencies and organizations, identified gaps and opportunities, and generated recommendations for cost-effective, environmentally friendly, and regionally coordinated responses to red tide. The study aimed to improve the regions capacity to prepare for, respond to, and recover from HABs.

Strategy

Activity 8.1	Support development of coordinated, standardized tools for monitoring and reporting on HABs, evaluating their impact on the environment,

economy, and human health, and improving capacity to prepare for, respond to, and recover from them.

Timeframe: Ongoing; CCMP Monitoring Strategy in [202X
Collaborators: SBEP (Support); FWC; FDOH; FDEP; Florida Sea Grant; NOAA; Colleges & Universities; County & Municipal Governments; Mote Marine Laboratory; SWFWMD; TBEP; Science and Environment Council
Projected 5-Year Costs and Funding Sources: $$$$/SBEP (320); FWC; FDOH; FDEP; Florida Sea Grant; USF and UF; NOAA; Mote Marine Laboratory; SWFWMD; GCOOS; GOMA; FWC; TBEP
Location: SBEP waterbodies

Activity 8.2 Support research and monitoring to better understand the taxonomic composition, toxicity, severity, extent, and duration of HABs, and the role nutrient sources and climate change play in bloom initiation, growth, maintenance, and termination.

Timeframe: Ongoing; CCMP Monitoring Strategy in [202X
Collaborators: SBEP (Support); FWC; Florida Sea Grant; USF; Colleges & Universities; County & Municipal Governments; Mote Marine Laboratory; NOAA; GCOOS; FDEP
Projected 5-Year Costs and Funding Sources: $$$$$/SBEP (320); FWC; NOAA; FDEP; Florida Sea Grant; Colleges & Universities; Mote Marine Laboratory; SWFWMD; USACE
Location: SBEP waterbodies

Benefits

Improved knowledge about HABs and their impacts on environment, economy, and human health and improved capacity to prepare for, respond to, and recover from them will build public support for water quality improvement and habitat restoration and will increase human and ecosystem resilience to impacts from HABs.

5-Year Performance Metrics

- Improved coordination on HAB monitoring, reporting, and response
- Improved HAB communication tools.

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WATERSHED HABITATS ACTION PLAN

GOAL: Restore shoreline, wetland, and bay habitats and eliminate future losses

Introduction

The majority of the Greater Sarasota Bay Watershed has been altered by urban and agricultural development, leaving isolated natural and conservation areas with limited ecosystem function and services necessary for a healthy estuary and thriving fish and wildlife. The community vision for Sarasota Bay is abundant seagrass meadows teeming with fish and shellfish, well-developed oyster reefs filtering water and providing essential habitat for fish and birds, living vegetated coastal wetlands and shorelines filtering runoff and protecting the coast, a mosaic of uplands, freshwater wetlands, and tidal creeks supporting natural waterflow and habitat for fish and wildlife, and unimpeded vegetated dunes and sandy shorelines along Gulf beaches.

Sarasota Bay Estuary Program and its partners are making significant progress towards this vision of protecting and restoring the Sarasota Bay area's iconic ecosystems. Through water quality improvements (see Water Quality and Quantity Action Plan), total seagrass coverage has surpassed the restorable levels of the 1950s (SWFWMD) and live oysters are increasing in most tidal creeks (Meaux *et al.* 2016). Through protection and restoration, total coastal wetland acreage is stable (Leverone *et al.* 2017) and freshwater wetlands are increasing (SWFWMD). From 2014–2018, SBEP leveraged $12.6 million in public and private funds for 66 habitat restoration projects on over 1100 acres and 900 linear feet of shoreline (Table 1). Projects included beach and dune restoration, bird island habitat enhancement, oyster reef and artificial reef construction, coastal wetland restoration, exotic vegetation removal and native planting, prescribed burns, and land conservation. Every priority habitat type was improved, and eight projects from the most recent Habitat Restoration Plan (2016) have been initiated or completed.

Table 1. Habitat restoration projects completed 2014–2018.

Project Name	Number of Projects	Habitat Type	Acres	Feet
Beach and Dune Restoration				
Coquina Beach Dune Restoration	2	Beach & Dune	0.02	0
Bird Island Habitat Enhancement				
Oscar Sherer Park Habitat Restoration: Phase 3	1	Freshwater Shoreline	5.00	0
Perico Bird Rookery Island	1	Coastal Shoreline	16.00	0
Invasives Control/Removal - Vegetation				
Arlington Park exotic vegetation removal	2	Upland	2.00	0

FISH Preserve Habitat Restoration	1	Coastal Wetland	15.00	0
G.T. Bray Park Exotic Removal	1	Upland	1.00	0
Leffis Key Exotic Vegetation Removal	1	Beach & Dune	2.00	0
Jordyn Parcel Habitat Restoration	1	Upland	0.00	0
Leffis Key Preserve Exotic Species Management	1	Coastal Wetland	2.00	0
Neal Preserve Exotic Species Management	1	Coastal Wetland	10.00	0
Neal Preserve Exotic Species Removal	1	Upland	10.00	0
New College Native Plant Showcase	1	Upland	0.50	0
North Lido Preserve Australian Pine Removal	2	Beach & Dune	2.00	0
North Water Tower Park Exotic Removal	2	Upland	6.00	0
Orchid Oaks Environmental Enhancement	1	Freshwater Shoreline	4.00	0
Oscar Sherer Park Habitat Restoration: Phase 2	1	Freshwater Wetland	3.00	0
Palma Sola Scenic Highway Restoration	1	Coastal Shoreline	5.00	0
Palmer Point Exotic Vegetation Treatment	1	Coastal Shoreline	20.00	0
Perico Perimeter Berm Preserve Exotics Treatment	1	Upland	5.00	0
Perico Preserve Exotic Species Management	1	Coastal Wetland	40.00	0
Philippi Estate Park Exotic Removal	1	Coastal Wetland	1.00	0
Plymouth Harbor Peninsula Restoration Project	1	Coastal Wetland	0.30	0
Red Bug Slough Preserve exotic vegetation removal	1	Upland	1.00	0
Robinson Preserve Exotic Species Maintenance	3	Coastal Wetland	225.00	0
Robinson Preserve Expansion Exotics Removal	1	Upland	20.00	0
Sarasota Bay Watershed Exotic Management	1	Coastal Wetland	80.00	0
Save Our Seabirds Native Planting Project	1	Upland	0.20	0
Siesta Beach Exotic Treatment	1	Beach & Dune	20.00	0
South Gate Community Association Planting	1	Freshwater Shoreline	1.00	0
South Lido Beach exotic vegetation removal	1	Upland	2.00	0
Tom Bennett Park Exotic Species Control	3	Upland	55.00	0
Ungarelli Preserve Exotic Species Management	1	Coastal Wetland	2.50	0
Ungarelli Preserve Exotic Species Removal	2	Upland	8.50	0
Land Acquisition and Easements				
Siesta Key Tax Deed Lots Acquisition	1	Beach & Dune	1.08	0
Thaxton Preserve	1	Upland	287.00	0
555 Verna Road Land Acquisition	1	Upland	20.40	0
129 Bayview Lane Acquisition	1	Coastal Shoreline	1.15	0
Robinson/Perico Connector Property Acquisition	1	Coastal Wetland	15.52	0
Planting				
Emerson Point Preserve Native Planting	1	Coastal Shoreline	1.50	0
Jiggs Landing Native Vegetation Planting	1	Upland	0.20	0
New College of Florida Native Plantings	1	Coastal Shoreline	0.50	0
Sarasota Audubon Center Bioswale	1	Upland	0.00	75
Sherwood Forest HOA Planting	1	Freshwater Wetland	0.40	0
North Water Park Addition	1	Upland	6.20	0

Perico Preserve Native Planting	1	Coastal Wetland	40.00	0
Robinson Preserve Expansion Phase II-A	1	Coastal Shoreline	120.00	0
Sarasota Audubon Society Bioswale	1	Upland	0.00	100
Prescribed Burn				
Robinson Preserve Prescribed Fire Application	1	Upland	15.00	0
Sarasota Bay Watershed Prescribed Burning	1	Upland	25.00	0
Reef Construction - Artificial Materials				
Manatee County artificial reef deployments	1	Artificial Reef	2.00	0
Reef Construction - Natural Materials				
Robinson Preserve Oyster Habitat Creation	3	Oyster	0.30	200
Sarasota Bay 34th Street Oyster Habitat Creation	1	Oyster	1.00	0
Shoreline Stabilization/Enhancement				
Oscar Sherer Park Habitat Restoration: Phase 1	1	Freshwater Shoreline	0.00	250
Riverview High School shoreline restoration	1	Coastal Shoreline	0.00	200
Phillippi Creek Shoreline Demonstration Project	1	Freshwater Shoreline	0.00	75
Grand Total	**66**		**1102**	**900**

Action Plan Strategy

In this CCMP update, the SBEP Management Conference commits to six major objectives for the goal of restoring shoreline, wetland, and bay habitats and eliminating future losses.

- **Objective 1**: Update and implement the SBEP Five-Year Habitat Restoration Plan;
- **Objective 2**: Protect, enhance, and restore uplands and freshwater wetlands;
- **Objective 3**: Improve tributary habitats with a special emphasis on fisheries;
- **Objective 4**: Protect, enhance, and restore coastal wetlands and improve shoreline resiliency;
- **Objective 5**: Protect, enhance, and restore hard bottom and seagrass habitats; and
- **Objective 6**: Protect, enhance, and beaches and dunes for wildlife and resiliency.

WH Objective 1: Update and implement the SBEP Five-Year Habitat Restoration Plan.

Activity 1: Update the five-year Habitat Restoration Plan with consideration of resiliency strategies; and coordinate, track, and report progress metrics for habitat restoration.

In the highly altered landscape of the greater Sarasota Bay watershed, upland and wetland habitat restoration is an important component of improving the ecological health of Sarasota Bay. Even inland natural areas not adjacent to the bay play an important ecological role to support the natural hydrologic cycle of storing, infiltrating, and filtering stormwater and providing essential habitat for bay-associated fauna. These areas require protection and restoration to continue to provide essential ecosystem services to the area. SBEP developed the first Five-Year Habitat Restoration Plan (HRP) in 2004 to guide efforts of SBEP and its partners to identify, prioritize, and implement restoration projects throughout the bay and its watersheds.

In general, the site selection approach of the HRP recognizes that a watershed level habitat mosaic, in appropriate proportions, is necessary to maintain ecological health. Revisions to the original 2004 ranking criteria were made in successive 5-year plans (2010 and 2016) to encompass new regulatory and ecosystem management priorities, while providing flexibility to prioritize selected projects when funding opportunities arise. Fourteen site-scoring criteria cover logistical considerations and habitat balance considerations, and support the following restoration objectives:

- Essential habitat restoration and/or creation;
- Water retention and water quality improvements; and
- Historic habitat restoration and/or preservation.

The site selection approach prioritizes sites where essential habitat, defined as habitat with physical and biological features that are vital to a species' existence, can be protected, restored, or enhanced. For example, low-salinity zones in creeks or complex prop root structure of mangroves are essential for the juvenile stages of many fish. Restoring connectivity by removing or retrofitting impassable culverts, installing road under-crossings for wildlife, or planting vegetated wildlife corridors promotes the natural movement of aquatic and terrestrial species. These pathways restore critical areas for feeding, nesting, roosting, and migrating.

Sites with potential for improving estuarine water quality and hydrology are preferred. Restored upland vegetation and wetlands filter nutrients, sediment, and toxics from stormwater before

reaching waterways. In addition to natural habitat creation, sites which can support green infrastructure projects to retain runoff and filter pollutants are also preferred.

Focusing on both terrestrial and aquatic areas and restoring or enhancing processes and corridors that connect them within watersheds is essential. Restoring native vegetation, managing invasive plants, and removing development from the riparian and floodplain area also increase connectivity between stream corridors and their associated uplands. Sites with opportunities to restore and create freshwater wetlands within the drainage basin of tidal creeks are preferred, even if not directly congruous with the bay. To promote living shorelines (see Bay Habitats Objective 4), locations with potential for demonstration living shoreline installations are ranked higher. Restoration plans incorporate climate-resilient designs where appropriate. For example, designs for coastal sites subject to sea level rise include more high marsh and upland areas, which will allow restored plant communities to naturally migrate inland as sea level rises.

Potential sites are identified through extensive coordination with regional experts and SBEP partners. Almost 70 projects have been identified and ranked in the HRP over the last 15 years, and more than 35 projects, including some with multiple phases, have been completed (updated Map of projects). Eight projects from the latest FY2016-2020 Plan have been initiated:

- North Lido (partial completion 2016);
- South Lido (partial construction 2017);
- Tidy Island (plans and permits 2018, exotic pest plant removal 2021);
- Dit-Dot-Dash Bird Islands (plans and permits 2018);
- Jim Neville Preserve (plans 2018);
- 34th Street Oyster Restoration (completed 2017, monitoring and shell replenishment ongoing);
- FISH Preserve (partial construction 2019, additional exotic pest plant removal 2021); and
- Perico Bayou Oyster restoration (plans and permits 2019, completed 2020).

Habitat restoration accomplishments are tracked and reported annually to USEPA in the National Estuary Program On-line Reporting Tool (NEPORT) database. Metrics include acres or linear feet restored or enhanced. In addition, planting success and oyster recruitment and size distribution are monitored. There is a need to better coordinate reporting among partners and to standardize project reporting categories and metrics for restoration, monitoring, and management activities (see Community Engagement Action Plan Objective CE-4).

Continued funding support is necessary to complete projects identified in the HRP. This requires close coordination with priorities and funding opportunities of Program partners, especially the Southwest Florida Water Management District (SWFWMD), Manatee County, and Sarasota County.

The next update to the HRP should continue to coordinate with priorities of the Sarasota Bay (JEA 2012a), Little Sarasota Bay (JEA 2012b) and Roberts Bay (JEA 2010) Water Quality Management Plans, the SWFWMD Surface Water Improvement and Management Plan (SWIM) for Sarasota Bay (SWFWMD 2002), and the Audubon Gulf of Mexico restoration strategy (NAS 2019). As sea level rise and increased storm intensity threaten to drown coastal wetlands squeezed by upland development, there is a need to analyze projected changes in coastal wetlands and prioritize remaining coastal wetland restoration opportunities (see Watershed Habitat Action Plan Objective WH-4).

Strategy

Activity 1.1 Update the five-year Habitat Restoration Plan with consideration of resiliency strategies; and coordinate, track, and report progress metrics for habitat restoration.

Timeframe: Complete update by 2024
Collaborators: SBEP (conduct); SWFWMD (except beach and dune projects), FDEP, FWC, FDOT, Audubon, County and Municipal governments
Projected 5-Year Costs and Funding Sources: $/SBEP (CWA 320)
Location: SBEP watersheds

Benefits

A science-based approach to identifying and prioritizing restoration projects effectively and efficiently guides program resources to maximize habitat protection and restoration.

5-Year Performance Metrics

Updated and adopted Habitat Restoration Plan

WH Objective 2: Protect, enhance, and restore uplands and freshwater wetlands.

Activity 1: Encourage and support the permanent conservation of natural lands through acquisition and conservation easements, including freshwater wetlands and flowways, corridors, and uplands adjacent to coastal habitats necessary for habitat resilience and migration.

Activity 2: Restore and manage natural lands through prescribed fire, eradication of invasive exotic plants and animals, hydrologic improvement, and reestablishment of threatened and endangered plants.

Benefits and Priority Concerns

Healthy bay water quality and wildlife require a diversity of interconnected habitats in the watershed — including upland forests and freshwater wetlands — that support the full suite of natural processes necessary to sustain life. Even though these inland habitats may not be confluent with the bay, they influence the health of the bay through hydrologic connectivity that affects bay water quality and habitat connectivity that supports fish and bay wildlife (see Water Quality & Quantity Action Plan and Fish & Wildlife Action Plan).

Important upland habitats include pine prairies (pine flatwoods and dry prairie), oak hammocks, and scrub (sand pine scrub and scrubby flatwoods). All provide habitat value for a variety of birds, reptiles, and small mammals. Forested areas capture rainwater, allowing it to slowly evaporate from the canopy or seep into the ground. Upland habitats are threatened by development, lack of fire management, and invasion by exotic vegetation, including Brazilian pepper, melaleuca, cogon grass, and air potato.

Wetlands are highly productive habitats, providing food and shelter for a large variety of mammals, birds, fish, amphibians, reptiles, and insects. Many of the bay's colonial nesting birds forage in freshwater wetlands, and some commercially and recreationally important fishes use freshwater wetlands during their juvenile life stages. Wetlands are also critical for cycling nutrients and filtering and storing water, thus providing water quality and flood protection benefits (see Water Quality & Quantity Action Plan).

Contiguous wetlands, such as forested swamps, grassy marshes, and sloughs, are periodically flooded by adjacent waterways. Isolated wetlands are fed by rainwater and runoff from surrounding uplands. Wetlands typically form where the water table is at or above the surface of the ground and remain inundated for most of the year. They contribute to the hydrologic cycle through high rates of evaporation and evapotranspiration, as well as recharge groundwater and aquifers in some areas.

Wetlands are threatened by development that changes local hydrology, resulting in fragmentation, too little or too much water, and pollution. Changes in precipitation and warming temperatures from climate change also threaten wetlands by affecting water balance and soil characteristics (Twilley 2007). Increased flooding and prolonged drought may make wetland communities more susceptible to sedimentation and erosion, pollutants, pests and disease, and competition from exotic species leading to local extirpation (SBEP and Shafer 2017). Loss of habitats and changes in wetland community structure are expected with climate change (Root *et al.* 2003). These changes have important implications for restoration efforts.

Monitoring and Status

Since the 1950's, urban development and agriculture have degraded, fragmented, and replaced upland forest and freshwater wetland habitats. The Greater Sarasota Bay watershed is highly urbanized; natural areas are fragmented and isolated as relatively small public parks and preserves, golf courses, water bodies, and subdivision easements. The SBEP area has 5,599 acres of freshwater wetlands and 4,648 acres of forested uplands remaining. Due to regulatory protection and restoration of wetlands, wetland area has remained relatively stable over the last 30 years, but upland forests have declined (Water Atlas, SWFWMD 2014). [UPDATE with LULC analysis using 2017 SWFWMD data].

Regionally, 20% of the total land area of Manatee and Sarasota Counties is conservation lands in public and private ownership (Table 2). Sarasota County has a conservation land acquisition program approved by voter referendum and financed through dedicated *ad valorem* property tax revenue and other sources. Manatee County successfully identifies and acquires conservation lands through general funds, grants, and innovative public-private partnerships. In addition to public acquisitions, the Conservation Foundation of the Gulf Coast provides leadership and initiates conservation land acquisitions on private lands and through public-private partnerships.

Table 2. Managed conservation lands (acres) in Sarasota and Manatee counties include public and some privately-owned lands. (SOURCE: Florida Natural Areas Inventory. Florida Conservation Lands, updated March 2019)

County	Local	State	Federal	Private	Total	County Area	% Conserved
Manatee	26,040	32,910	1,090	1,660	61,700	474,240	13%
Sarasota	47,710	60,590	10	880	109,190	366,080	30%
TOTAL	**73,750**	**32,910**	**1,100**	**2,540**	**170,890**	**840,320**	**20%**

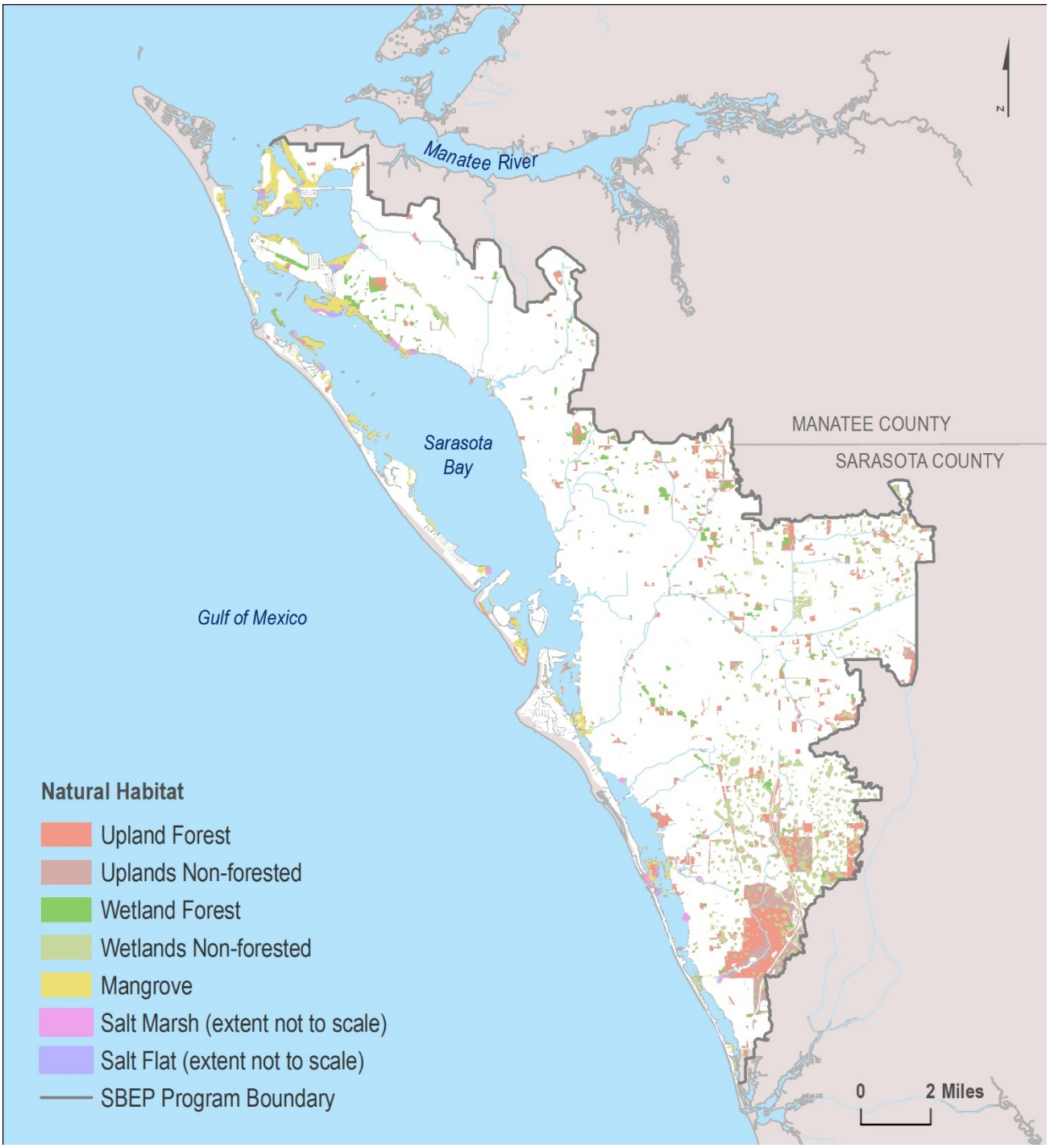
Often, private lands are protected through purchase of conservation easements, a legal agreement between a property owner and a qualified conservation organization, such as a land trust or government agency. The easement usually contains permanent restrictions on the use or development of land in order to protect its conservation values.

SBEP supports and promotes existing federal, state, water management district, and local conservation land acquisition programs, including:

- Florida Department of Environmental Protection Florida Forever;
- Florida Forest Service Rural and Family Land Protection Program and Forest Legacy Program;
- U.S. Department of Agriculture National Resources Conservation Service; and
- Southwest Florida Water Management District.

Wetlands are protected from dredging and filling under the Federal Clean Water Act through the US Environmental Protection Agency (USEPA) and the Florida Department of Environmental Protection (FDEP). Florida provides further protection by also regulating the alteration of uplands that may affect surface flows to isolated wetlands not falling under federal jurisdiction. Sarasota County land development regulations include open space requirements and protections for certain sensitive and rare native habitats, including wetlands, grassy dry prairies, and scrub. Protection and restoration of uplands and freshwater wetlands in the floodplain also contributes to flood plain management, potentially lowering a community's flood insurance rates (FEMA 2015).

Figure 1. Natural habitat in the watersheds of Sarasota Bay estuary, including upland forests and freshwater wetlands.



Accomplishments and Priorities

Within the SBEP area, Oscar Scherer State Park and many County and City parks and preserves are actively managed for their upland and freshwater wetland habitat. From 2014-2018, SBEP and its many partners and volunteers supported 23 upland restoration projects on over 150 acres involving prescribed fire, removal of exotic plants, native planting, and creation of 175 feet of vegetated bioswale. In addition, 314 acres of upland were purchased for conservation, including the 287-acre Thaxton Preserve adjacent to Oscar Scherer State Park. Wetland restoration projects during this period included removing exotics and planting native species on 13 acres plus shoreline enhancement along 325 feet of creeks and lakes.

SBEP will continue to monitor habitat gains or losses and identify opportunities for upland and freshwater wetland acquisition and restoration in the Habitat Restoration Plan. By partnering with public and private landowners to provide technical and funding guidance for priority projects, SBEP can facilitate and accelerate progress in protecting the remaining vulnerable natural forests and freshwater wetlands in the area. SBEP also has an important role in educating the community about the benefits of upland and freshwater wetland habitat protection and restoration for floodplain management, groundwater recharge, and wildlife protection.

Strategy

Activity 2.1 — Encourage and support the permanent conservation of natural lands through acquisition and conservation easements, including freshwater wetlands and flowways, corridors, and uplands adjacent to coastal habitats necessary for habitat resilience and migration.

Timeframe: Ongoing
Collaborators: SBEP (support); FWC, SWFWMD, FDEP, FDACS, County & Municipal Governments, NOAA, Conservation Foundation of the Gulf Coast
Projected 5-Year Costs and Funding Sources: $$$$$/SBEP, County and Municipal Governments, Conservation Foundation of the Gulf Coast, Land owners, SWFWMD, and USDA-NRCS
Location: SBEP watersheds with a focus on areas recommended in the HRP

Activity 2.2 — Restore and manage natural lands through prescribed fire, eradication of invasive exotic plants and animals, hydrologic improvement, and reestablishment of threatened and endangered plants.

Timeframe: Ongoing; CCMP Monitoring Strategy by 2024

Collaborators: SBEP (support); FWC, SWFWMD, FDEP, FDACS, County & Municipal Governments, NOAA, Audubon (golf course restoration)
Projected 5-Year Costs and Funding Sources: $$$$$/SBEP (CWA 320), County and Municipal Governments, SWFWMD, FWC, FDEP, NOAA, USDA-NRCS, USFWS
Location: SBEP watersheds with a focus on areas recommended in the HRP

Benefits

Healthy and interconnected, upland and freshwater wetland habitats support the natural processes necessary for a healthy bay.

5-Year Performance Metrics

Increased acreage of conserved, restored, or managed habitat

WH Objective 3: Improve tributary habitats with a special emphasis on fisheries.

Activity 1: Create and implement a strategy for restoring habitat in tributaries to:

- *characterize, delineate, and quantify tributary shoreline and habitat features supportive of fisheries;*
- *prioritize habitat restoration projects that increase critical juvenile fish habitat; and*
- *design restorations of urban creek, canal, and stormwater flowways to mimic natural stream function, including elimination of barriers and hardened shorelines.*

Benefits and Priority Concerns

Tidal creeks are relatively small coastal tributaries, either natural or manmade, that fluctuate in salinity due to exchanges of fresh and estuarine waters (Janicki and Mote 2016). Although tidal creeks provide an important connection between freshwater and estuarine systems, they possess water quality characteristics that differ from either system. In particular, they can have relatively high nutrient and chlorophyll concentrations and low dissolved oxygen levels relative to downstream estuaries.

Tidal creeks provide food and habitat for crustaceans, wading birds, alligators, and small bodied and larger piscivorous fishes and provide nursery areas for crustaceans and fishes of high ecological and economic value. They also provide many beneficial hydrologic services including water retention, groundwater recharge, and flood prevention.

Historically, wetlands adjacent to tidal creeks were drained for agriculture and creeks were dammed to prevent salinity from reaching farmland. Other harms include ditching, channelizing, and shoreline hardening. Road crossings and culverts impact natural flow and nutrient pollution from stormwater and wastewater, bacterial pollution, and sedimentation degrade water quality. Climate change will further magnify stresses to SBEP area tidal creeks (SBEP and Shafer 2017), including warmer water temperatures, increased intensities of rainfall and storms, prolonged winter droughts, and rising sea levels. These stresses will impact water quality and hydrology, affecting plant and animal communities along the full extent of creeks (Jassby *et al.* 1995).

Monitoring and Status

Currently, the only approved guidance for evaluating tidal creek biological integrity (*e.g.*, Karr *et al.* 1986) is narrative criteria based on State of Florida dissolved oxygen (DO) and chlorophyll-a threshold values alone. To improve upon this standard, SBEP led a collaborative study of all three Florida Gulf Coast NEPs to develop numeric nutrient criteria (NNC) for tidal creeks.

Researchers found that creek segments with low dissolved oxygen and high chlorophyll levels could still support high densities of juvenile fishes and baitfish (Janicki and Mote 2016), suggesting that current narrative-based criteria for water quality in tidal creeks based on DO and chlorophyll may be ineffective and misleading as indicators of the biological integrity of tidal creeks. Large differences among creeks suggested that no single optimum water quality criterion may be appropriate for setting nutrient targets and thresholds to maintain ecological health for all creeks. Instead, the status of juvenile fishes using the creeks might be a more reliable indicator of ecological health. Work on establishing NNC for tidal creeks in the SBEP area is ongoing, including a tidal creeks nutrient Report Card and additional indicators of creek condition will be used locally to identify and prioritize creeks for further evaluation (Janicki and Mote 2019).

In order to better understand how tidal creek habitat quality affects creeks' effectiveness as a nursery habitat for fish, researchers from the Bonefish and Tarpon Trust and FWC analyzed statewide maps of juvenile snook and tarpon locations and assembled a list of habitat characteristics common to successful nursery habitats (Wilson 2017). Locally, Mote Marine Laboratory scientists conducted a study to determine the status of juvenile fishes in canal systems. Results suggest that creek segments with secondary stage habitat — such as curved channels, wetland plants, or slower moving waters — tend to have increased fish diversity and support proportionally more recreationally important species (Locascio *et al.* 2017). This is likely due to these sections better resembling natural creeks. In addition, Mote researchers have ongoing studies examining shoreline habitat use of snook and mullet in Sarasota County tidal creeks. Data gathered to date suggest that fish associated with stretches of creek with hardened shorelines spend less time along seawalls. However, if the hardened shorelines have vegetation associated with them, then fish use them as much as nearby natural shorelines (R. Schloesser, Mote Marine Laboratory, personal communication).

Accomplishments and Priorities

These findings support ongoing work and the SBEP priority to understand how to "naturalize" altered waterways and manmade canals to functionally provide better habitat for fish and wildlife.

Naturalizing waterways can be accomplished in a number of creative ways. For example, multiple benefits can be achieved by removing weirs or dams that no longer serve a functional purpose, including improvements to water quality, ecological integrity, economic development, recreational activities, restoration of fish migration, flood control, and public safety (USEPA 2016). Sinuosity can be added to straightened channels, shorelines can be planted with native vegetation and stabilized with trees, snags and other habitat can be created to provide refuge for fish, and fish ladders can be installed on stormwater weirs to facilitate fish migration.

[Call-out box Case Study]:

Phillippi Creek, the largest freshwater creek in the SBEP area creek assemblage, has about seven miles of creek and over 100 miles of manmade canals and channels. The creek drains a highly urbanized watershed and regularly exceeds its total maximum daily load limits for bacteria pollution. Phillippi Creek collects stormwater from many older neighborhoods developed without central sewer or stormwater treatment and is subject to overflows of treated wastewater high in nitrogen from the Bee Ridge Wastewater Treatment Plant. Sarasota County has focused its attention on improving Phillippi Creek through purchase of the Celery Fields stormwater treatment area, construction of sediment catchment systems, converting 10,000 septic systems to sewer, and extensive outreach and education to community members about fertilizer use, pet waste, and proper maintenance of septic systems and sewer laterals. Sarasota County is also considering upgrading its Bee Ridge Wastewater Treatment Plant from Secondary to Advanced Wastewater Treatment, which will greatly reduce the amount of nitrogen input into the creek during overflows. Restoration of habitats along Phillippi Creek is an ongoing SBEP priority that local creek-adjacent communities support through volunteer cleanups with the Sarasota Bay Guardians and demonstration restoration projects. Over the past five years, SBEP has supported or managed projects to replace exotic plants with native vegetation along shorelines facing Orchid Oaks Condominium, South Gate Community Association, and Riverview High School.

Strategy

Activity 3.1

Create and implement a strategy for restoring habitat in tributaries to:

- characterize, delineate, and quantify tributary shoreline and habitat features supportive of fisheries;
- prioritize habitat restoration projects that increase critical juvenile fish habitat; and
- design restorations of urban creek, canal, and stormwater flowways to mimic natural stream function, including elimination of barriers and hardened shorelines.

Timeframe: Ongoing

Collaborators: SBEP (collaborate); Mote Marine Laboratory, County & Municipal Governments, SWFWMD, FWC, FDEP

Projected 5-Year Costs and Funding Sources: $$$$$/SBEP (CWA 320), FDEP, County & Municipal Governments, SWFWMD, FWC, NFWF, Colleges and Universities, NOAA

Location: SBEP tributaries

Benefits

Improvements to the habitat quality and connectivity of tributaries support water quality and fish populations, while providing flood control and increasing property values.

5-Year Performance Metrics

Increased acreage and linear feet of improved shorelines and tributary habitats

WH Objective 4: Protect, enhance, and restore coastal wetlands and improve shoreline resiliency.

Activity 1: Continue coastal wetland restoration and protection projects prioritized by the Habitat Restoration Plan.
Activity 2: Continue spoil island restoration and protection. Support establishment of protected managed areas for bay islands.
Activity 3: Implement shoreline resiliency strategies to:

- *conserve adjacent uplands;*
- *encourage installation of living shorelines through education, incentives, technical and permitting assistance, workshops, and trainings; and*
- *support consistent policies across jurisdictions regarding rolling easements, coastal construction setbacks, and shoreline alterations that encourage (or do not prohibit) living shorelines, especially for resiliency and post-disaster planning.*

Benefits and Priority Concerns

Coastal wetlands are vegetated intertidal areas that occur around the perimeter of the bay and its tidal tributaries, including mangrove forests, salt marshes, and salt flats. They provide food and habitat for hundreds of species of bay fish and wildlife and are considered critical habitat for many important recreational and commercial fish species, including gray striped mullet (*Mugil cephalus*) and pink shrimp (*Farfantepenaeus duorarum*). Tidal tributary shorelines serve as prime nursery habitat for a variety of estuary-dependent fauna. Coastal wetlands are critical to the world's carbon balance; they take up carbon dioxide and store "blue carbon" in plant biomass and associated wet soils at roughly 25 times the annual rate of temperate and tropical forests (Moyer *et al.* 2016, McLeod 2011). They also help stabilize shorelines from erosion, provide buffering from storm surge, and help filter pollutants from land-based runoff into the estuary.

Historically, large losses and fragmentation of coastal wetlands accrued from coastal development where marshes were ditched and drained to help control mosquitos and dredged and filled to make way for buildings and seawalls. While the extent of tidal wetlands has stabilized over the past fifteen years [UPDATE with LULC 2017] (Figure), these ecosystems have experienced profound loss and fragmentation since the 1950s. In 1950, 4,104 acres of tidal wetlands fringed Sarasota Bay, and the average size of wetlands was about 22 acres. About 40 acres were lost annually between 1950 and 1975, followed by losses of about 20 acres per year through 1990, while the average size of wetlands decreased to 5.6 acres during this period (SBEP 1992). The most recent bay-wide shoreline habitat survey shows 55% of the 410 miles of shoreline of Greater Sarasota Bay, including upland-cut canal systems, are hardened by bulkheads and riprap (Serviss and Sauers 2003).

Although State and County regulations now protect coastal wetlands from being cleared for development, impacts still occur. For example, boat wakes can accelerate erosion along stressed shorelines. Moreover, shoreline development reduces ability for salt marshes and mangroves to migrate inland as sea level rises, eventually causing coastal wetlands to be squeezed and drown in place.

Mangrove trimming is common practice for many waterfront properties in Sarasota County; in the unincorporated area, 54% of coastal parcels with mangroves are trimmed, and 18% of those are trimmed to less than 6 feet in height in violation of State and County regulations (Sarasota County 2016). Excessively trimmed mangroves lose productivity, longevity, and habitat value. Invasive vegetation, particularly Brazilian pepper (*Schinus terebinthifolius*), and Australian pines (*Casuarina spp*.) encroach on the boundaries of coastal wetlands and can outcompete native species in impacted areas.

Altered upland hydrology, where natural sheet flow of freshwater has been replaced by highly variable flow through stormwater control structures, causes rapid changes in salinity of coastal wetlands and shorelines. Too much freshwater flow can increase erosion and polluted runoff. To little flow can cause stress from stagnation, anoxia, or hypersalinity, and lead to collapse of marsh root structure, making it more difficult for coastal wetlands to accrete substrate and maintain elevation with rising sea level.

Monitoring and Status

Mapping and monitoring of coastal wetlands is achieved by remote mapping and field surveys. Regional land use and land cover mapping by photointerpretation of aerial imagery is conducted by the Southwest Florida Water Management District (SWFWMD) every three years. Field-based shoreline morphology and vegetation surveys focus on juvenile fisheries habitat (Serviss and Sauers 2003), tidal creek assessment (Eilers 2013, Eilers 2014, and SBEP 2016), and mangrove trimming (Sarasota County 2016). A new monitoring method can identify stressed mangroves via remote sensing and can inform management strategies to prevent mangrove mortality (Beever *et al.* 2016). SBEP supports continuing regular mapping and surveying efforts.

Wetlands make up 37% of shorelines, while beach and upland shoreline total 8% (Serviss and Sauers 2003). As a percentage of total shoreline, Little Sarasota Bay has the most coastal wetlands (65%), while Sarasota Bay has the least (31%) (Table 3).

Table 3. Sarasota Bay shoreline type (in linear feet) by bay segment. (SOURCE: Serviss and Sauers 2003)

Bay Segment	hardened	%	wetland	%	beach/upland	%	TOTAL
Anna Maria	127,199	86%	18,704	13%	1,819	1%	147,722
Palma Sola	155,266	45%	173,883	50%	18,959	5%	348,108
Sarasota Bay	531,122	62%	262,599	31%	63,246	7%	856,967
Roberts Bay	245,509	55%	139,913	31%	60,186	14%	445,608
Little Sarasota Bay	51,454	26%	129,066	65%	17,049	9%	197,569
Blackburn Bay	73,659	43%	82,442	48%	14,415	8%	170,516
TOTAL	1,184,209	55%	806,607	37%	175,674	8%	2,166,490

Mangroves make up 95% of the coastal wetlands in Sarasota Bay (Table 4). In recent years, areal extent of mangroves has increased [UPDATE with LULC 2017] as a result of mangrove restoration efforts and natural succession of salt marsh to mangrove (Figure 2). This trend is expected to continue due to climate change and sea-level rise, which favor mangrove expansion at the expense of other estuarine habitats (Sherwood and Greening 2012, 2014). Salt marsh habitat has declined in the bay, the remainder of which is located primarily around Jim Neville Preserve in Little Sarasota Bay and upstream in tidal creeks. Manatee County's extensive coastal preserves, including Robinson, Perico, and Neal Preserves, are major highlights in showcasing the region's efforts to protect and restore coastal wetlands, oyster reefs, and coastal uplands (Figure 1).

Figure 2. [UPDATE with LULC 2017] Historical acreage of mangrove swamps, salt marshes and salt flats in the Sarasota Bay region. The increase in salt flats is due to inclusion of a new salt flats land cover category that had not been mapped in previous years. Data source: SWFWMD 2011. From Leverone et al 2017

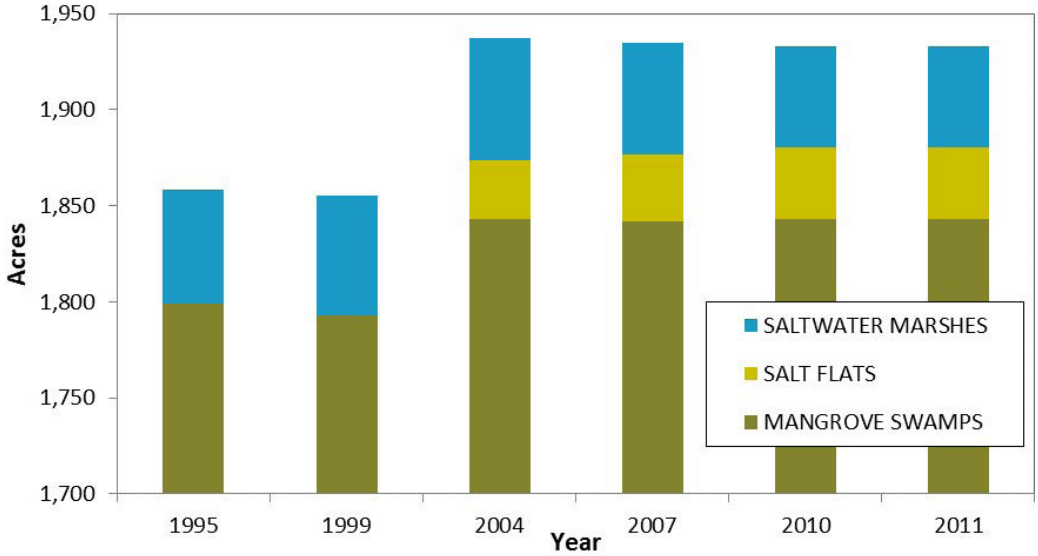


Table 4. [UPDATE with LULC 2017] 2011 acreages for emergent wetlands and tidal flats in Sarasota Bay and selected bay segments. Data source: SWFWMD 2011. From Leverone et al 2017.

	Mangroves	Salt Flats	Salt marsh	Total
Blackburn Bay	54	0	2	56
Little Sarasota Bay	124	7	12	143
Palma Sola Bay	550	11	8	568
Roberts Bay	149	0	1	149
Sarasota Bay	966	20	29	1,016
TOTAL	1,843	38	52	1,933

Accomplishments and Priorities

Between 2014-2018, twenty-one projects on about 500 acres were completed to protect, enhance or restore coastal wetlands and shorelines. Activities included removing exotic vegetation, planting native vegetation, creating new habitat, and acquiring coastal properties. Most of these efforts focused on coastal preserves in Manatee County, including Robinson Preserve and Robinson Preserve Expansion, Perico Preserve, and FISH Preserve. Many of these projects were supported by local volunteers organized through the Bay Guardians Program (See Community Action Plan) and Bay Partners Grants.

[callout box on Perico with photos of the restored preserve]

Perico Preserve Restoration

In 2007, Manatee County purchased 176 acres of highly disturbed fallow farmland slated for high intensity development in western Manatee County. The Manatee County Parks and Natural Resource Department and partners restored the property to a mosaic of ecologically valuable habitats that improve ecological values, water quality, and passive recreational opportunities (Table 5). Hundreds of volunteers assisted in the restoration effort, including Sarasota Bay Estuary Program Bay Guardians. Perico Preserve's proximity and accessibility to the public makes it an ideal location for education and outreach about the importance of protecting and restoring Sarasota Bay area natural habitats.

Table 5. Habitat created, restored, and enhanced at Perico Preserve, Manatee County.

Created	**Restored**	Enhanced
3.6 acres scrub	0.1 acre salt marsh	1.3 acres salt marsh
4.5 acres freshwater marsh	2.29 acres flatwoods/salt marsh	2.6 acres upland hammock
3.8 acres salt marsh	9.5 acres flatwoods	
0.8 acres coastal strand hammock	3.8 acres maritime marsh	

Improving coastal shoreline resilience through the installation of living shorelines is a SBEP priority. Living shorelines can reverse the negative effects of hardened shorelines in many SBEP area locations. Over 50 public waterfront parcels have been identified as candidates for living shoreline projects (ESA Scheda 2018), and a majority of Sarasota County shorelines may be candidates for hybrid living shorelines, composed of natural and structural elements (Dobbs *et al.* 2017).

A continuum of shoreline stabilization techniques is available for different wave energy and infrastructure conditions [Insert Figure: “NOAA Green to Grey”] that vary from tidal creek to canal to bayfront locations. Where existing seawalls cannot be removed, seawall enhancement projects can create habitat in front of the seawall. SBEP will continue to implement living shoreline demonstration projects and encourage consistent policies across jurisdictions for permitting and design. There is a need for broader education on the benefits and efficacy of living shorelines along with technical and permitting assistance for the marine construction industry and shoreline property owners.

Bay islands feature some of the last remaining undeveloped shorelines. Although some islands have natural origins, most were created from dredge material produced during creation of the Intracoastal Waterway and other coastal development. Many serve as important colonial bird rookeries, hosting threatened and endangered species such as the roseate spoonbill (*Platalea ajaja*) and reddish egret (*Egretta rufescens*). SBEP has identified projects to enhance spoil island hydrology, native coastal habitats, and shorelines to improve their ecological function. While spoil island restoration projects generally rank lower in SBEP’s Habitat Restoration Plan than those associated with water quality improvements in the watershed (SBEP 2016), there are important opportunities in Braden River, north Sarasota Bay, and Roberts Bay.

SBEP is committed to supporting coastal wetland and shoreline protection, enhancement, and restoration projects prioritized in the Habitat Restoration Plan (see Bay Habitats Objective 1). Consistent effort and vigilance are needed to prevent further spread of invasive vegetation and recognize new invasive species. Early identification of coastal wetland stressors such as erosion, illicit trimming, pollution, and altered hydrology can be used to help prioritize intervention projects. Opportunities for establishing and maintaining wetland habitat connectivity and buffer zones for landward migration of coastal wetlands should also be prioritized. Coordinating projects and funding opportunities among SBEP partners will enhance success and may create opportunities for aggregated blue carbon offset financing for coastal wetland restoration (Herr *et al.* 2015).

Strategy

Activity 4.1 Continue coastal wetland restoration and protection projects prioritized by the Habitat Restoration Plan.

Timeframe: Ongoing
Collaborators: SBEP (conduct); SWFWMD (4.1, confirm with L.G. specifically about 4.2-4.5), FDEP, FWC, Florida Sea Grant, USACE, County and Municipal Governments
Projected 5-Year Costs and Funding Sources: $$$$/SBEP (CWA 320), County and Municipal Governments, Landowners, SWFWMD, FWC, FDEP, NOAA, Florida Sea Grant, USACE, WCIND, NFWF, NOAA
Location: SBEP watersheds with a focus on areas recommended in the HRP

Activity 4.2 Continue spoil island restoration and protection. Support establishment of protected managed areas for bay islands.

Timeframe: Ongoing
Collaborators: SBEP (conduct); and County and Municipal Governments (leads), FWC, USACE, Audubon, FDEP
Projected 5-Year Costs and Funding Sources: $$$$/SBEP (CWA 320), FWC, USACE, WCIND, NFWF, NOAA, FDEP, RESTORE
Location: SBEP watersheds with a focus on areas recommended in the HRP

Activity 4.3 Implement shoreline resiliency strategies to:
• conserve adjacent uplands;
• encourage installation of living shorelines through education, incentives, technical and permitting assistance, workshops, and trainings; and

• support consistent policies across jurisdictions regarding rolling easements, coastal construction setbacks, and shoreline alterations that encourage (or do not prohibit) living shorelines, especially for resiliency and post-disaster planning.

Timeframe: Ongoing
Collaborators: SBEP (conduct); FWC, NOAA, Florida Sea Grant, USACE, County & Municipal Governments, FDEP
Projected 5-Year Costs and Funding Sources: $$$$/SBEP (CWA 320), County and Municipal Governments, Landowners, NOAA, FDEP
Location: SBEP watersheds with a focus on areas recommended in the HRP

Benefits

Expanded use of softened shorelines in bay and tidal tributary locations improves wildlife habitat, water quality, and resilience to storms and sea level rise. Expanded ecosystem services and non-habitat related benefits.

5-Year Performance Metrics

• Increased acreage and linear feet of created or restored coastal habitat

• Ten workshops or consultations with government, waterfront property owners, or marine contractor representatives.

WH Objective 5: Protect, enhance, and restore hard bottom and seagrass habitats.

Activity 1: Monitor artificial and oyster reef habitat quality, explore optimal placement of new reefs, and establish/enhance oyster and artificial reefs in Sarasota Bay.
Activity 2: Inventory hard-bottom habitat in Sarasota Bay and nearshore Gulf water and passes.
Activity 3: Reevaluate seagrass targets in bay segments. Implement water quality improvement strategies to increase productive and resilient seagrass habitat.
Activity 4: Continue seagrass mapping and monitoring and expand seagrass monitoring to Manatee County.

Greater Sarasota Bay spans approximately 52 square miles of open water in Manatee and Sarasota Counties. As a shallow lagoonal estuary, the bay bottom is primarily composed of soft sediments ranging from mud to sand to shell that provide habitat to hundreds of species of small benthic invertebrates. In impacted dredged areas, soft sediments act as a major sink for nutrients and toxic substances. Hard-bottom habitat is relatively rare and consists of oyster reefs along shoreline fringes, sporadic rock outcrops, and strategically located artificial reefs. About a third of the bay bottom is covered in patchy and continuous seagrass meadows. The hard-bottom habitats and seagrass meadows are priority habitats for protection, enhancement, and restoration.

Hard-bottom habitats

Natural rock outcroppings

Isolated and sporadic occurrences of natural rock occur in the nearshore waters of the Gulf of Mexico and bays. The limestone or dolomite sedimentary rock (also known as coquina rock) is composed of consolidated shells of marine animals formed over millions of years. In some places, such as Point of Rocks on Siesta Key, the rock forms outcroppings with relief of 2–3 meters, but in most natural hard-bottom areas it takes the form of low relief bedrock covered with a thin veneer of sand or shell. These natural hard-bottom areas provide habitat for distinct communities of plants, fish and invertebrates, and in turn provide recreational opportunities for fishers and snorkelers. The full extent of rocky hard-bottom habitat has never been comprehensively mapped in Sarasota Bay, although various benthic habitat assessments have contributed piecemeal information over time. The Florida Coastal Mapping Program (FCMaP), an initiative between Federal and Florida State agencies and institutions, has aggregated many of the available benthic habitat maps for the state's coastal and marine waters to identify gaps in coverage, develop a multi-year plan for filling those gaps, and complete a high-resolution map for all of Florida's waters. A comprehensive inventory could be achieved by 1) underwater visual surveys, 2) aerial image interpretation, and/or 3) vessel-based side-scan sonar or acoustic sounders. These rare habitat

locations may warrant special protection, similar to Sarasota County's Point of Rocks Protection ordinance prohibiting damage, destruction, or taking of rock at that location.

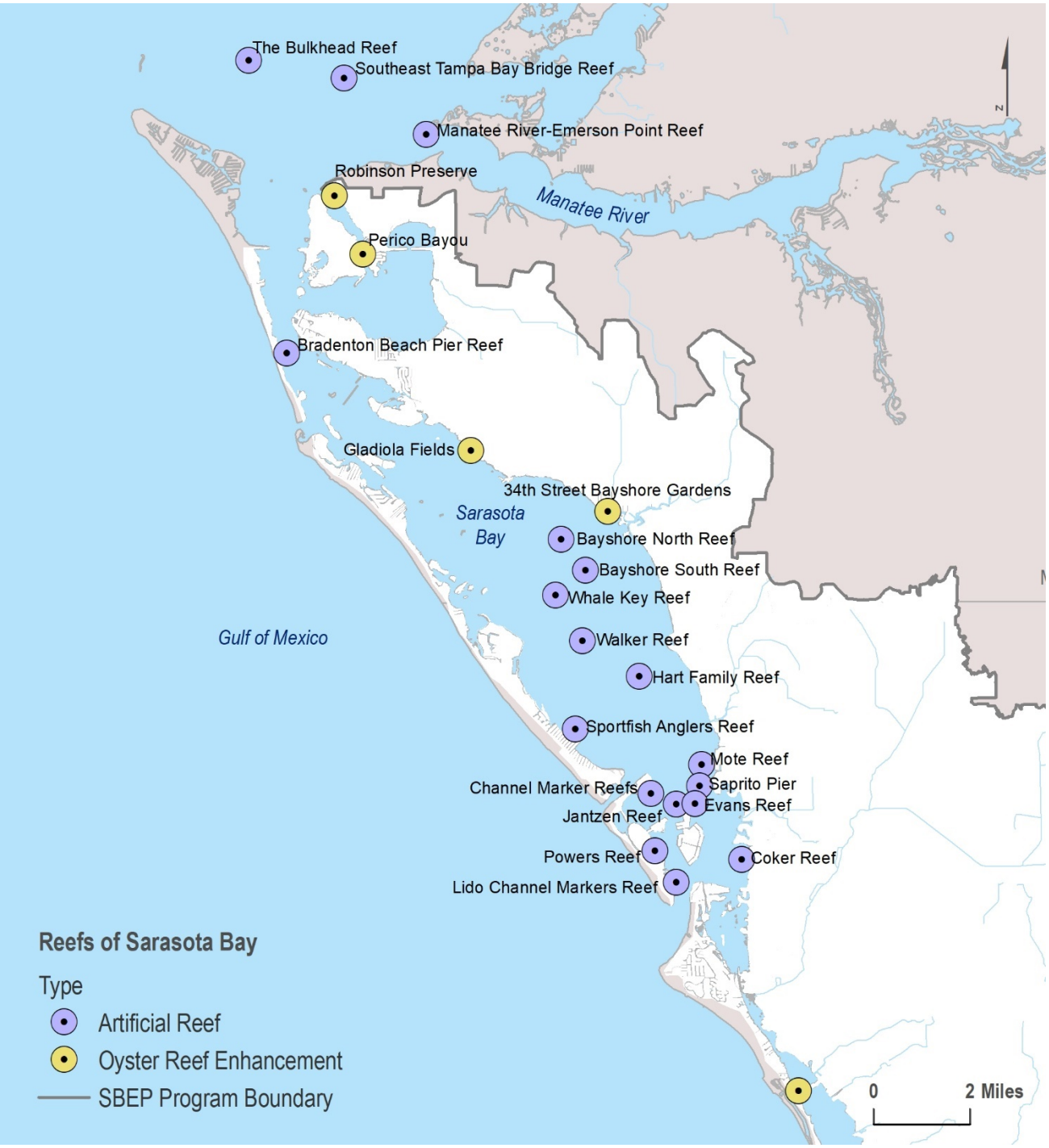
Artificial Reefs

Artificial reefs are man-made structures designed to mimic the habitat characteristics of high-relief natural hard-bottom (reefs). They provide suitable substrate for colonization by encrusting organisms, invertebrates, and fish on sandy bay bottom otherwise only inhabited by small benthic invertebrates. Artificial reefs can help compensate for historical losses of hard bottom habitat due to dredge and fill operations in the bay. Artificial reefs can also provide substrate for oyster recruitment and reef generation and can enhance shoreline protection. Artificial reefs can be constructed of a variety of materials, including concrete rubble, reef balls, and limestone boulders. Artificial reefs with greater complexity and constructed from a variety of materials tend to host a wider variety of species (Serviss and Sauers 2003). A study to monitor the colonization of artificial reef habitats in Sarasota Bay and Tampa Bay showed that artificial reefs were important seasonal habitats in these systems for both finfish and invertebrates (Blackburn *et al.* 2008). Reefs appeared to benefit both recruitment and retention of organisms and abundance on reefs was positively correlated to reef size.

The Florida Fish and Wildlife Conservation Commission (FWC) Division of Marine Fisheries Management administers the statewide artificial reef deployment program in partnership with Counties. SBEP's reef restoration efforts focus on enhancing and monitoring artificial reefs in Greater Sarasota Bay (Figure 3), although there are dozens more located in the nearshore gulf. Between 2014 and 2018, two acres of artificial reefs were deployed in Manatee County waters and two new sites were permitted by FWC. Hart Reef, Walker Reef, and Sportfish Angler Club Reef are being monitored via baited remote underwater video and underwater visual census methods to better characterize and compare fish abundance, species richness, and composition.

SBEP will continue working with Sarasota County, Manatee County, and FWC to design, permit, and deploy artificial reef modules to designated sites in the bay. Continued monitoring of fish habitat usage is important in order to maximize reef array design and placement for maximum fishery habitat benefit.

Figure 3. Reefs in Sarasota Bay.



Oyster reefs

Oyster reefs are a critical component of estuarine ecosystems. They provide habitat and food for other invertebrates, fish, and birds, provide shoreline protection from wave energy, and improve water quality by capturing pollutants as they filter feed. One acre of restored oyster reef has been shown to remove up to 543 pounds of nitrogen pollution per year (Kellogg *et al.* 2013). Oyster reefs are protected under Federal and State law; they are considered Essential Fish Habitat and afforded federal protection under the Magnuson-Stevens Fisheries Conservation and Management Act.

Eastern oysters (*Crassostrea virginica*) live in particular estuary mixing zones, where they receive regular tidal inundation and freshwater input that creates an optimal salinity regime. In Sarasota Bay, oysters form reefs along the coastal fringe, often flanking mangroves. They also recruit to the vertical surface of seawalls and form clumps around mangrove roots.

Sarasota County conducts annual oyster surveys in 14 bay and tidal creek locations. Of the 55 acres of oysters found in the Sarasota County bays and creeks of the SBEP, 20% are found in creeks, with half in Phillippi Creek and about 30% in Little Sarasota Bay (Meaux *et al.* 2016). Aerial oyster habitat mapping is conducted by Southwest Florida Water Management District (SWFWMD) every two years in conjunction with seagrass mapping but without ground-truthing; 2016 maps show 78 acres of oyster habitat in the SBEP area with recent increases over all bay segments. SBEP participates in the Oyster Integrated Mapping and Monitoring Program (OIMMP) coordinated by FWC to create a publicly available mapping layer and statewide report on mapping and monitoring methods, data gaps, and priorities.

Oyster reefs are expected to grow in elevation at pace with sea level rise in some locations, but they face other climate stressors including ocean acidification, eutrophication and algal blooms, disease, and parasites (Rodriguez *et al.* 2014). Oyster reefs located at the mouths of tidal creeks will likely migrate upstream with sea level rise but may encounter limited substrate availability in narrower creek beds. Due to their potential as bioindicators of estuarine health, continued annual monitoring of live oysters in Sarasota County tidal creeks will help track watershed health and evaluate watershed management programs — especially hydrologic restoration of natural freshwater flows to the bay and reduction of stormwater pollutants such as nutrients, toxins, and sediment.

Oyster habitat creation and enhancement continues to be a priority activity for SBEP in order to support essential fish habitat and water quality goals. Habitat Restoration Plan projects with potential for oyster habitat restoration, such as the Cortez Key and Dit Dot Dash Bird Sanctuaries, are ranked higher for their fisheries, shoreline enhancement, and water quality benefits. In 2017, four 20-foot diameter reefs were installed in northern Sarasota Bay at the 34th Street Canal in Bayshore Gardens, creating one acre of new oyster habitat. From 2017–2019, hundreds of feet of

shoreline were enhanced with recycled oyster shell at Robinson Preserve and Perico Preserve through the unique local partnership of the Gulf Coast Oyster Recycling and Renewal program (GCORR). With the help of community volunteers who bag and deploy the oyster shells, GCORR coordinates the use of live oyster shell discards, collected and cleaned by eleven participating restaurants, for oyster habitat restoration. This operation reduces impacts from shell mining and eliminates an estimated 80 tons of restaurant waste going to the landfill. Monitoring shows that oyster reefs created with live shell produce 23% more new oyster growth than those built with fossil shell. Manatee County is also planning large scale oyster habitat restoration on the shallow banks of the Manatee River, where oyster beds were once very abundant.

Seagrass Habitats

Expansive seagrass meadows are one of Sarasota Bay's signature features. Seagrass meadows provide essential food and habitat for juvenile and adult finfish and shellfish, hosting about 70 percent of commercially and recreational important species during some portion of their life cycle. Seagrasses also play an important role in cycling nitrogen and carbon. Their extensive root systems also stabilize sediments and reduce coastal erosion and wave action.

Climate change may impact the growth and distribution of seagrass. Seagrass could be inhibited by increased turbidity from more intense storms and increased algal growth with rising water temperature. Alternatively, elevated carbon dioxide and water temperature may make seagrass grow faster, taking up excess carbon dioxide from the water and creating localized micro-refugia from ocean acidification (Manzello *et al.* 2012).

Boat propellers that run aground in seagrass beds can tear root systems and dislodge seagrass, which can lead to further substrate erosion and collapse. Seagrass propeller scarring appears to be more prevalent in Sarasota Bay where boat traffic is not as constrained by the intracoastal waterway channel (Ali 2013). There is a need to update propeller scarring maps and evaluate the rate of scar recovery, as well as improve boater education and awareness of seagrass beds to reduce scarring (see Community Action Plan).

Seagrasses need adequate water clarity for sunlight to penetrate to depth. Reduced water clarity from sedimentation, color changes, and excessive algal growth due to nutrient pollution can impact the health of seagrass meadows, making them a good biological indicator of water quality and efforts to reduce watershed pollutant loads.

In 2008, SBEP developed seagrass restoration and protection targets for Sarasota Bay's five bay segments. Targets for each bay segment were set to either the historical (1950) (minus the

unrestorable areas that have since been dredged) or recent (2004-2006) seagrass extent, whichever was greater (Janicki *et al.* 2008). In turn, water quality criteria necessary to meet these targets were developed in 2010 by analyzing water clarity condition (chlorophyll-*a*) in bay segments that already met their targets and relating it quantitatively to levels of existing nutrient pollution (see Water Quality Action Plan) (Janicki 2010).

Aerial seagrass mapping is completed biennially by SWFWMD, with some mapping beginning as early as 1988. FDEP has monitored seagrass annually in Sarasota Bay since 1999 at seven permanent transects. Since 2006, Sarasota County has conducted semi-annual field surveys of bay seagrass to characterize density, species composition, and occurrence of epiphytic and drift algae (Figure 4).

Table 6. Seagrass acreage by bay segment by year. Acres shown in red do not meet the seagrass target. Data: SWFWMD [data for 2020 is provisional and subject to modification]

	Bay Segment					
Year	**Palma Sola**	**Sarasota**	**Roberts**	**Little Sarasota**	**Blackburn**	**Total**
TARGET	**1,031**	**7,269**	**348**	**702**	**447**	**9,797**
1988	1,111	6,323	334	533	411	8,712
1994	1,089	6,910	347	592	411	9,349
1999	1,025	6,750	332	770	374	9,251
2001	1,046	6,862	273	699	301	9,181
2004	1,002	6,646	371	763	468	9,250
2006	1,028	7,436	325	640	425	9,854
2008	1,164	9,997	302	837	346	12,646
2010	1,177	9,917	329	891	382	12,696
2012	1,185	9,798	307	902	399	12,591
2014	1,238	10,378	326	929	422	13,293
2016	1,258	10,659	361	806	390	13,473
2018	1,278	10,326	349	610	295	12,857
2020	Palma Sola + Sarasota	9,293	332	608	307	10,540

Figure 4 [INSERT SEAGRASS MAP]

In 2020, seagrass acreage does not meet restoration targets in most bay segments (Table 6). There was an increase in frequency of drift algae and a decrease in frequency of shoal grass (*Halodule wrightii*) across all segments from 2010–2015 (Christman 2015). Seagrass recovery in Sarasota Bay tracked bay-wide nutrient load reductions implemented between the 1980s and 2016 (Tomasko *et al.* 2018). Recent declines in seagrass coverage (Table 6) may be attributable to complex factors, from anthropogenic eutrophication in southern bay systems to episodic red tide impacts in the northern bays.

Long-term seagrass monitoring should be continued and augmented with a monitoring framework to detect the effects of climate change and ocean acidification on seagrass and other estuarine habitats. Efforts should be undertaken to better translate the significance of changes in seagrass coverage to policymakers, managers, and the general public. In addition, measures of ecosystem services provided by seagrass, such as suitability for fishery habitat and water quality improvement, should be considered alongside conventional measures of areal extent.

Strategy

Activity 5.1 Monitor artificial and oyster reef habitat quality, explore optimal placement of new reefs, and establish/enhance oyster and artificial reefs in Sarasota Bay.

Timeframe: Ongoing
Collaborators: SBEP (conduct); County Governments (co-leads), FWC, FDEP, Florida Sea Grant, Mote Marine Laboratory, USACE
Projected 5-Year Costs and Funding Sources: $$$/SBEP (CWA 320), SWFWMD, County Governments, FWC, FDEP
Location: SBEP bays

Activity 5.2 Participate in inventory of benthic and living hard-bottom habitat in Sarasota Bay and nearshore Gulf water and passes.

Timeframe: Begin in 2022
Collaborators: SBEP (collaborate); USGS, Florida Coastal Mapping Program
Projected 5-Year Costs and Funding Sources: $$/SBEP (CWA 320), FIO, USF, SWFWMD (living hard bottom only)
Location: SBEP bays

Activity 5.3	Reevaluate seagrass indicators and targets in bay segments. Implement water quality improvement strategies to increase seagrass habitat. ***Timeframe***: Begin reevaluation in 2020 ***Collaborators***: SBEP (conduct); County & Municipal Governments, FDEP, SWFWMD ***Projected 5-Year Costs and Funding Sources***: $$/SBEP (CWA 320), County and Municipal Governments, SWFWMD, FDEP ***Location***: SBEP bays
Activity 5.4	Continue seagrass mapping and monitoring and expand seagrass monitoring transects to Manatee County. ***Timeframe***: Ongoing; biennial ***Collaborators***: SBEP (support); SWFWMD (lead), County Governments ***Projected 5-Year Costs and Funding Sources***: $$$/SWFWMD, County Governments ***Location***: SBEP bays

Benefits

Mapping, monitoring, and enhancing hard bottom and seagrass habitats supports fish and shellfish populations and improves water quality.

5-Year Performance Metrics

- Reporting of acres of extant seagrass and hard-bottom habitats
- Net area of hard-bottom habitat created or restored

WH Objective 6: Protect, enhance, and restore beaches and dunes for wildlife and resiliency.

Activity 1: Restore coastal dunes and encourage protection of beach wrack communities.
Activity 2: Curate scientific knowledge of habitat impacts of dredge and fill projects from changes in grain size and turbidity.
Activity 3: Explore the role of SBEP in regional sediment management planning, including coordination with USACE for dredge and fill activities.

Benefits and Priority Concerns

SBEP area Gulf Coast barrier island beaches provide critical habitat for fish and wildlife and significant ecosystem services to Sarasota Bay. Many fish and wildlife species commonly associated with Sarasota Bay utilize beaches, dunes, and surf zone environments during various life stages. For instance, during May–October, loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*) use area beaches for nesting. Resident and migratory shorebirds depend on beaches and dunes for resting, foraging, and nesting. A community of small invertebrates live among the beach wrack that washes up on beaches. Beach wrack is the primary source of nutrients for beach communities, particularly for shorebirds (Dugan *et al.* 2003). Small animals living in wrack and nutrients from decomposing wrack regularly wash into the surf zone, making it an important nursery area for ecologically and economically important bay-associated fishes like snook, redfish, spotted seatrout, and sheepshead. Barrier island beaches and dunes also provide protection to relatively fragile bay habitats like seagrass meadows, salt marshes, and mangrove forests by reducing the impact of high energy waves and storms.

In addition to their environmental importance, Florida's beaches are the most prominent feature of Florida's brand and are the state's primary tourist attraction (EDR 2015). Top ranked beaches in the SBEP area include Bean Point, Coquina, Manatee, Lido, Siesta, Turtle, Caspersen, and Venice Beaches. Area beaches extend 47 miles along the Gulf barrier islands from Anna Maria Island in Manatee County to Manasota Key in Sarasota County with five passes opening to the bays between Tampa Bay and Charlotte Harbor. Passes provide important habitat for fish and wildlife and their dynamic geomorphology affects tidal mixing and flushing of bay waters.

Beaches are naturally dynamic systems that include both onshore terrestrial and offshore submerged components. The interaction of winds, waves, tides, and currents constantly reshapes beaches and dunes. High energy storm waves reposition sand from the upper beach and dunes to offshore sandbars. Between storms, lower energy waves return sand to the beach, where wind can blow it inland to rebuild dunes. Beaches are further shaped by natural inlet dynamics and variable

patterns of onshore-offshore and longshore sand transport. Adequate sediment availability also plays a role in beach accretion and erosion.

Priority management concerns include erosion, invasive species, recreational impacts, beach grooming, and pollution from infrastructure failures.

Erosion

Beach erosion is a natural process of barrier island movement. It becomes a management concern when it threatens coastal development or infrastructure. Beach erosion in the SBEP area is caused by sea level rise, tropical storms and hurricanes, winter frontal systems, and the effects of development, coastal armoring, and passes on adjacent beaches.

Of the 21.4 miles of beaches in FDEP's Sarasota Barriers North Reach subregion — which extends from the Southwest Channel entrance to Tampa Bay in Manatee County to the northwest end of Siesta Key in Sarasota County — 21.2 miles are designated as critically eroded. A total of 16.4 miles have been restored and maintained (FDEP 2018b). Of the 18.9 miles of beaches in the Sarasota Barriers South Reach subregion — which extends from the northwest end of Siesta Key to the north end of Manasota Key — 10.8 miles are designated as critically eroded. A total of 5.4 miles have been restored (FDEP 2018b).

Climate change is expected to drive warmer air and water temperatures, higher sea levels, more acidic ocean waters, and increased intensity of storms (SBEP and Shafer 2017). These pressures will negatively impact beaches and dunes and the flora and fauna that depend on them. Sea level rise will increase erosion and reduce the size of beaches or eliminate them altogether where beaches have lost the capacity to retreat due to coastal construction or armoring. More extreme storms will exacerbate ongoing beach erosion and create new problems for previously stable beach and dune systems.

Recent storms causing major erosion in the SBEP area (FDEP 2018b)

1982 No-Name Storm
1985 Hurricane Elena and Tropical Storms Bob and Juan
1996 Tropical Storm Josephine
2004 Hurricanes Frances, Ivan, and Jeanne
2005 Hurricane Wilma
2008 Tropical Storm Fay
2012 Tropical Storm Debby
2016 Tropical Storm Colin and Hurricane Hermine

2017	Hurricane Irma
2020	Tropical Storm Eta

Development, sand replenishment, and coastal armoring

When dynamic, moving beaches interact with fixed coastal construction, they can erode and be lost. When beaches erode, communities often respond with engineered solutions ranging from sand replenishment to coastal armoring (Doyle *et al.* 1984), the latter often leading to loss of beach (Doyle *et al.* 1984, Kaufman and Pilkey 1984). Sand replenishment projects are costly and tend to be temporary and repetitive. For example, between 1964 and March 2015, Lido Key Beach underwent 13 sand replenishment projects, adding a total of almost 3.3 million cubic yards of sand to the beach (FDEP 2018b).

Environmental impacts of sand replenishment projects can include:

- Burial of existing flora and fauna living on and in the sand, including invertebrates that are important food sources for surf-feeding fish, crabs, and shorebirds;
- Increased turbidity, which can negatively affect surrounding inlets and their bays;
- Mismatches between natural and dredged sand size and composition, which can negatively affect organisms that live in the sand and wildlife's ability to dig through it for nesting (Mallach and Leberg 1999); and mismatches in sand color, which can change the temperature of the beach surface by differential absorption of solar energy and affect reproductive habits, sex determination, and development of young (Standora and Spotila 1985); and
- Disturbances to wildlife due to operation of heavy machinery on the beach.

The Sarasota Bay area lacks a comprehensive understanding of the effects of turbidity on surrounding areas during dredge and fill operations, the importance of dredge material quality on habitat suitability, and the recovery of flora and fauna in and on beaches following replenishment activities.

Invasive exotic species

Invasive exotic plants can outcompete and exclude native beach and dune vegetation, creating diet and shelter mismatches with native fauna and building less-effective vegetative mats for dune stabilization.

Recreational use impacts and beach grooming

Recreational impacts to beaches include marine debris and litter, diminished water quality, disturbance and trampling of nests, exacerbation of erosion, and impacts from domesticated

animals. Domestic animals like dogs and cats can disturb and kill shorebirds, beach nesting birds, and sea turtle hatchlings, and reduce the suitability of beach habitat for their use. Recreational impacts also include beach maintenance practices like grooming that eliminates beach wrack. Beaches without wrack have lower species richness, abundance, and biomass of invertebrates, many of which are important prey species for shorebirds (Dugan *et al.* 2003, Defeo *et al.* 2009, Gilburn 2012). Removing wrack also interferes with sand retention and dune building (Dugan and Hubbard 2010, Nordstrom *et al.* 2012). FWC recommends that best beach management practices should avoid beach grooming, but if used, it should be done sparingly and, in a way to minimize impacts to wildlife and natural beach habitat succession (FWC 2017).

Infrastructure failures

Habitat quality at beaches can be degraded by impacts from human infrastructure failures, including wastewater overflows and spills, stormwater pollution, and oil spills. Bacteria pollution from stormwater and human sewage can contaminate coastal waters — impacting fish and wildlife and closing beaches for recreation. Florida's Department of Health manages the Florida Healthy Beaches Program, which provides information on high fecal indicator levels in water samples collected at beaches and informs the public about beach closures. Excess nutrient pollution in coastal waters from wastewater, stormwater, and a variety of other sources can fuel harmful algal blooms (HABs) like Florida red tide. Such blooms can reduce water and air quality, killing fish and beach-dependent animals that can further foul the beach and dune habitat.

Oil spills can impact beaches and the wildlife that use them by contaminating habitat and sources of food. Florida's NEPs can play an important role in providing credible and continuously updated information to local communities, leading outreach efforts, and serving as a conduit for local scientific information and data to local, state, and federal agency scientists and officials (Greening *et al.* 2018). Post-spill, they can lead restoration efforts and organize community involvement to ensure resiliency and long-term recovery.

Management Status and Regional Sand Management Planning

Beach and inlet management and practices in Florida are governed by the Florida Beach and Shore Preservation Act (Chapter 161, F.S.). Under the Act, FDEP identifies critically eroding beaches each year in their Critically Eroded Beaches Report (*e.g.*, FDEP 2018a, 2019) and develops, updates, and implements a Strategic Beach Management Plan (FDEP 2018b) that guides beach preservation and restoration. The Plan also overviews FDEP's beach management programs, permitting, coastal barrier inlets, beach restoration projects, and sand resources.

In the SBEP area, beaches are naturally replenished with sand by onshore-offshore and longshore sand transport, whereby sand generally moves in a southerly direction along the shore. For

example, sand from Lido Key naturally travels southward to replenish beaches on Siesta Key [aerial photo of sand plume from Lido Key to Siesta Key]. Artificially adding or removing sand from any part of the coastline can ultimately affect beaches downstream. As a result, longshore sand transport must be considered as a regional system that requires regional management coordination. The SBEP area lacks a comprehensive regional sand management planning process. Exploring regional sand management may provide collaborative and cost-effective solutions to sand management across municipal, county, state, and federal jurisdictions. It may also result in strategies for conservation and restoration uses for dredged materials other than for beach replenishment (*e.g.*, the Regional Sediment Management initiative in the Tampa Bay area). SBEP's trusted reputation as a science-based convener together with its established partnerships makes it well-positioned to assist in such planning processes.

Accomplishments and Priorities

Over the past five years, SBEP has led and participated in a variety of beach and dune restoration projects. In 2014, SBEP participated in replacing invasive exotic Australian pine trees on Siesta Beach with more than 400 native plants. Further protection was accomplished by acquisition of coastal beach and dune property through the Sarasota County Environmental Land Acquisition Program (ELAP) Program in 2015. In 2017 and 2018, SBEP created dunes along a section of Coquina Beach in Manatee County. SBEP also removed exotic vegetation on Leffis Key in 2017 and removed Australian pines from coastal upland habitat on North Lido Key. Over the next five years, SBEP will continue to prioritize projects to remove exotic species and restore beach and dune communities.

Strategy

Activity 6.1 Restore coastal dunes and encourage protection of beach wrack communities.

Timeframe: Ongoing
Collaborators: SBEP (collaborate); County & Municipal Governments, Audubon, FWC, Mote Marine Laboratory, USACE, DEP, Audubon
Projected 5-Year Costs and Funding Sources: $$$/SBEP (CWA 320), FWC, WCIND, USACE
Location: SBEP beaches

Activity 6.2 Curate scientific knowledge of habitat impacts of sand replenishment and movement.

Timeframe: Begin in 2022

Collaborators: SBEP (conduct); Mote Marine Laboratory, Florida Audubon, FWC, FDEP, NOAA
Projected 5-Year Costs and Funding Sources: $$/SBEP (CWA 320)
Location: SBEP beaches

Activity 6.3 Explore the role of SBEP in regional sediment management planning and monitoring, including coordination with USACE.

Timeframe: Begin in 2022
Collaborators: SBEP (conduct); County & Municipal Governments, USACE, FDEP
Projected 5-Year Costs and Funding Sources: $/SBEP (CWA 320)
Location: SBEP beaches

Benefits

Better understanding of impacts of dredge and fill activities on beach and dune habitat improves comprehensive planning and protection of sensitive fish, birds, turtles, and invertebrates.

5-Year Performance Metrics

- Increased acreage of restored dunes
- Peer-reviewed and adopted technical report on impacts of dredge and fill activities on beach and bay habitats

FISH AND WILDLIFE ACTION PLAN

GOAL: Protect, restore, and enhance fish and wildlife populations in SBEP bays and watersheds.

Introduction

The Sarasota Bay Estuarine System supports a rich diversity of fish and wildlife. Bay habitats, especially wetlands, oyster reefs, seagrass meadows, and tidal tributaries are animated with birds, fish, crustaceans, dolphins, manatees, and sea turtles. From cryptic to charismatic, these species are foundational to marine, estuarine, and freshwater ecosystem integrity, function, and services and are drivers of the cultural identity and economies of local communities. From the Calusa, Timucuan, and Tocobago tribes, to early Cuban fishers, to post-war Americans and their baby boomers, fish and wildlife have attracted and sustained human populations on Sarasota Bay for the past ten thousand years. Historical and sustained impacts associated with human population growth, especially during the 20th century (Figure 1 in Introduction), threaten the health and sustainability of fish and wildlife in SBEP bays and watersheds.

Threats to this goal include impacts associated with:

- Land development;
- Agriculture;
- Natural systems disruptions;
- Overharvesting;
- Human intrusions and disturbance;
- Invasive and nuisance species;
- Pollution; and
- Climate change.

To address these threats, a suite of integrated management activities is ongoing across multiple agencies, organizations, and partnerships to protect, restore, and enhance fish and wildlife, including species monitoring and assessment, fishing and hunting regulations, law enforcement, imperiled and invasive species management, public education, best management practices, incentives, and habitat protection and restoration. The SBEP Fish and Wildlife Action Plan supports these ongoing efforts.

The goal of the Fish and Wildlife Action Plan — to protect, restore, and enhance fish and wildlife populations in SBEP bays and watersheds — and the goals of the three other CCMP Action Plans are interdependent. Healthy populations of fish and wildlife depend on clean water (see Water Quality and Quantity Action Plan) and a mosaic of resilient, interconnected habitats ranging from freshwater wetlands, ponds, and creeks to brackish tidal creeks and estuaries, to marine waters of the Gulf of Mexico (see Watershed Habitats Action Plan). They also benefit from an informed public

that supports protection and restoration and reduces harmful interactions, unsustainable harvest, littering, and other negative impacts (see Community Engagement Action Plan).

Action Plan Strategy

This Fish and Wildlife Action Plan builds upon goals of the 2014 CCMP to protect fish and shellfish populations, and introduces new actions addressing other bay-associated wildlife. With this Plan, the SBEP Management Conference commits to three major objectives with the goal to protect, restore, and enhance fish and wildlife in SBEP waters and watersheds.

OBJECTIVE 1: PROTECT, RESTORE, AND ENHANCE THE DIVERSITY AND ABUNDANCE OF NATIVE FISH

OBJECTIVE 2: PROTECT, RESTORE, AND ENHANCE THE DIVERSITY AND ABUNDANCE OF NATIVE SHELLFISH

OBJECTIVE 3: MONITOR AND PROTECT THREATENED, ENDANGERED, AND VULNERABLE WILDLIFE

FW Objective 1: Protect, restore, and enhance the diversity and abundance of native fish.

Activity 1: Continue fish population monitoring programs to support fisheries management, monitor invasive species, and understand habitat usage through all life stages. Explore opportunities to expand monitoring programs to include a greater diversity of species, tidal creeks and canals, and use of innovative monitoring technologies.

Activity 2: Support research to fill fisheries data gaps, including habitat connectivity between SBEP tidal tributaries, bays, and the Gulf of Mexico; migration barriers; HAB response and recovery; and projected climate change impacts.

Activity 3: Explore capacity and potential effectiveness of protected managed areas, enhanced fishery management actions, and stock enhancement to protect and restore fish diversity, abundance, and resilience.

Activity 4: Promote ethical angling practices that increase conservation and prevent marine debris, including catch-and-release and monofilament recycling.

Background

SBEP bays and tributaries support a diversity of marine, estuarine, and freshwater fishes. They are critical components of bay ecosystem integrity, function, and services and are important to the cultural identity and economy of Sarasota and Manatee Counties.

For thousands of years, fish have been caught and used as an important source of dietary protein to human inhabitants of Sarasota Bay. Today, the Cortez fishing Village is the last local working waterfront, with a history of fishing families dating back over 100 years. The native striped mullet is still harvested by small local fishing boats. The mullet roe is collected, processed, and exported to Europe as exclusive Gulf Coast caviar, also known as bottarga.

Commercial fishing occurs throughout SBEP bays and coastal waters, with most fish landed in Manatee County (Table 1). According to the Florida Fish and Wildlife Conservation Commission (FWC), from 2014 to 2018, over 31.6 million pounds of finfish were commercially landed in Manatee County, worth over $25.6 million and 616,000 pounds of finfish were commercially landed in Sarasota County, worth $943,000. Commercial finfish landings are dominated by striped mullet (*Mugil cephalus*), thread herring (*Opisthonema oglinum*), small miscellaneous bait fish, ladyfish (*Elops saurus*), and red grouper (*Epinephelus morio*).

Table 1. Top ten commercially landed fish in Manatee and Sarasota Counties by weight for combined years 2014–2018. Source: FWC.

Manatee County Total Catch 2014-2018	
Fish	**Pounds**

Sarasota County Total Catch 2014-2018	
Fish	**Pounds**

striped mullet (*Mugil cephalus*)	9,881,783
thread herring (*Opisthonema oglinum*)	9,214,328
miscellaneous bait fish	2,931,205
ladyfish (*Elops saurus*)	2,583,114
red grouper (*Epinephelus morio*)	2,468,531
miscellaneous industrial fish	1,395,885
crevalle jack (*Caranx hippos*)	509,797
Spanish sardine (*Sardinella aurita*)	440,257
yellowedge grouper (*Hyporthodus flavolimbatus*)	244,225
Spanish mackerel (*Scomberomorus maculatus*)	230,295

striped mullet (*Mugil cephalus*)	375,911
red grouper (*Epinephelus morio*)	163,138
sheepshead (*Archosargus probatocephalus*)	11,458
striped mojarra (*Eugerres plumieri*)	9,716
Florida pompano (*Trachinotus carolinus*	9,316
gray snapper (*Lutjanus griseus*)	7,390
tilapia/nile perch (*Oreochromis spp.*)	6,879
red snapper (*Lutjanus campechanus*)	6,038
lane snapper (*Lutjanus synagris*)	4,010
miscellaneous jacks	3,278

Florida is popularly called the "Fishing Capital of the World" based on the number of anglers, time spent fishing, economic impact, diversity of recreational fishery species, international fishing records, and popularity of fishing tourism. In 2016, more than 3.7 million recreational anglers made over 13.2 million trips in Florida and spent over $5.9 billion on trip and durable goods expenditures (NMFS 2018). The most popular catch and release species are spotted seatrout (*Cynoscion nebulosus*), gray snapper (*Lutjanus griseus*), red drum (*Sciaenops ocellatus*), and common snook (*Centropomus undecimalis*). Recreational fishing occurs throughout SBEP bays and tributaries. In 2020, over 65,000 valid freshwater and saltwater state fishing licenses were held by recreational fishers in Manatee and Sarasota Counties (Table 2).

Table 2. Number of valid fishing licenses in Manatee and Sarasota Counties. Numbers of valid licenses do not necessarily reflect the number of unique fishers, as a fisher could be counted in both saltwater and freshwater license categories due to combination licenses. Source: FWC, 19 March 2020.

	Manatee	**Sarasota**	**Total**
Saltwater	22,466	24,054	46,520
Freshwater	9,061	9,866	18,927
Total	31,527	33,920	65,447

Many fishes depend on estuaries during all or part of their life cycle (Hollweg *et al.* 2019). In fact, more than 95% of US commercial fishery landings by weight in the Gulf of Mexico are estuary-dependent species (Chambers 1992, Lellis-Dibble *et al.* 2008). Some species, like common snook, striped mullet, and spotted seatrout, typically complete their entire life cycle in estuarine environments, moving in and out of tidal creeks, oyster reefs, seagrasses, mangroves, open beaches, and passes. Other species reproduce in the Gulf of Mexico, but complete part of their life

cycle in estuaries. For example, gray snapper and gag grouper (*Mycteroperca microlepis*) spend the first 12–18 months in estuaries, red drum and goliath grouper (*Epinephelus itajara*) spend their first few years in estuaries, and striped mullet spend most of their life cycle in estuaries.

[Callout Box: Tarpon.]

> Atlantic tarpon (*Megalops atlanticus*) are highly prized saltwater gamefish in Florida. They are powerful, acrobatic fighters with great stamina. They are almost exclusively a catch and release fishery, as their flesh has poor seafood value. Florida fishing regulations require a special tarpon tag if fishers intend to keep a tarpon, and then only if it is intended to be kept in pursuit of a Florida state record.
>
> Tarpon utilize saltwater, brackish, and freshwater habitats during different stages of their life history. Adults spawn in offshore waters in late spring to early summer, where larvae begin to grow and develop. Larvae later move inshore to salt marshes, creeks, and rivers where they become juveniles. As they transition into adulthood, they move back into offshore waters, though many can remain in freshwater habitats. They can survive in low oxygen waters due to their abilities to gulp air at the surface and attain oxygen from their swim bladder, which they also use for buoyancy. Juveniles feed on insects, fish, crabs, and shrimp, whereas adults typically feed on midwater prey species. Juveniles are preyed upon by fishes and birds, especially when they come to the surface for air. Adults are preyed upon by sharks, dolphins, and alligators.

Threats to local fish populations include degradation and loss of critical habitats, loss of corridors linking those habitats, altered hydrology, degraded water quality, harmful algal blooms, and overfishing.

Finfish are managed by an integrated complement of laws, regulations, and activities coordinated across federal and state agencies. State waters extend nine nautical miles into the Gulf of Mexico, where federal waters begin and extend to 200 miles offshore. The Magnuson-Stevens Fishery Conservation and Management Act governs fisheries management in federal waters (NMFS 2007). It protects long-term biological and economic sustainability of marine fisheries by preventing overfishing, rebuilding depleted stocks, increasing economic and social benefits, and ensuring a safe and sustainable supply of seafood.

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), also called NOAA Fisheries, works under the guidance of the Magnuson-Stevens Act and in partnership with Regional Fishery Management Councils to assess and predict the status of fish stocks, set catch limits, ensure compliance with regulations, and reduce bycatch. The Gulf of Mexico Fishery Management Council partners with NMFS for federal waters of the Gulf of Mexico.

The US Fish and Wildlife Service (USFWS) works with partners to conserve, protect, and enhance fish, wildlife, and their habitats for the continuing benefit of people.

The Florida Constitution authorizes FWC to enact rules and regulations to manage and regulate fish resources in the state and to enforce those regulations. Together, FWC's Division of Marine Fisheries Management and the Division of Freshwater Fisheries Management develop management and regulatory recommendations to ensure long-term conservation of fisheries. They prepare fishery management plans, issue special activities licenses, facilitate artificial reef development and deployment, assist with derelict trap-retrieval, and develop and implement recreational and commercial fisheries outreach and education programs. The Marine Fisheries Division serves as a liaison to federal agencies on marine issues and represents Florida on the Gulf of Mexico Fisheries Management Council. They also provide information about fish populations and angler activities to inform management decisions and to assess impacts. FWC's Division of Law Enforcement educates the public and enforces state and federal fisheries laws, protects endangered species and habitats, and investigates fish and wildlife crimes. In addition, they educate the public and enforce state and federal environmental laws preserving natural and cultural resources and protecting state lands and water quality.

Status

Protecting, restoring, and enhancing the diversity and abundance of native fish populations is a long-standing management priority for SBEP (SBEP 1995). A variety of management activities are ongoing or proposed to accomplish this objective, including research and monitoring, protected areas, stock enhancement, habitat protection and restoration, and outreach and education.

Research and Monitoring

Understanding the life history, ecology, and population dynamics of fishes in SBEP bays and tributaries through research and monitoring is fundamental for informed management of estuarine ecosystems, commercial and recreational fisheries, water quality, and habitat protection and restoration. A variety of programs monitor fishes in SBEP bays and tributaries.

FWRI Fisheries Independent Monitoring (FIM) Program provides timely, fisheries-independent data and analysis to help conserve and protect Florida's fisheries. The program aims to

- detect changes in relative abundance of fishes and select invertebrates
- improve knowledge of species life history, habitat utilization, and recruitment dynamics
- describe baseline conditions and document changes in the biological condition of Florida's estuaries.

FIM has conducted routine bimonthly fish surveys in SBEP bays since 2009, using three gear types to sample juvenile, subadult, and adult life history stages in multiple estuarine habitats (Jones *et al.* 2019, FWC-FWRI 2018). FIM records species, size, sex, number caught, habitat features (type and quantity of submerged and shoreline vegetations and the presence of seawalls or oyster beds), and water quality data (temperature, pH, salinity, and dissolved oxygen). In 2018, 106,892 fishes from

92 taxa[3] were collected. Bay anchovy (*Anchoa mitchilli*), pinfish (*Lagodon rhomboides*), and mojarra (*Eucinostomus spp.*) accounted for more than 66 percent of the total catch. FIM monitoring is an important tool for understanding changes in species diversity and abundance as impacted by stressors such as red tide, climate change, and fishing pressure.

New College of Florida (NCF) has conducted monthly fish surveys from April to October in Big Sarasota Bay since 2016 (Moncrief-Cox *et al.* 2020). They monitor relative abundance, size distributions, and habitat characteristics and assess long-term trends and the impacts of acute perturbations, such as harmful algal blooms. The NCF survey, conducted in conjunction with NOAA's Gulf of Mexico Shark Pupping and Nursery (GULFSPAN) survey, uses gillnets to capture a variety of fish, primarily upper trophic level species. Data including species, size, number caught, habitat type, and water quality (temperature, salinity, dissolved oxygen, and turbidity) are collected. For sharks and rays, sex and life stage are also recorded, and animals are tagged to facilitate identification in the event of recapture. From 2016–2019, 2,410 fish representing 50 taxa were collected. The ten most abundant species captured (in descending order) include hardhead catfish (*Ariopsus felis*), bonnethead (*Sphyrna tiburo*), yellowfin menhaden (*Brevoortia smithii*), gafftopsail catfish (*Bagre marinus*), Spanish mackerel (*Scomberomorus maculatus*), Florida pompano (*Trachinotus carolinus*), striped pinfish (*Lagodon rhomboides*), bluefish (*Pomatomus saltatrix*), ladyfish (*Elops saurus*), and crevalle jack (*Caranx hippos*).

The Chicago Zoological Society's Sarasota Dolphin Research Program (CZS-SDRP) conducts seasonal multi-species fish surveys to explore relationships between resident dolphins in Sarasota Bay and their prey. SDRP monitors abundance, distribution, and body size of fishes in seagrass habitats during winter (Jan-Mar) and summer (Jun-Sep) months. In the winter of 2016, SDRP sampled 31,681 fish from 59 species (Berens McCabe and Brennerman 2017). SDRP seasonal surveys can be an important tool for understanding red tide impacts to fishes and dolphins. During the 2017–2018 red tide, surveys detected an 88% decline in primary dolphin prey fish species from Aug/Sep 2017 to Aug/Sep 2018 (Wells and McCabe 2020)

Sarasota Coast Acoustic Network (SCAN) is operated collaboratively by Mote Marine Laboratory, SDRP, New College of Florida, Florida Atlantic University, and Loggerhead Instruments. SCAN researchers tag fish with transmitters that send signals to strategically-placed listening stations as fish swim near them. SCAN can track predator and prey movements and how they respond to stressors like cold snaps, storms, pollution, and Florida red tide. To date, tracking efforts have focused on bull sharks (*Carcharhinus leucas*), great hammerheads (*Sphyrna mokarran*), spotted eagle rays (*Aetobatus narinari*), and common snook (*Centropomus undecimalis*). Mote researchers have installed acoustic receivers in six tidal creeks around Sarasota Bay and in passes connecting the bay to the Gulf of Mexico in order to track acoustic-tagged snook between areas used for shelter and reproduction. New College of Florida tracks young blacktip sharks (*Carcharhinus limbatus*) to determine resident or migrant status. Presence of newborn blacktips suggests that

[3] Taxa refer mostly to species, but due to difficulties in identification may refer to complexes of similar species.

Sarasota Bay may host a primary nursery area for them. Blacktips may return to the bay from time to time and have been shown to flee shallow bays in response to tropical storms.

[Callout Box:]

Spotted eagle rays tagged in the Sarasota Bay area by Mote have been detected as far away as the Panhandle and Florida Keys. Tracking data suggest that spotted eagle rays reside in Sarasota Bay and nearby coastal waters spring through fall, then leave during winter months. Individuals can leave Sarasota Bay during red tide events and return when the coast is clear. During the summer of 2020, the City of Sarasota began dredging sand from the ebb shoal of Big Pass, an important habitat for spotted eagle rays.]

Passive Acoustic Listening Stations (PALS) is a collaborative network of passive underwater listening stations operated by CZS-SDRP, New College of Florida, Loggerhead Instruments, and citizen scientists in Sarasota Bay. Researchers use hydrophones connected to land-based stations to listen to underwater sounds emitted by a variety of animals to learn more about their biology and how they respond to disturbances. Compared to light, sound can travel considerable distances underwater. Many animals have evolved to use sounds for hunting, mating, territorial defense, and other social communication. For example, manatee mothers rely on sound to communicate with and locate their calves. Dolphins emit signature whistles that uniquely identify them to fellow dolphins in the area. Researchers hope to be able to use machine learning of these unique whistles to identify and track individual dolphins throughout the PALS network. During the 2018–2019 red tide event, listening stations on Longboat Key and Palma Sola documented a two-fold drop in biological sound levels.

The Sarasota Bay Artificial Reef Monitoring Project documented the ecological use and fish diversity of three artificial reefs (Hart's Family Reef, Walker's Reef, and Sportfish Angler's Club Reef) in Big Sarasota Bay. Side-scan sonar imagery produced maps of the entire permitted reef area showing the location of reef materials deployed since the reefs were created. Reef fish censuses were conducted using three techniques: roving divers, stationary divers, and baited underwater video recordings. A new reef module, called the "deep cover", showed great promise as a habitat for juvenile gag grouper (*Mycteroperca microlepis*), which use bays and estuaries before migrating to the offshore fishery. Results will help reef managers evaluate the ecological and economic benefits of artificial reefs in Sarasota Bay and inform future artificial reef planning and development.

Marine Protected Areas

Marine protected areas (MPAs) can provide ecological, cultural, and economic benefits, including enhancements to biodiversity, fishery populations, resilience, and ecosystem services. They can also serve as a local benchmark for environmental health and a laboratory for education and science. MPAs can help recover declining fish populations by restricting fishing methods, seasons, or catch limits, or by restricting fishing altogether. Reduced fishing pressure provides refuge for

spawning stocks and increases abundance within the MPA, creating spillover into nearby unprotected areas (Rolim *et al.* 2019, Christie *et al.* 2020). A network of MPAs can be especially valuable for repopulating adjacent areas impacted by episodic events like red tide or for mitigating and promoting adaptation to long-term stressors like climate change (Roberts *et al.* 2017).

[Callout box:]

The Sister Keys are the largest group of undeveloped, protected islands in Sarasota Bay. The Sister Keys Conservatory, formed by a group of concerned citizens, worked for four years to protect the islands from development. In 1992, the Town of Longboat Key purchased the islands for protection and in 2007, the town embarked on a $1 million mitigation project to remove invasive species, plant native species, and restore wetlands. Today, the Sister Keys host a diverse assemblage of wildlife, including gopher tortoises, fiddler crabs, ibis, and roseate spoonbills. Sarasota Bay Watch works to maintain the restored islands with an annual cleanup. Seagrass adjacent to the islands provides nursery areas for snook, redfish, sea trout, and flounder and habitat for crabs, oysters, scallops, and manatees. Enhanced fishing regulations in a fringing buffer around the islands could provide critical protections for these species and others, including species using the restored terrestrial and intertidal habitats of the protected islands. SBEP's first CCMP adopted an Action to establish a conservation area near Sister Keys with limited access or activity (Action 2.1, SBEP 1995). Increased human population size, development, and fishing pressure around Sarasota Bay — in addition to impacts of episodic red tides — makes this uncompleted Action even more relevant today for restoring fish diversity, abundance, and resilience.]

Stock Enhancement

Stock enhancement involves raising fish in a hatchery and releasing them at an optimal time and place to supplement existing populations. It is an important tool for recovering depleted populations impacted by overfishing, cold shocks, red tide, or other pressures. Stock enhancement typically focuses on commercially or recreationally important species but can also be used to restore populations of threatened, endangered, or vulnerable species. Some residential communities in the Sarasota Bay area are experimenting with stocking fish in private stormwater ponds to reduce algal blooms and to mimic a more natural aquatic ecosystem. The success of stock enhancement can often be improved when coupled with appropriate habitat protection and restoration to support enhanced populations. For example, released fish can quickly fall prey to predators if they cannot access suitable refuge habitats.

Research is underway on Florida's west coast to understand how stock enhancement can be used in conjunction with habitat restoration and fishing regulations to restore and enhance fish

populations. For example, FWC is experimenting with rearing red drum (*Sciaenops ocellatus*) to enhance wild populations and support the recreational fishery in Tampa Bay. Mote Marine Laboratory in partnership with FWC is studying optimal hatchery conditioning and release sites, times, and protocols for responsible common snook stock enhancement in the Sarasota Bay system. A recent study that released 1,920 juvenile snook into Phillippi Creek reported the highest survival among individuals released in the lower reaches of the tidal creek in the spring (Schloesser *et al.* 2019). They also found that exposing hatchery snook to live prey could improve post-release feeding performance and survival (Caldeney *et al.* 2019).

Habitat Protection and Restoration

SBEP and its partners support, coordinate, and conduct efforts to protect, restore, and promote recovery of critical fish habitats, especially wetlands, oyster reefs, and seagrass meadows (see Watershed Habitats Action Plan). A review of publications documenting habitat restoration projects in the northern Gulf of Mexico found that nekton colonization can be relatively rapid following seagrass and oyster reef restoration, with densities and assemblages matching reference sites with five years for seagrass and 1–2 years for oyster reefs (Hollweg *et al.* 2019). For restored marshes, fishes can recover to reference densities and assemblages about three years after restoration, but crustaceans can take longer than a decade to achieve reference densities and assemblages. SBEP's strategy for water quality improvement through nutrient management also improves fish habitat by promoting seagrass recovery (see Water Quality and Quantity Action Plan).

Outreach and Education

SBEP and its partners also promote ethical angling practices to fishers through a variety of outreach and education formats. Ethical angling includes behaviors that conserve fishery stocks and reduce impacts to water and habitat quality and to non-targeted species of fish and wildlife. Education focuses on increasing knowledge about fish and support for their conservation, fishing rules and regulations, prevention of marine debris, proper disposal or recycling of monofilament line and other fishing gear, catch and release, and reducing impacts to birds, turtles, and marine mammals. Public engagement focuses on fishing skills, ethical practices, and marine debris and monofilament line cleanups. Partners include FWC, FDEP, Mote Marine Laboratory, Sarasota Bay Watch, NOAA, Florida Sea Grant, and Audubon Florida.

Priorities

SBEP and partners will continue to protect and restore water quality (see Water Quality and Quantity Action Plan) and the full mosaic of interconnected aquatic habitats necessary to support fish populations, including seagrasses, mangrove shorelines, tidal creeks, and oyster reefs, and other hardbottom habitats (see Watershed Habitats Action Plan). SBEP will continue to increase knowledge about fish life history and population dynamics in tidal tributaries, bays, and Gulf of

Mexico. Priorities include understanding habitat usage by all life stages and connectivity among those habitats, response and recovery to harmful algal blooms, impacts of invasive species, and projected climate change impacts. Fish monitoring programs will continue to advance these understandings, support adaptive fishery management, and provide important feedback on the effectiveness of water and habitat quality improvement strategies. If monitoring leads to the recognition of a problem, for example, the rapid population growth of an invasive species, SBEP will collaborate with partners to develop adaptive management strategies.

SBEP and its partners will continue to promote research and use of enhanced fishery management tools and programs like artificial reefs, marine protected areas, and stock enhancement to protect, restore, and enhance fish populations in SBEP waters. We will continue to support and conduct outreach and education to promote ethical angling practices that increase conservation and prevent marine debris.

Strategy

Activity 1.1 Continue fish population monitoring programs to support fisheries management, monitor invasive species, and understand habitat usage through all life stages. Explore opportunities to expand monitoring programs to include a greater diversity of species, tidal creeks and canals, and use of innovative monitoring technologies.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate); FWC; CZS-SDRP; NCF; SCAN; Florida Sea Grant; NOAA; Mote
Projected 5-Year Costs and Funding Sources: $$$/SBEP (320); FWC; County & Municipal Governments; NOAA
Location: SBEP bays and tributaries

Activity 1.2 Support research to fill fisheries data gaps, including habitat connectivity between SBEP tidal tributaries, bays, and the Gulf of Mexico; migration barriers; HAB response and recovery; and projected climate change impacts.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate); Mote; FWC; NCF; Florida Sea Grant; NOAA
Projected 5-Year Costs and Funding Sources: $$$/SBEP (320); Grants
Location: SBEP bays and tributaries

Activity 1.3 Explore capacity and potential effectiveness of protected managed areas, enhanced fishery management actions, and stock enhancement to protect and restore fish diversity, abundance, and resilience.

Timeframe: Ongoing; Explore protected managed areas by 2023
Collaborators: SBEP (Support); FDEP; FWC; Mote
Projected 5-Year Costs and Funding Sources: $$$/Grants
Location: SBEP bays and tributaries

Activity 1.4 Promote ethical angling practices that increase conservation and prevent marine debris, including catch-and-release and monofilament recycling.
Timeframe: Ongoing
Collaborators: SBEP (Collaborate); FDEP; Florida Sea Grant; Sarasota Bay Watch; Mote; FWC; Audubon Florida; Save Our Seabirds; Fishing enthusiast organizations
Projected 5-Year Costs and Funding Sources: $$/SBEP (320); Grants
Location: SBEP bays and tributaries

Benefits

Native fish are critical components of the ecological integrity of SBEP bays and tributaries.

5-Year Performance Metrics

- Continued bimonthly fish population monitoring in priority SBEP estuary segments

FW Objective 2: Protect, restore, and enhance the diversity and abundance of native shellfish.

Activity 1: Monitor native bivalve populations and protect, restore, and enhance their habitats.
Activity 2: Support research to understand native shellfish recruitment, habitat needs, and vulnerabilities to climate change impacts.
Activity 3: Support research to understand the benefits of native bivalve stock enhancement for improvements to water quality, habitat, and native populations.

Background

Shellfish is a casual term applied to aquatic invertebrates with shells and exoskeletons that are commonly consumed as seafood. SBEP waters support diverse assemblages of shellfish, including oysters, clams, scallops, crabs, shrimp, and lobsters. These species are important components of the integrity and function of SBEP bays and tidal tributaries and provide a wide range of beneficial ecosystem services. They are also valuable to the culture and economy of Sarasota Bay communities.

Gastropods

Gastropods are a large and diverse taxonomic class of mollusks that include terrestrial, freshwater, and marine snails and slugs. Examples include conchs, whelks, sea hares, and nudibranchs. They serve a variety of roles in Sarasota Bay's food web. For example, herbivorous gastropods are important for reducing algae and dead matter in benthic environments. Many are an important source of food for fish, crabs, birds, and other gastropods and some are harvested in Florida as seafood. Their discarded shells can provide habitat and protection for other animals and are highly prized by seashell collectors.

Crustaceans

Crustaceans play an important role in Sarasota Bay's benthic food web and many are commercially important fishery species. From 2014–2018, over 623,271 pounds of crabs, shrimp, and lobster were commercially landed in Manatee and Sarasota Counties, worth over $5.4 million (Table 3). Fresh stone crab claws are a classic staple of Florida culinary culture, available only during stone crab season between mid-October to mid-May (Mink 2006). The stone crab fishery is unique in that fishers break one or two claws from the crab, then return it to the water to molt and regenerate missing claws. Taking only one claw is a local tradition and can lead to a more sustainable fishery.

Table 3 Top commercially landed decapod crustaceans in Manatee and Sarasota Counties by weight for combined years 2014–2018. Source FWC.

Manatee County Total Catch 2014-2018	Sarasota County Total Catch 2014-2018

Crustacean	Pounds
stone crab (*Menippe mercenaria*)	211,975
blue crab (*Callinectes sapidus*)	128,898
bait shrimp	80,070
pink shrimp (*Farfantepenaeus duorarum*)	34,955
miscellaneous invertebrates	6,091
rock shrimp (*Sicyonia brevirostris*)	488
Spanish lobster (*Panulirus guttatus*)	109
Grand Total	**462,586**

Crustacean	Pounds
stone crab (*Menippe mercenaria*)	123,919
blue crab (*Callinectes sapidus*)	36,516
bait shrimp	112
Spanish lobster (*Panulirus guttatus*)	73
spiny lobster (*Panulirus argus*)	65
Grand Total	**160,685**

Bivalves: Oysters, Clams, and Scallops

Bivalves are important to the ecosystem integrity, function, and services of Sarasota Bay and its tributaries and serve as important biological indicators of environmental health. They reduce erosion, stabilize shorelines, and provide habitat and food to invertebrates, fish, and birds (see Watershed Habitats Action Plan). Bivalves filter suspended particulates as they feed, including microalgae and suspended sediments. Transferring waterborne nutrients into shell and benthic sediments can reduce nitrogen and phosphorus in the water, improve water clarity, and sequester carbon. Harvesting wild and aquaculture bivalves can more permanently remove nutrients and carbon from the system.

Native Americans harvested oysters, clams, scallops, and other bivalves for food, and created large mounds of discarded shell, called middens, along the coast. Many middens were destroyed to support coastal development, but some are preserved and offer a retrospective natural history of shellfish abundance in Sarasota Bay. People collected and consumed bivalves from Sarasota Bay and its tributaries from prehistory up until around the 1970s, when hydrological alterations, habitat destruction, and diminished water quality reduced population sizes and bacterial pollution made them unsafe to eat.

Oysters

The Eastern oyster (*Crassostrea virginica*) is the only reef-building oyster in Florida and predominately grows in shallow estuarine areas near freshwater inputs. Oysters form subtidal and intertidal reefs by the cumulative buildup of successive generations of oyster shells, and can colonize most natural and artificial hard structures, including mangrove roots and seawalls.

An estimated 80–90 percent of historical oyster reefs in Florida have been lost due to human impacts (Radabaugh *et al.* 2019). Many oyster reefs were historically dredged for navigation, mined for construction material, or filled during shoreline expansion projects. By the late 1980s, nearly 3,500 acres of benthic habitats in Sarasota Bay were filled with dredge material (SBEP 2006).

Oysters have also declined due to increased water pollution, sedimentation, and low oxygen conditions (VanderKooy 2012). Careless boating behaviors, including large boat wakes, groundings, and anchoring (TBEP 2017) can further stress populations.

Changes in salinity regimes due to human-caused changes in the historical timing, amount, and location of freshwater flow (see Water Quality and Quantity Action Plan) have been especially damaging to oysters. Eastern oysters have an optimum salinity range of 14–18, though they can temporarily tolerate extremes between 5–40 (Radabaugh *et al.* 2019). Low salinity conditions cause oyster growth and reproduction to decline, resulting in high mortality in freshwater conditions. Although oysters can tolerate high salinity better than low, the resulting stress can increase susceptibility to disease, parasites, and predation. Increased temperature, like that expected from climate change, will reduce tolerances to salinity extremes. Salinity regimes are expected to be further altered by climate change due to sea level rise, prolonged droughts, and more intense episodic rainfall (Tolley *et al.* 2010, SBEP and Shafer 2017). Climate change is also expected to impact oyster shell formation due to ocean acidification (Hofmann *et al.* 2010).

Bivalves can concentrate water-borne pollutants like bacteria, viruses, toxins, and chemicals in their tissues during filter-feeding, which can cause serious and sometimes fatal human illnesses if consumed from areas with polluted waters. The Florida Department of Agriculture and Consumer Services (FDACS) manages shellfish harvesting within designated harvesting areas in the state. In Sarasota Bay, FDACS conditionally approves harvest of oysters and clams in an area stretching from the SR 684 bridge to Anna Maria Island southward to the north shoreline of Phillippi Creek (Area 54). Between 1951–2019, only four commercial oyster harvests were recorded in Sarasota Bay (Radabaugh *et al.* 2019). Area 54 has been closed for shellfish harvest since September 2004 due to exceedances of waterborne bacteria. Sarasota County government monitors bacteria pollution in tidal creeks, but not in the bay (see Water Quality Action Plan). Monitoring bacteria pollution in Area 54 may be an important management tool in the future to provide feedback on water quality improvement efforts for bacteria-impaired waters, like nearby Phillippi Creek.

<u>Scallops</u>

Bay scallops (*Argopecten irradians*) live predominately in seagrass meadows in shallow nearshore waters along Florida's Gulf Coast. Though once common in Sarasota Bay, they have nearly disappeared. Commercial and recreational harvest of scallops in Sarasota Bay is prohibited.

<u>Clams</u>

Clams generally live in sandy coastal habitats with sufficient water circulation to bring food and oxygen and flush wastes. They are often found in association with seagrass and sometimes oyster reefs. Preliminary research suggests that hard clams can improve water quality and clarity through filter feeding and transferring nutrients to sediments. These actions may also promote seagrass

growth, but require further study (Peterson and Heck 2001a, 2001b, Gulf Shellfish Institute 2019). Environmental stressors to clams include habitat loss, sedimentation, disease, and hydrological changes. Little is known about the abundance of clams in Sarasota Bay today compared to historical levels.

The non-commercial Florida cross barred Venus clam (*Chione elevate*) is probably the most abundant clam in Sarasota Bay. Smaller numbers of commercially important clams are commonly present, including the indigenous southern hard clam (*Mercenaria campechiensis*), introduced northern hard clam (*Mercenaria mercenaria*), and sunray Venus clam (*Macrocallista nimbosa*). Only one area on the bay side of Longboat Key is conditionally approved for clam harvest in Sarasota Bay, and it has been closed since September 2004 due to bacteria pollution. A 1990 survey found *Mercenaria spp*. to be least abundant on the eastern shore of Sarasota Bay, and most abundant on the western shore — largely in the conditionally approved area for harvest (Dixon 1992). Depleted stocks of the indigenous southern hard clam on Florida's west coast motivated scientists in the late 1950s to introduce the northern hard clam into Florida's Gulf Coast waters to study its feasibility for commercial aquaculture — mainly because it had a longer shelf life than the southern hard clam (Menzel and Sims 1962). Large-scale introductions by the industry followed in 1993 and continue today. These introductions resulted in the creation of hybrids between the northern and southern hard clams, which threaten the southern hard clam (Arnold *et al.* 2004, Arnold *et al.* 2009). No commercial aquaculture of hard clams occurs in Sarasota Bay, although Sarasota Bay Watch is working to obtain a permit to grow the indigenous southern hard clam for restoration purposes.

The invasive Asian Green Mussel (*Perna viridis*) lacks native predators and can outcompete native bivalves for space and food (Yuan *et al.* 2016). Originally from the Indian and Pacific Oceans, they were likely introduced into the Gulf of Mexico in the 1990s through the release of ship ballast water (Baker *et al.* 2007). They were first discovered in Tampa Bay in 1999, which is their northern geographical limit due to temperature. New recruits of green mussels have been found in Sarasota Bay, but they do not appear to have established significant populations.

Status

Research and Monitoring

Understanding recruitment dynamics and water and habitat quality needs is central to managing shellfish populations. Monitoring shellfish distribution and abundance through time and space provides timely feedback to managers to assess and respond to threats and to evaluate benefits of water and habitat improvements. Improved understanding of shellfish population status and trends also provides important insights into ecosystem dynamics and health.

SBEP participates in the Oyster Integrated Mapping and Monitoring Program, which utilizes a collaborative network of experts to collect and synthesize mapping and monitoring data in Florida to characterize the status and trends of oysters and their habitats and to identify management

priorities (Radabaugh *et al.* 2019). Oyster reefs as critical habitat is discussed further in the Watershed Habitats Chapter.

The Southwest Florida Water Management District (SWFWMD) conducts aerial oyster mapping every two years ancillary to seagrass mapping efforts and without ground-truthing. In 2016, they mapped 76.74 acres of oysters in SBEP bays and tributaries, providing baseline information of habitat extent in the region (Table 4). Sarasota County Government produced maps of oyster assemblages in Sarasota County bays, estuaries, and tidal creeks from 2008–2012 to document baseline conditions and identify restoration opportunities (Meaux *et al.* 2016). They used a rapid assessment technique based on FWC protocols (Meaux *et al.* 2011) to estimate oyster cover, characterize oysters as reef, seawall, rip rap, mangrove apron, mangrove root, piling, clumps, or shell, and demarcate their upstream extent in creeks. Most oysters in SBEP bays are part of natural reef formations, with smaller populations growing on seawalls, rip rap, mangrove roots, and pilings. For SBEP bays located in Sarasota County, Little Sarasota Bay followed by Sarasota Bay and Roberts Bay host the highest oyster acreages (Figure 1). Work by Sarasota County has found that oysters favored seawalls over riprap and were absent from metal seawalls and bulkheads and from high density polyethylene pile wraps. These findings have important implications for designing seawalls that can better accommodate oysters. Seawalls have replaced coastal wetlands in over 80 percent of Big Sarasota Bay shorelines (SBEP 2010).

Table 4: Oyster area in SBEP bays as recently mapped by Sarasota County's rapid assessment and SWFWMD aerial photointerpretation methodologies. Mapping areas and times differ between the assessments. Adapted from Raulerson *et al.* 2019 with data from Sarasota County (Meaux *et al.* 2016) and SWFWMD (SWFWMD 2016).

Bay Segment	Oyster Area (acres)	
	Sarasota Co.	SWFWMD
Palma Sola Bay		6.91
Big Sarasota Bay	7.29*	23.83
Little Sarasota Bay	17.38	23.26
Roberts Bay	9.23	21.33
Dryman Bay	2.55	
Blackburn Bay	2.11	1.41
Lyons Bay	2.85	
Dona Bay	1.35	
Roberts Bay, Venice	1.49	

* Sarasota County only mapped oysters in their portion of Sarasota Bay, whereas SWFWMD mapped both Sarasota and Manatee County portions.

Figure 1. Oyster reefs and oyster reef restoration project locations.

Sarasota County began regular annual monitoring of oysters in 2006 to gauge effects of freshwater flow on oyster condition (Jones 2006). Sarasota County's program records percent of live oysters. They monitor oysters in the Hudson Bayou and Phillippi Creek tributaries of Sarasota Bay and North and South creek tributaries of Little Sarasota Bay.

Bay scallops are important indicators of water quality. Sarasota County monitors their populations to evaluate the effectiveness of water quality improvement efforts. The program conducts surveys of new scallop recruits (spat) and adults, and monitors survival of caged adults. Monitoring began in 2008 and is conducted in partnership with FWC's Fish and Wildlife Research Institute (FWC-FWRI), Mote Marine Laboratory, and Sarasota Bay Watch. Results from 2019 monitoring suggested a low recruitment year with a temporal shift in recruitment from spring (April) to summer (July) and winter (November-December), possibly due to the 2018–2019 red tide bloom (Janneman 2019).

Since 2008, Sarasota Bay Watch has hosted the annual Great Scallop Search, when volunteers from Sarasota and Manatee Counties head out in boats and kayaks to snorkel in seagrass meadows and count scallops. The event provides educational opportunities for citizens to discover Sarasota Bay's seagrass meadows, learn how water quality is connected to habitat quality and scallops, and if they are lucky – to encounter live scallops in the wild.

Stock Enhancement

Stock enhancement is underway in Sarasota Bay to restore and enhance populations of oysters, clams, and scallops.

For nearly two decades, SBEP has led oyster restoration efforts in SBEP bays. Oysters can be restored in areas if appropriate environmental conditions are restored, including availability of suitable hard substrate and salinity regimes. SBEP reviews historical oyster reefs, current water conditions, and potential oyster recruitment to identify optimum oyster restoration sites. In 2005, new reefs were created at White Beach and Turtle Beach in Sarasota County and in 2010 new reefs were created offshore the Gladiola Fields in Manatee County. Starting in 2017, 1.2 acres of new oyster reef was created at the 34th Street Canal in Bayshore Gardens and hundreds of feet of oyster habitat was enhanced at Robinson and Perico Preserves. Oyster restoration has recently received a boost from the Gulf Coast Oyster Recycling and Renewal Program (GCORR), a local partnership of community volunteers who bag and deploy oyster shells donated by eleven participating seafood restaurants. The GCORR program reduces impacts of shell mining and has eliminated approximately 80 tons of restaurant shell waste going to landfills. Manatee County is planning an ambitious program of over 100 acres of oyster restoration on the banks of the Manatee River, once called the Oyster River because of the historical abundance of oysters. Restoration of oyster reefs is discussed further in the Watershed Habitats Chapter.

Scallop restoration has been a longstanding interest of SBEP and partners. Recognizing that improvements in seagrass coverage and water quality in Sarasota Bay may make conditions favorable for a resurgence of scallop populations, Sarasota Bay Watch formed a community-based partnership in 2011 with citizens, businesses, and local organizations to restore scallops in Sarasota Bay with guidance from SBEP, FWC-FWRI, SBEP, Mote, and the Bay Shellfish Company. From 2011–2018, SBW released 105.2 million larval and 110,000 juvenile scallops at strategically selected locations in Sarasota Bay, utilizing a variety of approaches including free releases and boom-contained releases to reduce predation. From 2015–2017, SBW, Sarasota County, and Mote Marine Laboratory deployed 1,640 maturing adult scallops in protective cages to create natural spawning pulses to repopulate the bay. Despite these efforts, scallop populations in Sarasota Bay remain small. A relatively short 12 to 18-month lifespan makes scallops vulnerable to episodic salinity or temperature shocks, predator population dynamics, and red tide. Their short two-week larval stage limits the dispersal potential of remote populations to restore nearby impacted populations through new recruitment. Combined, these life history characteristics make restoration and enhancement of scallop populations in Sarasota Bay difficult.

In an effort to restore once abundant populations of southern hard clam in Sarasota Bay, SBW launched a stock enhancement program in 2016. To date, they have released a total of 380,221 southern hard clams into Sarasota Bay. Mote Marine Laboratory is conducting monitoring at release sites. Unlike bay scallops, southern hard clams are more tolerant of red tide and can remove *K. brevis* cells from the water column.

Priorities

Achieving healthy and resilient shellfish populations is an important benchmark of ecosystem health for Sarasota Bay and its tributaries. SBEP and partners will continue to advance understanding, monitoring, protection, restoration, and enhancement of priority shellfish populations. Priority research needs include native shellfish recruitment dynamics, water and habitat quality needs, and shellfish vulnerabilities to anthropogenic and climate change impacts. Continued monitoring will provide timely feedback to fisheries and ecosystem managers to assess ongoing and new threats and to evaluate benefits of improving water and habitat quality. SBEP and partners are committed to continuous improvement of water quality and hydrological conditions that mimic natural flow and reduce rapid changes in salinity and salinity extremes (see Water Quality and Quantity Action Plan). SBEP will continue to participate in the Oyster Integrated Mapping and Monitoring Program and support key recommendations for research, mapping, and managing shellfish that are appropriate for Sarasota Bay (Radabaugh *et al.* 2019). SBEP will support SWFWMD and Sarasota County shellfish mapping and monitoring programs. Improved understanding of the benefits of native bivalve stock enhancement for water and habitat quality and for building healthy, resilient populations of target shellfish is an important priority for SBEP and partners, as well. SBEP will continue to coordinate and support restoration and enhancement of oyster reefs in priority locations throughout the bay. SBEP will also continue to monitor and

provide scientific assistance to ongoing community-driven efforts to restore bay scallops and southern hard clams in the bay.

Strategy

Activity 2.1 Monitor native bivalve populations and protect, restore, and enhance their habitats.

Timeframe: Ongoing
Collaborators: SBEP (Conduct); County Governments; Sarasota Bay Watch; Mote; FWC
Projected 5-Year Costs and Funding Sources: $$$/SBEP (320); County Governments; FWC; Sarasota Bay Watch; Mote; RESTORE
Location: SBEP bays and tributaries

Activity 2.2 Support research to understand native shellfish recruitment, habitat needs, and vulnerabilities to climate change impacts.

Timeframe: Ongoing
Collaborators: SBEP (Coordinate); Florida Sea Grant; Shellfish Institute; Mote; FWC
Projected 5-Year Costs and Funding Sources: $$/SBEP (320); Grants; FWC
Location: SBEP bays and tributaries

Activity 2.3 Support research to understand the benefits of native bivalve stock enhancement for improvements to water quality, habitat, and native populations.

Timeframe: Ongoing
Collaborators: SBEP (Coordinate); Florida Sea Grant; Gulf Shellfish Institute; FWC; County Governments
Projected 5-Year Costs and Funding Sources: $$/SBEP (320); Grants; FWC
Location: SBEP bays and tributaries

Benefits

Native shellfish are critical components of the ecological integrity of SBEP bays and tributaries.

5-Year Performance Metrics

- 10 acres of oyster reef created or enhanced

FW Objective 3: Monitor and protect threatened, endangered, and vulnerable wildlife.

Activity 1: Support monitoring of threatened, endangered, and vulnerable wildlife.
Activity 2: Support protection of threatened, endangered, and vulnerable wildlife, including outreach and education to minimize adverse human-wildlife interactions.

Background

Sarasota Bay is well-known for its charismatic wildlife, many of which are afforded special federal, state, and local protections due to being threatened, endangered, or vulnerable to human impacts.

The federal Endangered Species Act of 1973, as amended, protects and recovers species from extinction and protects and restores their associated ecosystems. The Act is administered by NMFS for marine species and by USFWS for freshwater and all other species. Species that occur in both habitats are jointly managed.

The Florida Endangered and Threatened Species Act of 1977, administered by FWC, requires conservation and special management of imperiled species considered endangered or threatened by either federal or state designations. Florida's Imperiled Species Management Plan of 2016, as amended, focuses on conserving 57 imperiled fish and wildlife species by reducing extinction risks, maintaining essential habitat, and improving public and partner support. The Plan combines targeted individual species Action Plans with integrated Conservation Strategies that protect multiple species in shared habitats (FWC 2016).

Florida's State Wildlife Action Plan uses an ecosystem-based approach to benefit species and their habitats, including Species of Greatest Conservation Need (SGCN), federally and state listed species, and priority species in decline (FWC 2019). The Plan's SGCN list focuses on species at greatest risk of becoming imperiled and the actions necessary to prevent their decline. The Plan serves as an overarching resource for developing local and conservation plans produced by other agencies and integrating them into a comprehensive wildlife conservation strategy.

Marine mammals

The federal Marine Mammal Protection Act of 1972, as amended, prohibits hunting, killing, capture, and/or harassment of marine mammals. Three federal agencies protect marine mammals under the Act, including dolphins (NOAA Fisheries) and manatees (US Fish and Wildlife Service). The Marine Mammal Commission provides independent science-based oversight of the policies and actions of NOAA and USFWS to prevent human impacts on marine mammals and their ecosystems.

Sarasota Bay has a resident population of approximately 160 common bottlenose dolphins (*Tursiops truncatus*). They are protected by the Marine Mammal Protection Act. Major stressors and threats include predation by sharks on juveniles, water and habitat quality degradation, disease, red tide, and adverse human interactions — especially boat collisions, illegal feeding, harassment, and entanglement or ingestion of fishing gear. As top predators, dolphins can

bioaccumulate contaminants in the environment, especially mercury and organohalogen contaminants (POCs) used in industry, agriculture, and domestic settings such as flame retardants or insecticides.

The Florida manatee (*Trichechus manatus latirostris*) is a cherished occupant of Sarasota Bay and its tidal creeks. It feeds on submerged, emergent, and floating freshwater and marine vegetation and is commonly found grazing in seagrass. Manatees require access to freshwater for drinking. During winter, they concentrate in peninsular Florida, relying on warm water from natural springs and power plant outfalls as a refuge from colder temperatures. Many return to the same winter sites year after year.

Florida manatees are protected by the Endangered Species Act and the Marine Mammal Protection Act. Habitat degradation, fragmentation, and loss combined with historical overfishing caused populations to decline to a few hundred individuals around 1967. Significant efforts by federal, state, private, and nonprofit organizations to protect and restore the West Indian manatee (*T. manatus*), of which the Florida manatee is a subspecies, have improved critical manatee habitats and increased the Florida population to 6,620 individuals. In 2017, USFWS downlisted the West Indian Manatee from Endangered to Threatened (USFWS 2017). Threats to manatees include cold snaps, red tide, harassment, boat collisions, entanglement with and ingestion of fishing gear, and degradation and loss of habitat, especially warm water refuges. From 1993–2012, over 25 percent of manatee rescues in Florida were related to entanglement or ingestion of fishing gear (Reinert *et al.* 2017).

Sea turtles

Sea turtles have swum the world's oceans for the past 110 million years. Today, all species are federally listed as threatened or endangered. Three sea turtle species generally occur in SBEP waters, including loggerheads (*Caretta caretta*), green sea turtles (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*).

Sea turtles are relatively slow-growing and can live between 50–100 years. Every two to three years, females mate offshore then crawl onshore to dig nests, deposit eggs, and bury them before returning to the ocean. Nesting season on SBEP beaches is May 1–October 31. Eggs incubate for a couple of months, after which hatchlings emerge and scramble to the Gulf.

Sea turtles suffer high mortality during early life history. Turtle eggs and hatchlings face predation from terrestrial predators, including raccoons and birds. Light pollution from beach development can disorient hatchlings, causing them to crawl away from the water and perish. Hatchlings that make it safely to the ocean can be preyed upon by seabirds, fish, and other marine predators. Predation by sharks threatens larger adults. Other human threats include entanglement and drowning in fishing gear, collisions with watercraft, and red tide. Marine debris, especially plastic bags that can be mistaken for jellyfish and ingested, can cause death by choking or intestinal blockage. Synthetic particles, including microplastics, can also be a problem if they carry chemical"

contaminants, bacteria, or viruses. A recent study found synthetic particles in 100% of the guts of individuals from all seven species of sea turtles examined (Duncan *et al.* 2018).

Degradation and loss of beach due to waterfront development and armored shorelines threaten the availability or suitability of nesting habitat. A false crawl occurs when a female sea turtle emerges from the water to build a nest but returns to the water without laying eggs. False crawls can result from encountering obstructions on the beach like beach chairs or holes or being disturbed by light, people, or loud noises.

Sand replenishment activities conducted during nesting season (May 1–October 31) can also disturb nesting activities. If mismatched grain size or color is used, replenished sand can thwart nest building or alter temperature. Sea turtle sex is determined by nest temperatures during incubation— with cooler temperatures producing males and warmer temperatures producing females (Janzen 1994). A recent study on the Great Barrier Reef in Australia found that warmer northern GBR green turtle rookeries have been producing primarily females for more than two decades (Jensen *et al.* 2018). This finding has implications for understanding future effects of climate change on sea turtle populations.

Sea turtles are protected under the federal Endangered Species Act of 1973, as amended, Florida's Marine turtle Protection Act (379.2431 F.S.), and Florida's Endangered and Threatened Species Rule (68A-27 F.A.C.). Green and leatherback sea turtles are federally listed as Endangered and the loggerhead sea turtle is federally listed as Threatened. The Florida statute restricts the take, possession, disturbance, mutilation, destruction, selling, transference, molestation, and harassment of marine turtles, nets, or eggs. FDEP and FWC review coastal construction permits that affect sea turtles. Florida created the Model Lighting Ordinance for Marine Turtle Protection Rule (62B-55 F.A.C.) to provide guidance to county and municipal governments to develop ordinances for preventing light from reaching the beach. As of March 2020, Anna Maria Island, Bradenton Beach, Holmes Beach, Sarasota County, City of Sarasota, Town of Longboat Key, and City of Venice have lighting ordinances to protect sea turtle hatchlings (FWC 2020).

Birds

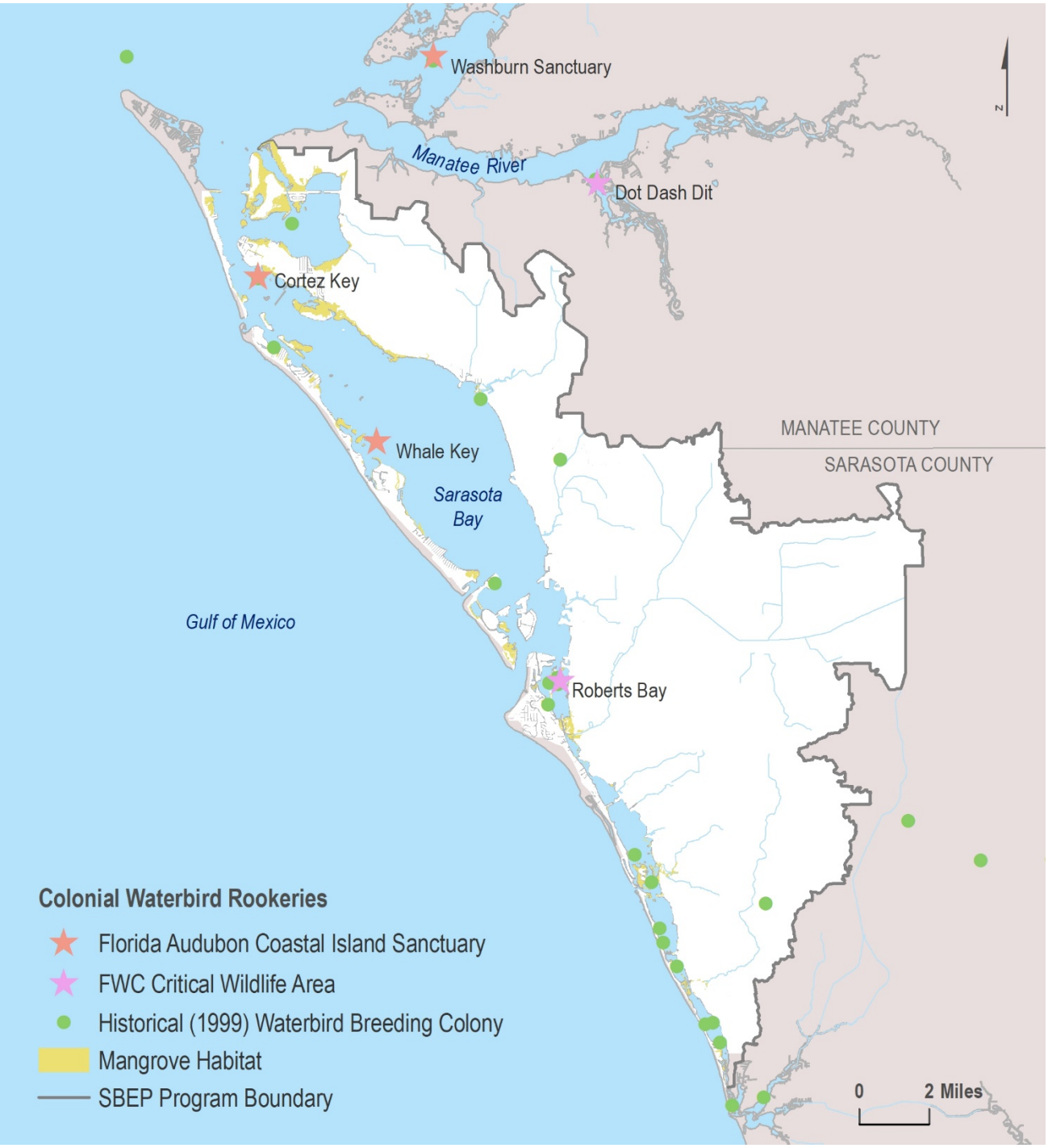
Birds contribute to the ecological integrity, function, and services of bay ecosystems. Together with their associated habitats, they are emblematic of Florida's wild heritage and culture and are a growing economic asset for tourism. Wildlife viewing, mostly of birds, is the second most popular activity in Florida, second only to beach recreation. In 2011, 4.3 million residents and nonresidents participated in wildlife viewing, with a total economic effect of $4.93 billion (Southwick Associates 2013).

Since the 1970s, North America has lost nearly 3 billion birds, or about 29% of their prior numbers (Rosenberg *et al.* 2019). For coastal and estuary-dependent birds, net trends are variable. Gulls, terns, herons, and plovers have declined, while ibises, spoonbills, cormorants, and pelicans have

increased over their 1970s abundance. Radar data also suggests a decline in the biomass of migrating birds in North America over the past ten years (Rosenberg *et al.* 2019).

Colonial-nesting water birds, like herons, egrets, and spoonbills, obtain most of their food from fresh or saltwater and nest in large multi-species assemblages, often on islands that offer some protection from terrestrial predators. Fourteen islands in SBEP bays support 18 colonial-nesting species, with the largest colonies at Roberts Bay and Cortez Key (Figure 2). Threats to colonial-nesting bird island habitats include erosion from boat wakes, storms, and sea level rise and mortality due to entanglement and ingestion of fishing gear. Fishing monofilament line can be picked up by birds near heavily fished areas and brought back to nesting areas, where it continues to entangle and kill birds until it is removed. Birds can become hooked when anglers reel their catch up from tall structures like piers or bridges. When fishers clean their catch near where they fish, they can attract birds to where gear is deployed. Additionally, the practice of throwing fish carcasses back into the water after cleaning can result in birds swallowing bones much larger than those of their typical prey, resulting in digestive tract punctures, obstructions, and death. Human disturbance, including approaching colonies too closely, can cause birds to temporarily abandon nests, and expose eggs and young to temperature extremes and predators. Frequent disturbance can cause adults to abandon eggs and young permanently, leading to failure of the colony.

Figure 2. Sarasota Bay managed and protected bird rookery islands and known historical waterbird breeding colonies.



Beach-nesting birds — like terns, plovers, and black skimmers — nest, lay eggs, and raise young on beaches. Breeding season for SBEP beach-nesting birds is February 15–September 1. Disturbance by beachgoers can flush beach-nesting birds from their nests, exposing eggs and young to temperature extremes and predators or they can inadvertently trample eggs and young. Human presence can also artificially increase predator densities, especially raccoons, dogs, and cats. Maintenance practices that remove beach wrack from recreational beaches also remove important shorebird prey species living in the wrack. Red tide and other harmful algal blooms can also significantly reduce prey availability and impact birds directly through toxins. Beach-nesting bird habitat can be degraded, eroded, or lost due to coastal development, shoreline hardening, beach replenishment activities, sea level rise, and other climate stressors (see BH-6: Protect, Enhance, and Restore Beaches and Dunes of Wildlife and Resiliency).

Declining nesting habitat and increased disturbance on existing habitat has caused some shorebirds to use alternative nesting habitat on gravel roofs, which can have many of the same qualities as beaches but are free from human and pet disturbance. Least terns are the most commonly encountered rooftop nesting species in Florida. New government-issued hurricane damage prevention guidelines for roofing materials prevent the use of gravel roofs, resulting in fewer and fewer roofs available for this alternative survival strategy.

A variety of migratory birds fly hundreds to thousands of miles to overwinter on SBEP coastlines, including the red knot, spotted sandpiper, and American white pelican. Others, like black terns, stop along the coasts during spring and fall migrations to rest and feed before continuing their travels. These long-distance travelers are often exhausted and hungry, and pushed to their physical limits when they arrive. Disturbances that reduce or prevent their ability to rest and feed can lead to significant mortality. Other threats include marine debris, especially discarded fishing gear, pollution, and harmful algal blooms. Reduction of prey abundance due to overharvesting and habitat degradation and loss has increased bird mortality. For example, mismanaging algae in stormwater ponds using copper sulfate can kill resident fish and result in a sterile pond. Many of these ponds also have mismanaged shorelines where grass is planted, fertilized, and mowed to their edge – creating no natural littoral shelf for invertebrates and fish to live. The federal Migratory Bird Treaty Act of 1918, as amended, protects migratory birds including their eggs, nests, and body parts. USFWS recently revised the list of migratory birds protected by the Act (USFWS 2020).

Horseshoe Crabs

The American horseshoe crab (*Limulus polyphemus*) is commonly found in shallow coastal waters, but mates and lays eggs on sandy beaches, especially during full and new moons in spring and fall. Closely related to spiders and scorpions, horseshoe crabs first appeared in the fossil record about 445 million years ago. Today, their numbers are declining, in part due to degradation and loss of beach habitat, including the proliferation of seawalls.

Status

SBEP waters and watersheds support at least 26 species listed as Endangered or Threatened by the Unites States Fish and Wildlife Service (USFWS) or listed as Threatened by FWC (Table 5). Management activities include protection and restoration of critical habitats and corridors, population assessment and monitoring, law enforcement, and education.

Table 5. Partial listing of Endangered and Threatened species that can occur in SBEP waters and watersheds. Data from Florida Natural Areas Tracking List April 2019 and FWC April 2019.

	Common Name	**Scientific name**	**Status**
Birds	American oystercatcher	*Haematopus palliatus*	ST
	black skimmer	*Rynchops niger*	ST
	Florida scrub jay	*Aphelocoma coerulescens*	FT
	least tern	*Sternula antillarum*	ST
	little blue heron	*Egretta caerulea*	ST
	piping plover	*Charadrius melodus*	FT
	red knot	*Calidris canutus rufa*	FT
	reddish egret	*Egretta rufescens*	ST
	roseate spoonbill	*Platalea ajaja*	ST
	snowy plover	*Charadrius nivosus*	ST
	crested caracara	*Caracara cheriway*	FT
	wood stork	*Mycteria americana*	FT
	Florida sandhill crane	*Antigone canadensis pratensis*	ST
	Florida burrowing owl	*Athene cunicularia floridana*	ST
	tricolored heron	*Egretta tricolor*	ST
	roseate tern	*Sterna dougallii*	FT
	Southeastern American kestrel	*Falco sparverius paulus*	ST
Reptiles	eastern indigo snake	*Drymarchon corais*	FT
	American alligator	*Alligator mississippiensis*	FT
	loggerhead sea turtle	*Caretta caretta*	FT
	green sea turtle	*Chelonia mydas*	FT
	leatherback sea turtle	*Dermochelys coriacea*	FE
	Kemp's ridley sea turtle	*Lepidochelys kempii*	FE
Mammals	Florida panther	*Puma concolor coryi*	FE
	Florida manatee	*Trichechus manatus latirostris*	FT

FT= Federally Listed Threatened
FE= Federally Listed Endangered
ST= State Listed Threatened

Manatees

Protecting and restoring the Florida Manatee is guided by the Florida Manatee Recovery Plan (USFWS 2001).

FWC surveys manatees by two methods. The Synoptic Survey is a winter aerial survey that targets specific wintering habitats on a particular date. The more comprehensive Abundance Survey takes place over a week or more during a time of year when Manatees are spread out instead of congregated. The 2015 estimate for Florida's west coast was 4,810 manatees with a 95% confidence interval of 3,820–6,010 (Hostetler 2018).

In 2018, FWC attributed 60 manatee deaths to red tide and seven to boat collisions in Manatee and Sarasota Counties (FWC Red Tide Manatee Mortalities and Mortality Database). To reduce mortality due to red tide, SBEP and partners have prioritized improving water quality to reduce the duration and severity of red tides and to recover seagrass meadows to levels that can support resilient manatee populations (see Water Quality Action Plan). In known manatee habitats and travel corridors, watercraft slow speed zones are established and enforced to reduce collisions with manatees (Calleson and Frohlich 2007). Pansy Bayou, a watercraft no-entry zone on Lido Key, is an important refuge for manatees. Larger restricted or no-entry sanctuaries are established to the north and south of SBEP bays, including National Wildlife Refuges at Pinellas, Egmont Key, and Passage Key to the north and Island Bay, Pine Island, and J.N. 'Ding' Darling to the south.

The Manatee Rescue and Rehabilitation Partnership is a cooperative of agencies and organizations that rescue, rehabilitate, release, and monitor Florida manatees. FWC responds to reports of distressed manatees and works to assist and release them onsite or to safely capture and transport them to a critical care facility for treatment. The closest acute care facility to Sarasota Bay is the ZooTampa at Lowry Park. The Bishop Museum of Science and Nature serves as a secondary holding facility.

Bottlenose dolphins

The Chicago Zoological Society's Sarasota Dolphin Research Program (SDRP) is the longest-running study of a wild dolphin population in the world. For 50 years, they have studied Sarasota Bay's 160 resident bottlenose dolphins focusing on population dynamics, health, behavior, genetics, and impacts due to adverse human interactions, red tide, and climate change. In addition to research, SDRP mitigates threats to dolphins through education and direct intervention, including rescues of entangled or injured animals. The 2018–2019 Florida red tide impacted dolphins directly through the lethal effects of *K. brevis* neurotoxins and indirectly through reduced prey availability. During the event, five Sarasota Bay dolphins died, eight calves born in 2018 and 2019 disappeared from the bay, and survivors suffered reduced weights due to an 88% drop in prey species abundance between Aug/Sep 2017–Aug/Sep 2018 (Wells and McCabe 2020). A common indirect effect of prey depletion is increased dolphin mortality due to hunger-driven adverse human interactions. For example, following the previous 2005–2006 red tide, SDRP recorded increased dolphin mortality due to ingestion of recreational fishing gear. To prevent a similar outcome following the 2018–2019

red tide, SDRP conducted extensive outreach to fishers. As of Spring 2020, SDRP has not detected significant increases in adverse human-dolphin interactions (Wells and McCabe 2020, McHugh 2020). A faster rebound in prey fish populations from the 2018–2019 than the 2005–2006 events may also have contributed to this result.

SDRP also monitors dolphins using listening stations installed at Mote Marine Laboratory, Longboat Key, and Cortez/Palma Sola to identify the presence of specific dolphins by their unique whistles and the occurrence of hunting behavior by the presence of echolocation clicks (Rutger 2018). This innovative monitoring program is also being used to understand how human noises like boat motors might mask dolphin communications or sounds necessary for them to identify and locate prey.

Sea turtles

Monitoring sea turtle nesting activity is important for understanding population status and trends and to minimize impacts to turtles and their habitats. Monitoring can also help identify important areas for enhanced protection or restoration. FWC-FWRI coordinates the Statewide Nesting Beach Survey (SNBS) and Index Nesting Beach Survey (INBS) through a network of surveyors, including federal, state, and local personnel, members of conservation organizations, researchers, and private citizens. Mote Marine Laboratory and Longboat Key Turtle Watch are important partners for SBEP beaches. FWC trains surveyors and coordinates data collection, compilation, and distribution to researchers, managers, and the public. The SNBS monitors the total distribution, seasonality, and abundance of nesting, covering about 825 miles of coastline on 215 beaches annually. The INBS employs more standardized methodology, including consistent effort by location, fixed dates, and highly trained personnel to survey a subset of 36 SNBS, representing 275 miles of coastline.

Loggerheads are the most common sea turtle found on SBEP beaches, followed by green sea turtles and leatherbacks on rare occurrences (Table 6). According to FWC, the 2018–2019 red tide killed 589 sea turtles on Florida's west coast. Nesting in 2018 was down significantly as well.

Table 6. Sea turtle nesting and false crawls on SBEP area beaches in 2019. Source: FWC.

Key	**Loggerhead**		**Green**		**Leatherback**	
	Nests	False Crawls	Nests	False Crawls	Nests	False Crawls
Longboat Key – Manatee Co.	623	660	8	11	0	0
Longboat Key – Sarasota Co.	686	840	25	7	0	0
Lido Key	96	192	2	0	0	0
Siesta Key	699	1144	10	14	2	0
Casey Key	2178	2813	135	169	1	3
Venice	644*	1133	2	4	1	0

Total	4926	6782	182	205	4	3

*includes 1 potential Kemp's ridley pending genetic confirmation

Birds

Eighteen coastal and estuary-dependent birds in SBEP watersheds are state or federally listed Threatened species (Table 5). Efforts to reverse declines and stabilize populations of these and other birds include critical habitat protection and restoration, surveys and monitoring, and outreach and education.

Audubon's Florida Coastal Islands Sanctuaries program manages colonial-nesting bird islands in SBEP bays and conducts annual bird surveys, field trips for protection partners, invasive vegetation and erosion control, predator removal, monofilament line cleanup, and posts protective signage (Table 7).

In 2016, FWC designated the Roberts Bay Bird Colony Islands a Critical Wildlife Area (CWA) (Figure 2). The designation prevents entry to the islands year-round, and protects hundreds of nesting and young roseate spoonbills, reddish egrets, tricolored herons, great egrets, great blue herons, brown pelicans, and double-crested cormorants. From 2007–2008 Sarasota County installed a breakwater between the Intracoastal Waterway and the islands to prevent erosion from boat wakes. Boat traffic on the mainland side of the islands, including that by ecotour companies and wildlife photographers, continues to be a challenge.

The Town of Longboat Key donated Whale Key and the Town Islands to the National Audubon Society to provide for their long-term conservation. Audubon Florida posts these islands "no trespassing". The healthy mangrove forests and shallow bay grass meadows surrounding them are important habitats for roosting birds, neotropical migrants, and fish.

Table 7: Number of nesting pairs of colonial-nesting water birds on nesting islands in SBEP bays from 2015–2020. Source: Audubon Florida.

Year **Species**	**2015**	**2016**	**2017**	**2018**	**2019**
anhinga (*Anhinga anhinga*)	7	37	13	30	9
double-crested cormorant (*Phalacrocorax auritus*)	250	201	137	206	218
brown pelican (*Pelecanus occidentalis*)	162	214	152	74	165
great blue heron (*Ardea herodias*)	80	65	51	31	97
great egret (*Ardea alba*)	249	326	135	220	242
snowy egret (*Egretta thula*)	95	86	81	29	70
little blue heron (*Egretta caerulea*)	65	20	27	11	15
tricolored heron (*Egretta tricolor*)	47	26	25	30	23
reddish egret (*Egretta rufescens*)	8	9	5	1	0

cattle egret (*Bubulcus ibis*)	75	21	37	7	14
green heron (*Butorides virescens*)	4	4	4	3	3
black-crowned night heron (*Nycticorax nycticorax*)	15	14	7	4	17
yellow-crowned night heron (*Nyctanassa violacea*)	3	1	0	0	0
white ibis (*Eudocimus albus*)	120	0	10	0	0
glossy ibis (*Plegadis falcinellus*)	0	0	0	0	0
roseate spoonbill (*Platalea ajaja*)	58	37	38	6	21
wood stork (*Mycteria americana*)	0	0	0	0	70
American oystercatcher (*Haematopus palliatus*)	1	0	0	0	0
Total nests	**1,239**	**1,061**	**722**	**652**	**964**

Education and outreach are important tools for reducing human impacts on bird populations. Multiple agencies, organizations, and partnerships conduct education and outreach in SBEP watersheds and beaches. Messaging includes best practices for reducing disturbances including safe distances, avoidance of habitats during nesting seasons, and leashing pets.

- The Florida Bird Conservation Initiative is a public-private partnership that promotes sustainability of Florida birds and their habitats through conservation planning, programs, monitoring, education and outreach, and policy.
- The Florida Shorebird Alliance is a statewide network of conservation partners advancing shorebird and seabird conservation. They collaborate to address research, education, outreach, and public policy.
- The National Audubon Society coordinates the Christmas Bird Count, a citizen science bird census. It is the longest-running citizen science survey in the world.
- Audubon Florida maintains an educational website and partners with local organizations to provide outreach, especially during monofilament cleanup events. Audubon Florida works with property owners to protect roof nesting birds.
- FWC provides education through their website featuring facts about common species and best practices for avoiding adverse interactions with them.
- Bird stewards monitor vulnerable colonial-nesting and beach-nesting bird sites and provide education and outreach about best practices for reducing human disturbance.
- Save Our Seabirds is a non-profit wildlife conservation and education organization that rescues, rehabilitates, and releases treated birds back into the wild. They respond to over 4,000 bird rescue calls per year and maintain a three-acre rehabilitation, education, and research center on Sarasota Bay.
- Sarasota Audubon built a Visitor and Nature Center at the Celery Fields Regional Stormwater Complex in 2015 to educate the public about birds, their habitats, and conservation. Over 215 species of birds use the Celery Fields for shelter, foraging, and breeding, making it a popular birdwatching hotspot and is featured on the Great Florida Birding Trail.

- Sarasota Bay Watch partners with Audubon Florida, Save Our Seabirds, Mote, and FWC to conduct volunteer monofilament cleanups that remove fishing line from bird nesting habitats each fall. Participants learn about the impact and dangers of improperly discarded fishing gear and how to recover gear safely, including from entangled birds.

Horseshoe Crabs

The Florida Horseshoe Crab Watch is a citizen science program managed by FWC and Florida Sea Grant that collects data about breeding horseshoe crabs. Their surveys are used to identify nesting beaches and monitor population status. Protection and restoration of breeding beaches is a priority management activity for horseshoe crabs.

Priorities

Protecting and restoring threatened, endangered, and vulnerable wildlife is a core priority for SBEP and its partners. SBEP will continue to support partner monitoring of threatened, endangered, and vulnerable species. Monitoring data will inform managers about population status and trends, help identify and address threats, and provide feedback to assess the results of efforts to protect and restore critical habitats. SBEP and partners are committed to habitat protection and restoration, especially seagrass meadows, oyster reefs, tidal creeks, and beaches (see Watershed Habitats Action Plan). Priorities include increasing oyster reef, replacing hardened shorelines with softened and living shoreline, and protecting and restoring habitat necessary to support upslope migration of coastal habitats to accommodate sea level rise. Identification of suitable alternative colonial-nesting bird colonies is a priority as natural disasters and human disturbances can eliminate entire nesting populations or habitats. SBEP will continue to support and conduct outreach and education about threatened, endangered, and vulnerable wildlife, including best practices to minimize adverse human-wildlife interactions. In particular, SBEP and partners will prioritize education and outreach to promote

- Ethical angling to reduce entanglement and ingestion of gear by turtles, dolphins, manatees, and birds
- Safer boating to reduce boat strikes to turtles, dolphins, and manatees and to maintain safe distances from colonial bird colonies
- Reduced wildlife feeding
- Best practices for recreational beach use, including maintaining safe distances from beach-nesting birds, turtle nests, and horseshoe crabs, keeping pets on leashes, and protecting dune vegetation from trampling
- Reducing use of contaminants, including pesticides

Strategy

Activity 3.1 Support monitoring of threatened, endangered, and vulnerable wildlife.

Timeframe: Ongoing
Collaborators: SBEP (Support); CZS-SDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; Florida Sea Grant
Projected 5-Year Costs and Funding Sources: $$$$/CZS-SBDRP; Mote; Audubon; New College of Florida; FWC; NOAA; Turtle Watches; Florida Sea Grant
Location: SBEP bays and tributaries

Activity 3.2 Support protection of threatened, endangered, and vulnerable wildlife, including outreach and education to minimize adverse human-wildlife interactions.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate); CZS-SDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; USFWS; FDEP; Save Our Seabirds
Projected 5-Year Costs and Funding Sources: $$$$/SBEP (320); CZS-SBDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; USFWS; FDEP; Save Our Seabirds
Location: SBEP bays and tributaries

Benefits

Healthy native wildlife populations are critical components of the ecological integrity of SBEP bays, tributaries, and watersheds.

5-Year Performance Metrics

Continued monitoring of threatened, endangered, and vulnerable wildlife

COMMUNITY ENGAGEMENT ACTION PLAN

GOAL: Engage, educate, and encourage environmental stewardship of Sarasota Bay and increase community connections to the estuary through low impact recreational use and enjoyment.

Introduction

Sarasota Bay is a defining part of the region's landscape, identity, and economic well-being. A recent Economic Valuation Study concluded that Sarasota Bay contributes $11.8 billion in value to the local economy, including 21,000 jobs that account for $751 million in earnings, $3.6 billion in waterfront real estate value, and $1.15 billion in tourism spending (Hindsley and Morgan 2014). In economic terms, Sarasota Bay directly and indirectly improves the well-being of the region. Community engagement on bay issues aims to capture this value and translate it into a sense of ownership and stewardship among area residents and visitors that motivates personal action and support for policies that protect the bay, even those that require behavior change or financial support.

Connecting the health of Sarasota Bay to economic and community values like quality of life, public health, recreation, and sense of pride and place can motivate a wider audience. Encouraging citizens to develop a personal relationship with the bay through low impact recreational experiences—like boating, fishing, walking, or simply taking in the view—can bolster a long-lasting appreciation for and desire to protect Sarasota Bay.

SBEP plays a critical role in convening, coordinating, and supporting a wide network of community partners and formal partners with shared missions and responsibilities to protect and restore Sarasota Bay. Program sustainability and the foundation of the National Estuary Program model relies on an informed and engaged citizenry to carry out its mission. The Goals of the CCMP's other three Action Plans can only be achieved with an informed public that supports protection and restoration and makes sustainable choices to reduce harmful interactions, overharvest, pollution, and other negative impacts.

Action Plan Strategy

This Community Engagement Action Plan combines and restates the goals and many of the objectives of the 2014 CCMP Recreational Use Action Plan, Governance Action Plan, and Citizens Participation Chapter. In this revised plan for community engagement, the SBEP Management Conference commits to four major objectives to engage, educate, and encourage environmental stewardship of Sarasota Bay, increase community connections to the estuary through low impact

recreational use and enjoyment, and support and coordinate community and Interlocal Partners for CCMP implementation.

Objective 1: Reduce recreational use impacts on Sarasota Bay and improve access for communities disconnected from waterways

Objective 2: Improve public understanding and action on bay-related issues

Objective 3: Coordinate and support community initiatives that advance CCMP implementation

Objective 4: Ensure coordination of interlocal partners for CCMP implementation

CE Objective 1: Reduce recreational use impacts on Sarasota Bay and improve access for communities disconnected from waterways.

Activity 1: Promote and support community-driven public land acquisitions and improvements, including new and expanded trails, blueways, launch points, and bay views that enhance recreational access for communities disconnected from waterways.

Activity 2: Educate recreational users about best practices to avoid impacts to bay waters, wildlife, and habitats, including pollution prevention, safe boating, ethical angling, and sustainable tourism.

Activity 3: Support responsive and adaptive management of bay access points and recreational trails to avert impacts from overuse.

Background

Sarasota Bay anchors our community's cultural identity. The quality and diversity of recreational life it creates—whether boating, fishing, wildlife viewing, or simply enjoying the view—is the reason many people come here and decide to stay. According to an early SBEP public survey, the number one recreational use of Sarasota Bay is simply taking in the view (SBEP 1995). Maintaining and enhancing recreational opportunities is an important aspect of the Sarasota Bay Estuary Program's mission. Participation in bay recreation can help instill a sense of ownership and stewardship among area residents and visitors that motivates personal action and support for policies that protect the bay, including those that require behavior change or financial support. Enhancing recreational access for environmental justice communities and communities disconnected from waterways increases watershed awareness and community-wide support for a healthy bay and can help overcome the misconception that bay restoration exclusively benefits waterfront communities.

Efforts to enhance access and promote recreational opportunities in the bay must be accompanied by education to prevent overuse and damage. Educating users about best practices to avoid impacts to bay waters, habitats, and wildlife is an ongoing need as part of responsive and adaptive management of recreational carrying capacity. Ultimately, improving and managing Sarasota Bay recreational opportunities is key to sustaining support for the large public investments needed to protect and restore Sarasota Bay.

Status

Access

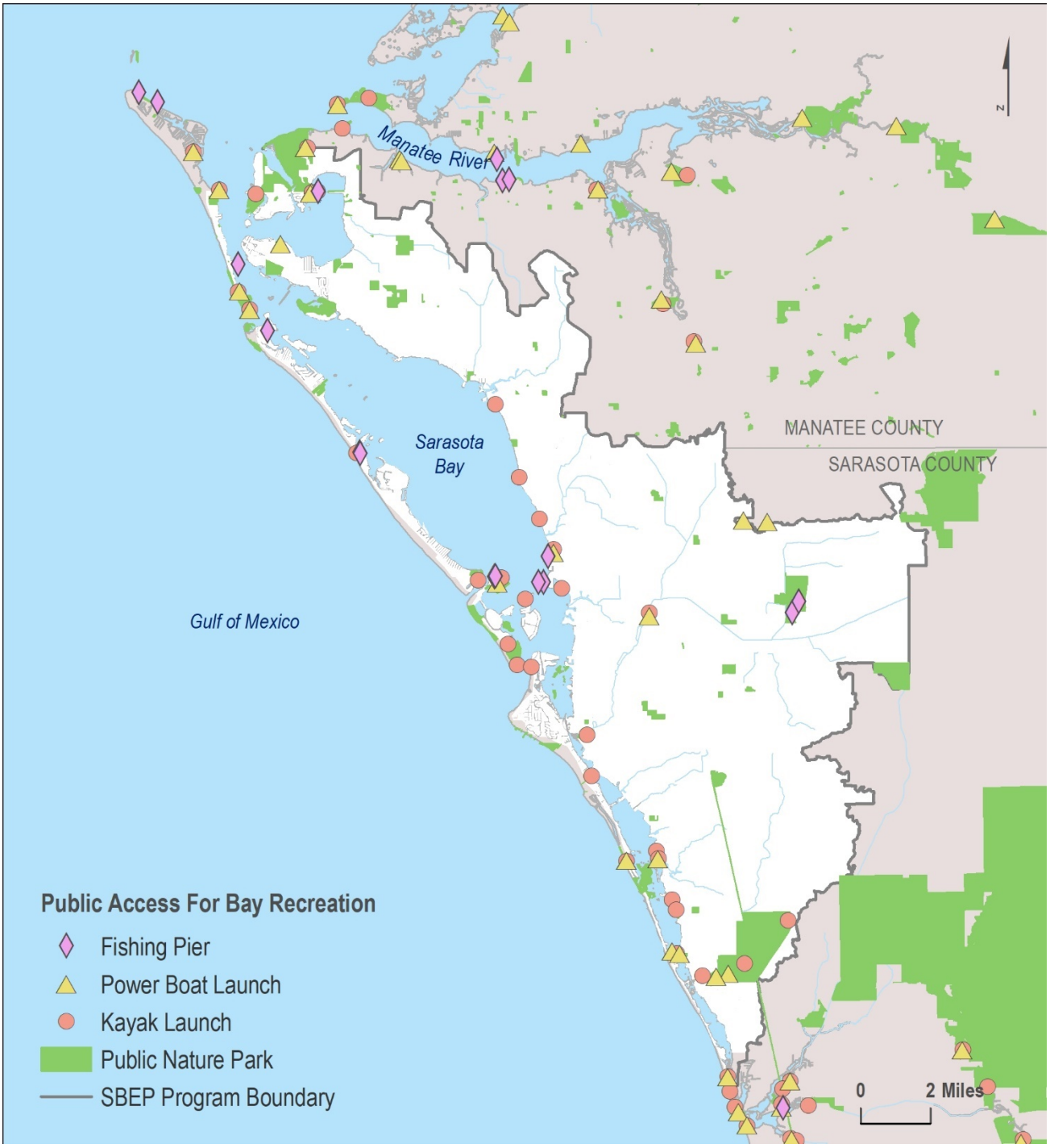
Despite the fact that a large proportion of Bay and creek shorelines is developed and privately-owned—limiting public access and viewshed—many coastal parks, piers, trails, boat launches, and view planes allow public access throughout the estuary (Figure 1). Public access to creek waterfronts is less available than bay waterfronts. From Anna Maria Sound to Lemon Bay and

including rivers and creeks, there are at least 66 paddle launch locations—on average one bayfront launch site per mile of estuary coastline. Power boats can launch from 22 public ramps in the Sarasota-Manatee area, and there are a number of public piers, bridges, and jetties that offer shore fishing and stunning bay and gulf views. Bay wildlife watching can happen almost anywhere with a bay view, but especially from the dozens of bayfront and beach parks and preserves throughout the area. Many of these waterfront access points are vulnerable to degradation and loss due to sea level rise and severe storms (City of Sarasota 2017). SBEP envisions that greater managed public access to waterfronts will increase public stewardship and ownership of water resources.

Facilities are owned and maintained primarily by counties and municipalities. Sarasota County and Manatee County have dedicated parkland acquisition programs that prioritize managed public access. Sarasota County's Neighborhood Parklands Acquisition Program (NPP), passed by voter referendum in 2005, prioritizes acquisition of sites that provide public access to the Gulf of Mexico, bays, and creeks for water dependent recreational activities and that fill a community need for equitable distribution of accessible public lands. NPP has acquired 17 properties totaling 71 acres, twelve of which provide waterfront access to bay, river, and locations (Figure 1). In 2020, Manatee County voters approved a funding referendum for conservation and park lands acquisition. Priorities will be identified by staff and a citizen advisory committee. Some privately owned homesites might be good candidates for public acquisition due to repetitive flood losses, thereby removing at-risk property from the flood zone, reducing community flood risk, and lowering flood insurance rates.

The Sarasota Bay Estuary Program Habitat Restoration Plan includes criteria to prioritize projects based on increasing or improving public access to the Bay and its tributaries. Conservation Foundation of the Gulf Coast, a private non-profit land trust, also prioritizes acquisition and managed public access of waterfront natural lands. Notably, the non-profit Bay Park Conservancy is implementing a long-term master plan to redevelop and re-green 53 acres of City of Sarasota-owned land on Sarasota Bay, ensuring open, public access to the bayfront for recreational and cultural activities. Along with adjacent Centennial Park and boat launch, The Bay project will be an iconic, publicly accessible destination that connects a diversity of neighborhoods and generations to the bayfront. Coordinating projects and funding opportunities among SBEP partners will enhance success (see WH-1, WH-4, and CE-4).

Figure 1. Recreational access points to Sarasota Bay estuary.



To facilitate and promote use of existing access sites, SBEP and its partners provide a variety of free printed and online resources to assist the public in finding and enjoying bay recreation opportunities, including regional guidebooks and maps on paddling, power boating, fishing, wildlife viewing, and cultural heritage. SBEP offered free guided paddle trips through SBEP Bay Wise Kayak Tours and Manatee County Parks and Natural Resources programs. SBEP sponsored 8–12 kayak tours annually taking 80–130 paddlers out on the bay and down tidal creeks to learn about Sarasota Bay's natural history, wildlife, and restoration projects. These trips facilitated access to local waterways and educated paddlers about bay stewardship and best practices to avoid recreational impacts to bay waters, wildlife, and habitats (see CE-2).

[Photo collage of guide covers]

Education

There is a need to update boat propeller scarring maps and evaluate the rate of scar recovery, as well as improve boater education and awareness of seagrass beds to reduce scarring (see WH 5.4). In 2019, SBEP partnered with Sarasota and Manatee Counties, Florida Sea Grant, Sarasota Bay Watch, New College of Florida, West Coast Inland Navigation District, and waterfront businesses to study seagrass scarring trends and boating behavior in Sarasota Bay and develop a boater outreach program featuring a Seagrass Safe Boating video, Scars Hurt sign, and Sarasota Bay waterway guide that delineates areas of seagrass and safe boating practices to avoid propeller scarring. In April 2021, seagrass-safe boating signs and maps were posted at public boat ramps, marinas, and rental/tackle shops in Sarasota and Manatee counties. Further distribution of these materials will be ongoing to waterfront locations and organizations that deliver boater education courses.

SBEP and its partners also promote ethical angling practices with a focus on techniques for catch and release, fishing rules and regulations, prevention of marine debris, proper disposal or recycling of monofilament line and other fishing gear (see FW 1.4), and reducing impacts to birds, turtles, and marine mammals (see FW 3.2). Florida Fish and Wildlife Commission (FWC) and Florida Sea Grant host sustainable fishing clinics, and Florida Sea Grant launched a Florida Friendly Fishing Guide Certification in 2020. SBEP helps fund the Science and Environment Council's Watershed Audio Tour, which features 2-minute audio messages at locations around the estuary with advice on best practices for plastic pollution prevention, sustainable fishing, seagrass-safe boating, and safe wildlife watching.

FWC manages the statewide Monofilament Recovery and Recycling Program (MRRP) with over 50 monofilament disposal tubes at boat launches, piers, and bridges throughout the estuary. FWC also works to increase awareness about the environmental impacts of marine debris through their Spiny Lobster, Stone Crab, and Blue Crab Retrieval Program and the Derelict Trap and Trap Debris Removal Program. Sarasota Bay Watch (SBW) conducts outreach and education about lost or discarded fishing gear through regular marine debris and monofilament line cleanups. In 2019, SBW

removed 29,805 pounds of fishing line and debris, 2,431 lbs of rope, 423 lbs of nets, and 365 lbs of lead weights from SBEP waters—engaging 1,457 adult and youth volunteers throughout the year.

Almost ten percent of the economic value derived by Sarasota Bay is driven by tourism. SBEP strives to educate all recreational users, including full- or part-time residents and tourists. In 2020, a SBEP Bay Partners grant supported the development of the Sarasota Bay Sustainability Guide for visitors to "stay, eat, and play sustainably while visiting Sarasota Bay." The guide will be printed and distributed to hotels and restaurants on the barrier islands in 2021. SBEP also encourages its contractors and partners to achieve certification by the Florida Society for Ethical Ecotourism. In fact, the Sarasota-Manatee area has more certified eco-destinations and guides than any other region of Florida and the only two Platinum certified guides in the State. Science and Environment Council supports ethical ecotourism by promoting guides, destinations, and ecotour itineraries that meet these standards.

Management

Ongoing education of recreational users to reduce impacts to habitat and wildlife and ensure positive user experiences is critical. But with the region's rapid population growth, the numbers of boaters, fishers, beachgoers, park visitors, and sight seers grows, while the natural resources that support those activities do not. From 2010–2019, the number of households and the total number of registered motorized boats in Sarasota and Manatee Counties both grew by 7% (US Census Bureau 2019, EDR 2020, FLHSMV 2019). On average, one out of every eight households owns a motorboat. Over that period, the number of mid-size 16–26-foot vessels—the size typically used to cruise the bay—increased by 13% or the equivalent of 22 boats joining the fleet every month. Over the same period, the number of saltwater recreational fishing licenses in Sarasota and Manatee Counties increased 44% from 43,636 in 2010 to 62,835 in 2020.

Managing recreational impacts is not just about tracking the numbers of users; understanding when, where, and how those users interact with natural resources is critical. Adaptive and responsive management of recreational access and use requires 1) establishing thresholds of acceptable impacts along with potential mitigating management tactics, 2) monitoring to know when thresholds are crossed, and 3) implementing those targeted management tactics. Adaptive management is especially important when opening new natural areas or increasing access to existing resources.

The net impacts of additional users may be reduced by widespread adoption of sustainable practices, enhanced by ongoing education by SBEP and its partners. Management of the time and place and intensity of recreational activities can also reduce impacts and user conflicts. For example, no-wake and speed zones have been established and enforced at inlets and certain segments of the intracoastal waterway. Buffer zones have been established around Critical Wildlife Areas (see FW 3-2), and some bay islands like Whale Key are off-limits for recreation. By default,

parking capacity at boat ramps limits the number of boats that can launch from that location on any given day.

In response to recreational user impacts and conflicts at popular kayak launch sites, Sarasota County implemented a capacity management scheme in 2013 wherein commercial kayak tour operators must register and pay an annual permit fee per kayak to launch from Ted Sperling Park at South Lido Beach. The program was expanded to Turtle Beach Park on Siesta Key in 2017. In 2021, the County will further limit the total number of commercial operators to twelve and the number of kayaks to 260 at these locations through a formal competitive bid process.

In 2021, Manatee County will begin limiting the total number of commercial kayaks permitted to launch from Robinson Preserve, Emerson Point Preserve, and possibly North Coquina Boat Ramp. Manatee County's overall strategy regulates user behavior rather than numbers by restricting recreational access and activities in certain areas of its preserves, such as limited access to mangrove shorelines, restricting wading and cast netting in certain areas, and prohibiting dogs in sensitive areas such as Perico Preserve.

Priorities

SBEP will continue to coordinate and collaborate with partners to improve bay recreation access points through community-driven land acquisitions and improvements and to promote managed sustainable recreational use of the bay. Bay access, including protection of bay views, will be encouraged as part of public and private sector coastal developments. In order to encourage bay recreation by environmental justice communities and communities disconnected from the bay, SBEP will focus on distributing existing bay resource guides and guided experiences targeted to audiences identified in the Communications Plan, especially traditionally under-represented bay user groups. New distribution partners, such as hotels, restaurants, marinas, neighborhood associations, and youth clubs, will be recruited. SBEP will facilitate community discussion and adoption of adaptive and responsive management strategies to minimize impacts from recreational use, including improved understanding of carrying capacity for new and popular sites.

Strategy

Activity 1.1 Promote and support community-driven public land acquisitions and improvements, including new and expanded trails, blueways, launch points, and bay views, that enhance recreational access for communities disconnected from waterways.

Timeframe: Ongoing
Collaborators: SBEP (Support); County & Municipal Governments, Bay Park Conservancy, Conservation Foundation of the Gulf Coast
Projected 5-Year Costs and Funding Sources: $/SBEP; $$$$$/acquisitions.
Location: SBEP bays and tributaries

Activity 1.2 Educate recreational users about best practices to avoid impacts to bay waters, wildlife, and habitats, including pollution prevention, safe boating, ethical angling, and sustainable tourism.

Timeframe: Ongoing
Collaborators: SBEP (Conduct); FWC, FDEP, SWFWMD, Sarasota Bay Watch, Chicago Zoological Society's Sarasota Dolphin Research Program, Audubon Florida, Save Our Seabirds, Mote Marine Laboratory, Around the Bend Nature Tours, Wayne Adventures, Science and Environment Council
Projected 5-Year Costs and Funding Sources: $$/SBEP (320)
Location: SBEP bays and tributaries

Activity 1.3 Facilitate responsive and adaptive management of bay access points and recreational trails to avert impacts from overuse.

Timeframe: Workshop 2022
Collaborators: SBEP (Coordinate); County & Municipal Governments, Conservation Foundation of the Gulf Coast, Science and Environment Council, NOAA, FWC, FDEP, SWFWMD
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP bays and tributaries

Benefits

Enhancing managed recreational access for communities disconnected from waterways helps grow watershed awareness and community-wide support for a healthy bay.

5-Year Performance Metric

Offer at least 15 guided kayak tours, coastal walks, and other recreational opportunities annually with a focus on engaging communities that are traditionally underrepresented in bay user groups.

CE Objective 2: Improve public understanding and action on bay-related issues and expand reach to priority audiences.

Activity 1: Inform and engage the public about priority environmental issues and the multiple benefits of watershed and estuary and restoration, including climate change adaptation.
Activity 2: Support volunteer restoration and citizen science activities that contribute to assessment, monitoring, and restoration of bay and gulf waters, shorelines, wetlands, and other habitats.
Activity 3: Assist and empower citizens to adopt sustainable bay-friendly lifestyles and to lead community initiatives that reduce pollution, conserve water and energy, and promote community health.

Background

Outreach that delivers consistent and compelling science-based environmental education can help inspire and motivate bay users, homeowners, visitors, and other target audiences to care about and participate in conserving, protecting, and restoring Sarasota Bay. SBEP education efforts focus specifically on bay-related priority issues such as reducing stormwater and wastewater pollution (see WQQ Action Plan), mitigating and adapting to climate change, protecting and restoring seagrass and coastal wetlands (see WH Action Plan), protecting native fish, shellfish, and wildlife (see FW Action Plan), and minimizing recreational use impacts (see CE-1).

Educational information alone is usually not enough to motivate individual and community action among all target audiences (Nisa *et al.* 2019). People tend to conform to social norms in a peer group, so providing a social comparison with respect to the behaviors of respected peers can help motivate action. Testimonials from trusted networks and messengers are often more effective than didactic instruction. This means one message does not suit all audiences and outreach must be appropriately tailored and targeted.

Framing recommended actions necessary for bay protection in terms of the multiple benefits they provide can also help motivate a wider audience, because the message is more relatable. Connecting community values such as quality of life, public health, recreation, sense of pride and place, and economic drivers like tourism and real estate, to the health of Sarasota Bay is an effective communication strategy. Other communication frames of reference include local food, harmful algal blooms, and water heritage.

In addition, providing resources or structuring choices that make it easy to get started—so-called choice architecture or nudges—can facilitate action, because the message is delivered in a context that makes the choice easy. This may take the form of tool kits, incentives, and hands-on experiences that make behavior change more personally rewarding, convenient, or economical.

Status

The SBEP Communications Plan (SBEP 2018) outlines strategic communication tactics and priority target audiences, including local business and community leaders, recreational users, seasonal residents and retirees, and especially those communities disconnected from the bay. Enhancing participation by communities disconnected from waterways increases watershed awareness and a sense of ownership and stewardship, that in turn increases community-wide support for SBEP's mission for a healthy bay.

SBEP's education programs and materials targeting K-12 students and teachers include field trips, classroom tech kits, and teacher training workshops. SBEP funds tens of field trips throughout the Sarasota Bay watershed through its Protection, Involvement, Education, and Restoration (PIER) program serving nearly 2,000 students each year. Professional teacher training workshops are funded by SBEP three times per year where K–12 science teachers improve teaching skills and science literacy.

In 2019, SBEP began a new partnership with Mote Marine Laboratory and local human service organizations to provide kayak instruction, bay exploration, and aquarium trips for youth in communities that are traditionally underrepresented in bay user groups. So far, this partnership has engaged approximately 50 youth living in public housing. SBEP, Mote, and community partners plan to continue the program in 2021 and beyond.

Throughout the year, SBEP staff interact with the general public by tabling at community events and through invited speaking engagements at colleges and universities, adult classes, homeowner associations, and other community groups. Almost 5,000 followers and subscribers are engaged on a variety of timely bay-related issues, activities, and program accomplishments through semi-weekly social media posts and SBEP's quarterly e-newsletter *Bay Reflections*. In 2017, SBEP redesigned and launched a new website that is easier to navigate, more visually engaging, mobile friendly, and more complete with new, improved, and better organized content. In particular, SBEP's comprehensive collection of brochures and booklets are organized and available for download. SBEP also promotes the online Sarasota County Water Atlas (see WQQ-1) that displays and explains local water resources and water quality monitoring data.

[Collage of brochure covers.]

SBEP also develops guides and tools to assist the public and practitioners in adopting best practices for bay protection. New in 2020, a comprehensive section of the SBEP website expands on the *Sarasota Bay Repair Kit* brochure with in-depth guidance on bay-friendly living—around the home, yard, community, school, workplace, and on the water. In 2018, SBEP oversaw development of *Living Shorelines: Guidance for Sarasota Bay Watershed*, which serves as a technical guide for crafting an outreach strategy to inform waterfront homeowners about the benefits of living

shorelines. In 2017, in collaboration with Mote Marine Laboratory, SBEP published the second edition of *Sea Level Rise: Tips for Adaptation Planning* along with a 7-minute professional video that draws from local, regional, and national examples to lay the groundwork for conversations about sea level rise scenarios and adaptation strategies.

Engaging the public with interactive and hands-on experiences is also a core strategy of SBEP outreach. For example, since 2016, SBEP has partnered with Sarasota County's Annual Volunteer Seagrass Survey to host the Seagrass Festival. The festival is an educational celebration that highlights the value of seagrass and progress toward seagrass recovery and gives participants the opportunity to snorkel and observe seagrass beds. The annual King Tide Photo Contest is an opportunity for citizens to observe and photograph the state of sea level rise in their neighborhood during autumn high tides.

SBEP's most popular signature program is the Sarasota Bay Guardians, empowering citizen volunteers to become stewards of the Sarasota Bay watershed. Bay Guardians annually engages 300–400 volunteers of all ages in hands-on work projects to restore Sarasota Bay. The program focuses on educating volunteers about watershed ecology and encouraging participants to look beyond the volunteer workday for opportunities to improve the Bay. Each year, volunteers remove thousands of pounds of invasive plants and trash, and they restore shorelines with thousands of native plantings and pounds of new oyster reef substrate. Between 2010–2020, 3,613 Sarasota Bay Guardians volunteers donated over 7,742 hours valued at $180K to remove 8,479 pounds of trash and 21,610 pounds of invasive plants and install 46,525 native plants and 80 tons of oyster shell reefs.

SBEP often collaborates with partners on Bay Guardians events, including Sarasota County, Manatee County, City of Sarasota, local colleges, Florida Sea Grant, and Florida Audubon. SBEP also strives to partner with local schools and human service organizations such as the Boys and Girls Clubs to reach new volunteers who are not actively involved with environmental issues. SBEP's partner organizations also engage citizens with hands-on projects and data collection, for example:

- UF/IFAS Water Watch and Lake Watch
- FWC and Florida Sea Grant Horseshoe Crab Watch
- Sarasota Bay Watch monofilament cleanup
- Reef Rover and Sarasota Bay Watch marine debris cleanup
- Sarasota Bay Watch clam restoration
- Gulf Coast Oyster Recycling and Renewal Program
- Mote Marine Laboratory Beach Conditions Reporting
- Florida Audubon beach nesting bird monitoring

- FWC-FWRI with Mote Marine Laboratory and Longboat Key and Anna Maria Island Turtle Watch turtle nesting beach survey

These community-level activities support the bay and increase stewardship. Some bay-related priority issues must be tackled at the individual level through personal choices and behaviors. SBEP's outreach strategy seeks to empower citizens with tools and incentives to make these choices—to provide the so-called nudge. SBEP co-promotes UF/IFAS Extension programs, such as the Florida Friendly Yards Program, the Florida Waters Stewardship Program, and home energy and water audit kits.

Priorities

SBEP's priorities for outreach include continuing general and targeted public education on priority issues, expanding citizen-science opportunities, and developing new behavior change campaigns targeted to households. SBEP will continue to work collaboratively with its many education partners to deliver messaging to the general public through web, social media, e-newsletters, and events. SBEP will use relevant framing such as benefits to public health, quality of life, and property values to connect with target audiences identified in the Communications Plan on a variety of bay-related issues, including:

- Reducing stormwater pollution from leaks and spills from improper use of domestic central sewer and septic systems, urban fertilizer, and reclaimed irrigation water;
- Reducing stormwater pollution and climate changing greenhouse gas emissions from gas-powered vehicles and equipment; and
- Reducing recreational impacts to seagrass, coastal wetlands, dunes, and wildlife.

In addition, SBEP will collaborate with Florida Sea Grant, National Estuary Programs, and other partners to develop new citizen-science opportunities for vertical oyster gardening, seagrass and macroalgae monitoring, plastic pollution, and sea level rise. Finally, SBEP will develop targeted outreach campaigns to empower citizens with tool kits, incentives, and hands-on experiences that make household changes more personally rewarding, convenient, or economical, such as irrigation evaluations and downspout modification kits.

Strategy

Activity 2.1 Inform and engage the public about priority environmental issues and the multiple benefits of watershed and estuary and restoration, including climate change adaptation.

Timeframe: Ongoing
Collaborators: SBEP (Conduct); County & Municipal Governments; Florida Audubon; Save Our Seabirds; Conservation Foundation of the Gulf Coast;

FDEP; Around the Bend Nature Tours; Florida Native Plant Society; Chicago Zoological Society's Sarasota Dolphin Research Program; Mote Marine Laboratory; UF/IFAS Extension; Florida Sea Grant; Science and Environment Council; Sarasota Bay Watch; FWC; FDEP; SWFWMD
Projected 5-Year Costs and Funding Sources: $$/SBEP (320)
Location: SBEP bays and tributaries

Activity 2.2 Support volunteer restoration and citizen science activities that contribute to the assessment, monitoring, and restoration of bay and gulf waters, shorelines, wetlands, and other habitats.

Timeframe: Ongoing
Collaborators: SBEP (Conduct); County & Municipal Governments; New College of Florida; Florida Sea Grant; UF/IFAS Extension; Florida Audubon; GCORR; FWC; Sarasota Bay Watch; Mote Marine Laboratory; Longboat Key Turtle Watch, Anna Maria Island Turtle Watch
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP bays and tributaries

Activity 2.3 Assist and empower citizens to adopt sustainable bay-friendly lifestyles and to lead community initiatives that reduce pollution, conserve water and energy, and promote community health.

Timeframe: Ongoing
Collaborators: SBEP (Conduct); Florida Sea Grant; UF/IFAS Extension; County & Municipal Governments
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP bays and tributaries

Benefits

Working collaboratively with partners on outreach and education that informs and empowers citizens to take community and individual bay-friendly actions helps sustain a healthy Sarasota Bay.

5-Year Performance Metrics

Engage Bay Guardians volunteers at 5 events annually.

CE Objective 3: Coordinate and support community initiatives that advance CCMP implementation.

Activity 1: Support capacity of non-profit, community, and business partners to educate and engage the public in outreach and stewardship that furthers CCMP implementation (professional development, workshops, grants).

Activity 2: Connect the value of natural resource protection with preservation of cultural heritage and traditional use of Sarasota Bay through partnerships with cultural heritage organizations.

Background

Support Partners to Educate and Engage the Community

Through the management conference, SBEP supports the capacity of non-profit, community, and business partners to educate and engage the public in outreach and stewardship that furthers CCMP implementation through supporting professional development, workshops and meetings, and grants. By developing, enhancing, and leveraging capacities of collaborating organizations, SBEP is able to drive implementation of CCMP goals and objectives for protecting and restoring Sarasota Bay.

SBEP's Bay Partners Grant Program promotes environmental education, community involvement, and stewardship to improve Sarasota Bay and its tributaries. Grants are provided to local businesses, non-profit organizations, schools, academic institutions, civic associations, religious organizations, homeowner associations, and neighborhood associations for a wide variety of projects that focus on water and habitat quality improvement and bay-related environmental outreach, education, and engagement. Bay Partners Grants are funded once per year and applications are reviewed by a Bay Partners Grant committee, recommended by the Citizen's Advisory Committee, reviewed by the Management Board, and approved by the Policy Board.

Connect Bay Protection to Cultural Heritage and Traditional Use

Sarasota Bay's waters and abundant fish and wildlife have attracted and sustained human populations along its shores for the past ten thousand years. From the Calusa, Timucuan, and Tocobago tribes, to Cuban fishers, to circus kings, to post-war Americans and their baby boomers, Sarasota Bay was central to developing their cultural identities and economies. From mullet and snapper to oysters, clams, and scallops, harvesting from the healthy, bountiful waters of Sarasota Bay was central to supporting early populations. Today, a growing urban population, together with degradation and loss of historically important bay waters and habitats, have reduced Sarasota Bay's capacity to provide plentiful seafood for the population. The Cortez fishing village, dating back over 100 years, is the last working waterfront on Sarasota Bay—and one of the last commercial fishing villages in Florida. Fishers depend on healthy waters and bay habitats to sustain their livelihoods

and cultural identity. Development pressure and climate stressors, including intensifying storms and rising seas, will continue to threaten working waterfronts. Remnants of historical cultural sites persist along the bayfront, some in the form of large mounds of discarded shell, called middens. Many of these sites are vulnerable to degradation and loss due to climate stressors.

SBEP and partners are working to protect and restore critical components of bay ecosystem integrity, function, and services necessary to protect and restore working waterfronts sustaining Sarasota Bay's cultural heritage. SBEP supports ways to promote protection and placemaking by connecting past and present cultural values through science, art, and alternative engagement initiatives. They are also working to mitigate vulnerabilities of coastal habitats and historical sites to climate change stressors. By connecting bay protection and restoration to cultural heritage and traditional use, SBEP can increase support for CCMP goals and objectives.

A number of dedicated organizations are working in the Sarasota Bay area to preserve working waterfronts and imperiled cultural heritage sites.

The Florida Institute for Saltwater Heritage (FISH) is a non-profit grassroots organization established in 1991 to promote, educate, and preserve Cortez and Florida's commercial fishing and other traditional maritime culture, including the environment upon which these communities depend. FISH assists in the operation of the Florida Maritime Museum Cortez, conducts research and assists in collecting, preserving, and interpreting the culture and folk-life of Florida's traditional Gulf Coast maritime communities and their commercial fisheries. They also promote public awareness and support for protecting marine resources and traditional maritime skills and values. Each year, FISH organizes the Cortez Commercial Fishing Festival in February.

Historic Spanish Point is a 30-acre environmental and museum complex located in Osprey, Florida operated by Marie Selby Botanical Gardens. The complex features an archeological exhibit of a prehistoric shell midden, a pioneer homestead historic house, and a traditional boatyard.

The Florida Public Archaeology Network (FPAN) promotes and facilitates conservation, study, and public understanding of Florida's archaeological heritage through regional centers throughout the state.

New College of Florida's Public Archaeology Lab facilitates studies of archaeology and historic preservation for Sarasota and Manatee Counties through ethical, community-based research and public engagement.

Other local organizations include Newtown Alive, Sarasota History Alive!, Time Sifters Archaeology

Society, and Sarasota Alliance for Historic Preservation.

Continuing to develop and nurture working relationships with cultural organizations on projects that co-benefit cultural and historic preservation and the environment will help increase support and implementation of CCMP goals and objectives.

Status

SBEP and partners continue to provide support to partners to educate and engage the community on issues related to protecting and restoring Sarasota Bay and to develop relationships and partnerships with organizations that can help strengthen and communicate the connection between protecting and restoring Sarasota Bay and preserving cultural heritage and traditional use.

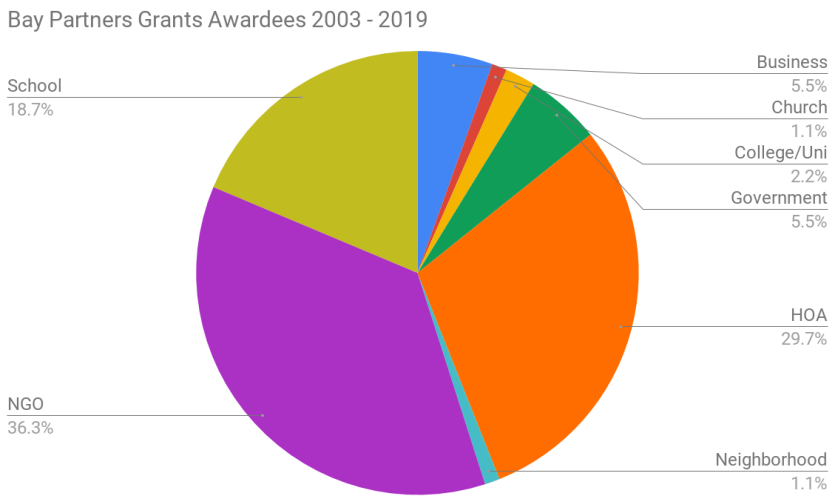
Support Partners to Educate and Engage the Community

SBEP supports and provides leadership for environmental workshops, meetings, and conferences that build capacity for communities to improve understanding and support for protecting and restoring SBEP bays, tributaries, and watershed. For example, in 2021 SBEP will convene high level stakeholders in a Water Quality Consortium to address cumulative water quality improvement in bay segments verified by FDEP as impaired (See WQQ-2). The Water Quality Consortium will develop an Action Plan to build community capacity to reduce nutrient inputs.

In 2018, SBEP sponsored and participated in the Environmental Summit, hosted by the Science and Environment Council. The Summit highlighted connections between environmental heritage and a resilient future, natural habitats and fish and wildlife, and a healthy environment and quality of life. The event featured over 70 speakers, including SBEP staff, and tackled many priority CCMP issues, including protecting and restoring our estuaries of national significance (featuring a panel of Florida's four NEP directors), clean water, land, legacy, and special places, climate change, urban ecology, and public education and engagement. In addition to the information sharing, networking, and professional development that occurred at the Summit, sessions were videoed and made available to the public online (environmental-summit.com).

Since 2003, SBEP has awarded over $338,000 in Bay Partners Grants to support projects conducted by over 80 organizations throughout SBEP bays, tributaries, and watersheds (Figure 2).

Figure 2. Organization type receiving grants taken from online database [update with 2020 projects].



[Callout box: Organizations receiving Bay Partners Grants 2003–2020]

Anna Maria Environmental Enhancement
Anna Maria Historical Society
Anna Maria Island Elementary School
Anna Maria Island Power and Sail Squadron
Anna Maria Island Turtle Watch
Aquarian Quest
Around the Bend Nature Tours
Ballard Elementary
Bay Haven Elementary School
Bay Wise Kayak Tours
Bayshore Elementary School
Bayshore High School
Bayside Terraces HOA
Beachplace Association, Inc
Beekman Place
Booker High School
Boys and Girls Clubs
Calusa Lakes Community
Central Cocoanut Neighborhood Association
City of Bradenton Beach
City of Holmes Beach
City of Sarasota
Cortez Village Historical Society

Crooked Creek Condominium Association
ELM West Coast, Inc.
Fairway Bay
Florida House Institute
Founders Garden Club of Sarasota
Foxfire West
Friends of Florida Maritime Museum
Gardeners Out East
Garden Lakes HOA
Gulf Coast Heritage Association, Inc
GWIZ
Happy Paddler Kayak Tours & EcoVentures
Hardee County Schools
Harllee Middle School
Hudson Bayou Association
Island Village Montessori School
Keep Manatee Beautiful
Kinnan Elementary School
Lakeridge Falls
Lakeshore Village HOA
Landings Management Association
Manatee County Government
Manatee Fish and Game Association
Manatee County YMCA
Selby Botanical Gardens
Meadows Community Association
Mission Estates
Mote Marine Laboratory
Nature's Academy, Inc
New College of Florida
Oaks Bayside HOA
Orchid Oaks Condominium Association
Palma Sola Botanical Park
Palma Sola Presbyterian Church
Pelican Cove Condominium Association
Plymouth Harbor
Reef Rakers
Reef Rovers
Riggs Landing
Riverview High School
Saint Stephen's Episcopal School
Sarasota Audubon Society
Sarasota Bay Watch
Save Our Seabirds
Scenic Waves Partnership Committee
Science and Environment Council of SWFL
Sea Breeze Elementary School
Sea to Shore Alliance
Sherwood Forest Owners Association
Sierra Club
Simply Green Solutions, LLC
South Gate Community Association

Stonebridge Community
Sunbow Bay Condominium Association
Suncoast School for Innovative Studies
Sunshine Community Compost
School in the Park
Tidy Island
Town of Longboat Key
USF Sarasota-Manatee
Venice Area Audubon Society
Village in the Pines
VillageWalk HOA
Wakeland Elementary School
WAVES
Westchester Condominium Association
Wilkinson Elementary School
Windward Bay Condominium Association

About 10–12 community projects are funded each year with a maximum of $4,000 per project (in 2020). Examples of recent projects include:

Restoration and Partner Building: Bowlees Creek Bird Sanctuary Island Diversity Plantings. Manatee Fish and Game Association partnered with New College of Florida, Around the Bend Nature Tours, Almost Kayak Heaven, and community members to plant 176 native coastal berm trees, shrubs, and forbs along a cleared path meandering through the center of Bowlees Creek Sanctuary Island. The project aimed to increase vegetative diversity by adding 24 species of native plants, many of which did not previously exist there.

Education: Dunes Do's and Don'ts. Anna Maria Island Turtle Watch organized local elementary school students to create and deploy 61 educational signs about dune and turtle protection on Anna Maria Island.

Restoration and Education: Save Our Seabirds Campus Native Planting. Save Our Seabirds created an oasis of native plants for migrating birds, improved the native plant footprint of their bayside campus, and educated the general public about the importance of native plants to the environment and bird populations.

Restoration and Community Building: Orchid Oaks Preserve Restoration Project at Phillippi Creek. VHB partnered with the Orchid Oaks Condominium Board, Sarasota County, and Riverview High School to remove nuisance and exotic invasive plants, including Brazilian pepper, carrotwood, and air potato from Orchid Oak's shoreline along Phillippi Creek. In addition to the direct environmental benefits of creating habitat for native species and improving water quality runoff in the creek, the volunteer event helped build support for restoring and improving the creek and other upstream habitats of Sarasota Bay.

Education: PUSH/SUCCESS. New College of Florida created and implemented an intensive educational program focused on using the scientific method to guide middle- and high-school

students through modules to learn about bay-related topics, including the effects of nutrient pollution and ocean acidification on waterbodies.

Education: EcoExplore Camp. Sea to Shore Alliance hosted a camp for under-represented Booker High School students to learn about marine issues important to the Sarasota region. Through classroom instruction and field experiences, students learned about how their actions can affect the environment, the importance of protecting marine animals and shorebirds, and the joys and rewards of studying science while developing social skills and enthusiasm for the environment.

Connect Bay Protection to Cultural Heritage and Traditional Use

Since its inception, SBEP and partners have understood the importance of connecting Sarasota Bay's rich cultural history and traditional use with healthy Bay waters. Early Program branding materials heavily referenced Sarasota's history and culture and their dependence on the bay. SBEP produced the *Gulf Coast Heritage Trail Guide* that identifies, describes, and locates the Bay's many historical, environmental, and arts and cultural points of interest on a detailed map. In addition to providing a compelling narrative of the history of the Sarasota Bay area, the guide makes important connections between preserving the health of Sarasota Bay and the development and sustainability of heritage, culture, and arts through history to present day. SBEP also created A *Chronicle of Florida's Gulf Coast*, which aims to increase appreciation and stewardship of Sarasota Bay by featuring its nature, recreation, culture, and history. Both guides are available for download from SBEP's online library of educational brochures.

SBEP supports fishing heritage through restoration of important fish habitats and oyster reefs (see FW Action Plan). For example, SBEP is a key partner on a coastal restoration project at the Florida Institute for Saltwater Heritage (FISH) Preserve, a 100-acre habitat east of the historic Cortez fishing village in Manatee County (see callout box in CE-4). FISH Preserve hosts important fish habitat necessary to support sustainable fishing activities in the area. SBEP also awarded the Friends of Florida Maritime Museum a Bay Partners Grant in 2014 for a bay-friendly landscaping and education project. SBEP Bay Guardians partnered with the group to plant bay-friendly plants around a tidal pool and to create a butterfly garden.

Priorities

SBEP and partners will continue to support the capacity of non-profit, community, and business partners to educate and engage the public in outreach and stewardship that further CCMP implementation through professional development, workshops and conferences, and Bay Partner Grants. SBEP will continue to develop funding for Bay Partners Grants through its Sarasota Bay Environmental Fund. SBEP will continue to improve public support for bay protection and restoration by improving understandings between healthy bay waters and preservation of cultural heritage and traditional use of Sarasota Bay. SBEP will develop and enhance working partnerships with area cultural heritage organizations.

Strategy

Activity 3.1 Support capacity of non-profit, community, and business partners to educate and engage the public in outreach and stewardship that further CCMP implementation (professional development, workshops, grants).

Timeframe: Ongoing
Collaborators: SBEP (Support and coordinate professional development and workshops; Conduct Bay Partners Grants); County and Municipal Governments, UF/IFAS Extension, Science and Environment Council, Bay Partner Grantees.
Projected 5-Year Costs and Funding Sources: $$$/SBEP
Location: SBEP bays and tributaries

Activity 3.2 Connect the value of natural resource protection with preservation of cultural heritage and traditional use of Sarasota Bay through partnerships with cultural heritage organizations.

Timeframe: Ongoing
Collaborators: SBEP (Coordinate); FISH; Historic Spanish Point; NCF Public Archaeology Lab; FPAN
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP bays and tributaries

Benefits

CCMP implementation can be improved by increasing the capacity of non-profit, community, and business partners to educate and engage the public about bay issues and solutions.

5-Year Performance Metrics

Fund at least $25,000 in Bay Partners Grants to community organizations annually

CE Objective 4: Ensure coordination of interlocal partners for CCMP implementation.

Activity 1: Implement the Finance and Implementation Plan, including continuation of the Interlocal Agreement and participation in the Florida Estuaries Alliance.
Activity 2: Coordinate multi-partner projects supportive of CCMP objectives and partner reporting of CCMP performance metrics.
Activity 3: Provide regular updates to policymakers and decisionmakers about priority issues, best available science, and examples of success.
Activity 4: Support and encourage interlocal partners to development and implement climate vulnerability assessments and adaptation plans. Provide tools and assistance to mitigate and adapt to climate change impacts.
Activity 5: Incorporate CCMP objectives and activities in local government comprehensive plans, land development regulations, or ordinances.

Background

SBEP is organized as a management conference of SBEP staff and four Committees that bring together a diverse assemblage of interest, perspective, and expertise to coordinate information sharing and problem solving in SBEP bays and watersheds (see CCMP general introduction for detailed conference structure and roles). By convening policy-makers (Policy Board), managers (Management Board), scientists (Technical Advisory Committee), and community members (Citizens Advisory Committee), SBEP has a unique, centralized role for informing policy and management decisions and guiding the development of technical studies, monitoring, restoration and management plans, projects, and outreach and education throughout SBEP watersheds.

SBEP's Comprehensive Conservation and Management Plan (CCMP) was first adopted in 1995 and updated in 2000, 2006, 2010, and 2014. It is a multi-partner, science-based, and consensus-driven strategic plan that prioritizes goals, objectives, and actions to protect and restore the water quality and ecological integrity of Sarasota Bay. Local, state, and federal governmental and regulatory partners have formally committed to implementing CCMP goals through adoption of an Interlocal Agreement, enacted in 2004. Partnering organizations include

- USEPA
- Town of Longboat key
- City of Bradenton
- City of Sarasota
- Manatee County
- Sarasota County
- Southwest Florida Water Management District
- Florida Department of Environmental Protection

- Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute
- US Fish and Wildlife Service
- US Army Corps of Engineers

Other agencies and organizations serve as informal partners, like the National Oceanic and Atmospheric Agency.

Other agencies and organizations referenced in the Interlocal Agreement serve as CCMP implementing partners, including Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute, US Fish and Wildlife Service, and US Army Corps of Engineers.

SBEP's Long Range Finance Plan (SBEP 2016) provides options and opportunities for funding to implement its 2014 CCMP. The Plan addresses funding for program operations, technical and outreach projects, implementation of the 5-year habitat restoration plan, research, and CCMP updates. Through the CCMP and Interlocal Agreement, SBEP and its partners have made significant progress in protecting and restoring Sarasota Bay. Continued support of the Interlocal Agreement and improved coordination among partners will catalyze continued success.

Coordination of Statewide Estuary Restoration, Research, Stewardship, and Education

In 2016, Florida's four National Estuary Programs—Coastal and Heartland National Estuary Partnership, Sarasota Bay Estuary Program, Tampa Bay Estuary Program, and the Indian River Lagoon Council, host of the Indian River Lagoon National Estuary Program—created the Florida Estuaries Alliance (Florida Estuaries Alliance 2016). The Alliance aims to help advance Florida as a national leader in coastal and estuarine restoration, research, stewardship, and education. It provides a comprehensive approach to estuarine challenges statewide, cost-effective collaboration and shared resources, fundraising, and public and private stakeholder support on multiple levels and geographic scales. The Alliance will partner with agencies and organizations that share its goals, such as FDEP's Coastal Office, National Estuarine Research Reserves, Aquatic Preserves, Florida's five water management districts, The Florida Keys National Marine Sanctuary, The Florida Ocean Alliance, and others. The Alliance will work to inform statewide leaders and the public about environmental, economic, and cultural assets associated with Florida's estuaries.

Coordination of Communication with Policymakers

Improved protection and restoration of Sarasota Bay depends on sound environmental policy and decision-making. Providing regular updates to policymakers about environmental challenges and solutions and making multiple connections between a healthy Sarasota Bay and healthy economies, communities, and families will enhance support for CCMP implementation. Demonstrating the value of the NEP model to leverage federal support and create efficient, coordinated, and collaborative local partnerships is important. SBEP staff travel to Washington DC and Tallahassee at least once per year to meet with federal and state elected and agency leaders to inform them about priority challenges and science-based, consensus-driven solutions for

environmental protection. SBEP is a trusted broker of science-based knowledge about Sarasota Bay and can be an important resource to decision-makers through effective communication.

Coordination of Multi-Partner Projects and Reporting

Local coordination of multi-partner projects can leverage partner investments and create efficiencies in accomplishing CCMP goals. SBEP has participated in more than 200 water quality or habitat improvement projects since the program's inception in 1989. Through its role as a project manager, SBEP brings together partners, funding, and contractors. SBEP's five-year Habitat Restoration Plan (2004, 2010, and 2016) guides efforts of SBEP and its partners to identify, prioritize, and implement restoration projects throughout the bay and its watersheds. Funding for projects requires coordination with funding opportunities and partner priorities, especially SWFWMD, Sarasota County, and Manatee County. Tracking and reporting habitat restoration accomplishments is important for monitoring progress toward water quality and habitat goals. SBEP reports accomplishments annually to USEPA through the National Estuary Program Online Reporting Tool (NEPORT). Improved coordination of partner reporting, such as standardizing categories and metrics for restoration, monitoring, and management activities and CCMP performance metrics will increase the clarity and value of these reports for tracking improvements in water and habitat quality in SBEP bays and tributaries.

Coordination of CCMP Implementation by Partners

CCMP implementation can be facilitated by encouraging partners to identify and prioritize goals, objectives, and activities from the CCMP that complement their priorities and incorporate them into their own comprehensive plans, land development regulations, ordinances, and other guidance documents. Tampa Bay Estuary Program and Tampa Bay Regional Planning Council's *Comprehensive Conservation and Management Plan—Local Government Comprehensive Plan Crosswalk Project* provides an effective model to accomplish this activity (TBEP CCMP 2017). Their approach prioritizes CCMP goals, objectives, and actions suitable for inclusion in local government comprehensive plans, land development regulations, and other guidance documents; identifies relevant elements of government plans, regulations, and documents that could serve as the most appropriate vehicle for incorporating CCMP priority goals and actions; and provides model language for local governments to consider.

Development and Implementation of Climate Vulnerability Assessments and Adaptation Plans

Sarasota Bay and its coastal communities are vulnerable to climate change stressors, including rising air and water temperatures, changing patterns of rainfall, increased intensity of storms, rising seas, and ocean acidification (SBEP and Shafer 2017). Threats arising from climate stressors will interact with threats from ongoing and new anthropogenic stressors and will change over time. As climate changes, so does our understanding of climate science and environmental impacts. Similarly, conservation, restoration, mitigation, and adaptation management tools are evolving to help mitigate or adapt to changes. Effective resource management will need to be adaptive and sensitive to new information and management tools and will need to operate at scales sometimes

other than traditional political boundaries. Adaptation will require collaboration and partnerships among various sectors of the community and coordination across municipal, county, state, and federal governments. As a science-based, consensus driven, multi-partner regional organization, SBEP is uniquely positioned to help partners coordinate and collaborate to develop and implement climate vulnerability assessments and adaptation plans. Continuing to incorporate the effects of climate change into the management framework for Sarasota Bay is essential to the continued success of SBEP and its partners to protect and restore Sarasota Bay.

Status

Funding Coordination

SBEP implemented its 2016–2020 Finance Plan through matching federal NEP funds with local funding from partners through its Interlocal Agreement, successful grant proposals, and a new Sarasota Bay Environmental Fund established through the Gulf Coast Community Foundation. The new fund has already begun to support outreach and education through Bay Partners Grants and restoration through a stormwater retrofit design at G.T. Bray Park in Manatee County.

SBEP worked through the newly-created Florida's Estuaries Alliance with state and federal legislators to secure NEP status and funding. The Florida National Estuary Program Act (HB 791 and S 1608) aimed to make Florida NEPs eligible for recurrent dedicated funding from FDEP, which would make it easier to plan and implement large multi-year habitat restoration and clean water initiatives. Both bills were withdrawn. The federal Protect and Restore America's Estuaries Act (HR 4044), cosponsored by US Representative Vern Buchanan, and its companion legislation in the Senate (S 3171) reauthorized the National Estuary Program for FY2022–2026, expanded annual funding from $26.5 to $50 million, and increased the types of projects that qualify for grants under the program, such as those addressing coastal resiliency, stormwater runoff, and accelerated land loss. The Act was signed into law January 2021. Additional funding will become available to NEPs, nature-based climate change solutions, and water infrastructure from 2020 year-end omnibus legislation.

The Florida Estuaries Alliance will host a set of statewide workshops in March 2021 to identify and address gaps in knowledge about managing large macroalgae blooms in Florida estuaries. [Update after meeting].

These accomplishments demonstrate the value of working together with Florida's other Estuary Programs to communicate the environmental, economic, and public health importance of NEPs and estuaries to policymakers.

Project and Partner Coordination

Coordinated, multi-partner projects—such as required for habitat restoration—are key to protecting and restoring Sarasota Bay. Of the almost 70 projects identified in SBEP's Habitat Restoration Plan, 35 have been completed and nine are underway (see Watershed Habitats Action

Plan Objective 1). Outreach projects like SBEP's *Be Seagrass Safe* program also benefit from collaboration among multiple partners (see CE-1).

[Callout Box Example of Multi-partner Project with before/after photos and restoration volunteers]

The Florida Institute for Saltwater Heritage (FISH) Preserve encompasses over 100 acres of environmentally sensitive coastal habitat east of the historic Cortez fishing village in Manatee County. The Preserve provides important fisheries habitat in an area of Sarasota Bay called the Kitchen—so named for its historically rich bounty of seafood. SBEP recently restored nearly half of the preserve through a cooperative funding agreement with FISH and SWFWMD. The restoration removed accumulated refuse on the site and improved wetland acreage, tidal circulation, and natural hydroperiods while replacing invasive exotic vegetation with native species. An additional parcel of the Preserve was completed through a partnership with the Florida Fish and Wildlife Commission, adding new hydrological connections to the adjoining bay. When fully restored, FISH Preserve will be an important piece of the diverse mosaic of habitats necessary to support sustainable fishing activities in the area. Other restoration partners at FISH include the Southeast Aquatic Resources Partnership, Ocean Trust, US Fish and Wildlife Service, Fish America Foundation, Bonefish Grill and Outback Restaurants, Manateens, and private citizens.

The USEPA's Climate Ready Estuaries (CRE) Program provides funds to SBEP to support local planning for climate change. The CRE assists NEPs and coastal communities to conduct climate vulnerability assessments, adaptation strategies, education, and engagement. Using CRE funds, SBEP conducted a vulnerability assessment to determine potential impacts on its ability to protect and restore Sarasota Bay due to climate change (SBEP and Shafer 2017). The Assessment identified 54 threats arising from four climate stressors (sea level rise, changes in precipitation, warming air and water temperatures, and ocean acidification) that present a range of challenges to achieving CCMP goals. The project was guided by the USEPA's *Being Prepared for Climate Change; A Workbook for Developing Risk-Based Adaptation Plans* (USEPA 2014). During development of the Assessment, SBEP coordinated input from its partners, Technical and Citizens Advisory Committees, the Science and Environment Council, non-governmental organizations, and citizens. In all, 74 people contributed to the Assessment.

Over the past five years, SBEP partners have made progress in assessing climate vulnerabilities and planning for climate change.

> **The City of Sarasota** conducted a climate vulnerability assessment and adaptation plan of over 200 city-owned assets in 2017 (City of Sarasota 2017). The assessment considered how sea level rise, storm surge, extreme heat, and extreme precipitation might impact city water supply, stormwater and wastewater management, transportation, public lands, and critical buildings. Eighty assets, including nine public lands and two public shorelines, were identified as being vulnerable to future climate conditions and high-level strategies were presented to protect them.

The City of Sarasota also tracks greenhouse gas emissions community-wide and within city operations, supports transition to renewable energy through the Ready for 100 initiative, participates in the community canopy program that distributes free native trees to city residents and the Partners for Green Places Program that helps local nonprofits become more energy efficient.

The Town of Longboat Key has completed the first phase of a four-phase Comprehensive Adaptation Plan for sea level rise.

Manatee County conducted a sea level rise vulnerability analysis for its public infrastructure, natural environment, and social environment (Manatee County 2019). Results can be viewed by the public on the County's innovative Climate Adaptation Portal, along with tools, data, and case studies.

Sarasota County conducted a sea level rise vulnerability assessment that analyzes vulnerabilities of county assets and provides recommendations for sea level rise planning (Sarasota County 2021). Recommendations included

- developing an administrative directive that formalizes evaluation procedures and establishes an organizational commitment to considering SLR if county projects collaboratively across departments most involved in capital projects and other facility and infrastructure investments
- joining and participating in regional local government and non-profit collaborations to inform county actions as appropriate
- working with county departments to inventory additional data, analyses, and tools
- conducting public education and outreach

Sea level rise is also addressed in the County's Post Disaster Redevelopment Plan, and watershed planning for Sarasota Bay, Little Sarasota Bay, Lemon Bay, and Dona Bay.

Sarasota and Manatee Counties are members of the Tampa Bay Regional Resilience Coalition, where they convene with members from Citrus, Hernando, Hillsborough, Pasco, and Pinellas Counties and 21 Tampa Bay municipalities to discuss complex regional issues associated with climate change, develop strategic regional responses, and build consensus for accomplishing regional goals.

SBEP is a founding partner of the Sarasota-Manatee Climate Council, a network of experts and practitioners working on climate change issues, facilitated by the Science and Environment Council. The Climate Council works collaboratively to advance regional understandings of climate change through science and education and to translate those understandings into planning and projects. SBEP provides leadership and guidance through its work with the Climate Council Education Outreach Working Group and participates in a variety of collaborative education projects.

SBEP has also produced a short video about preparing Sarasota Bay for Sea Level Rise, a brochure featuring information and resources for sea level rise adaptation planning, King Tides photo contests, and a climate change tech kit that provides lesson plans and hands-on activities for teaching students about climate change. SBEP also participated in a blue carbon citizen science volunteer event, where the community learned about the benefits of carbon sequestration by natural systems.

Priorities

SBEP will continue to provide exceptional value to its Interlocal Agreement Partners in protecting and restoring Sarasota Bay so that it can continue to provide a wealth of ecosystem services and economic and recreational benefits to the region. SBEP will continue to advance CCMP implementation through coordination with the Florida Estuaries Alliance, multi-partner education and restoration projects, local government comprehensive plans, land development regulations, and ordinances, and by supporting development and implementation of partner climate vulnerability assessments and adaptation plans.

Strategy

Activity 4.1 Implement the Finance and Implementation Plan, including continuation of the Interlocal Agreement and participation in the Florida Estuaries Alliance.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate); USEPA; Town of Longboat Key; City of Bradenton; City of Sarasota; Manatee County; Sarasota County; SWFWMD; FDEP; Coastal and Heartland National Estuary Partnership; Tampa Bay Estuary Program; Indian River Lagoon National Estuary Program; Gulf Coast Community Foundation
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP watersheds

Activity 4.2 Coordinate multi-partner projects supportive of CCMP objectives and partner reporting of CCMP performance metrics.

Timeframe: Ongoing
Collaborators: SBEP (Collaborate), County and Municipal Governments, SWFWMD, FDEP, NGOs, USEPA, USFWS, NOAA, USACE
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP watersheds

Activity 4.3 Provide regular updates to policymakers and decisionmakers about priority issues, best available science, and examples of success.

Timeframe: Ongoing
Collaborators: SBEP (Conduct)
Projected 5-Year Costs and Funding Sources: $/SBEP (320)
Location: SBEP watersheds

Activity 4.4 Support and encourage interlocal partners to development and implement climate vulnerability assessments and adaptation plans. Provide tools and assistance to mitigate and adapt to climate change impacts.

Timeframe: 2021-2023
Collaborators: SBEP (Collaborate); County and Municipal Governments
Projected 5-Year Costs and Funding Sources: $/SBEP (320); $$$/USEPA, NOAA, USACE, Grants, County and Municipal Governments
Location: SBEP watersheds

Activity 4.5 Incorporate CCMP objectives and actions in local government comprehensive plans, land development regulations, or ordinances.

Timeframe: 2021-2025
Collaborators: SBEP (Coordinate); County and Municipal Governments
Projected 5-Year Costs and Funding Sources: $/SBEP (320); $$$/County and Municipal Governments
Location: SBEP watersheds

Benefits

Coordination of partners, projects, and funding for CCMP implementation will leverage resources and create efficiencies to protect and restore SBEP bays, tributaries, and watersheds.

5-Year Performance Metrics

Develop a CCMP performance metric reporting tool for the SBEP website.

APPENDIX 1: ACTION PLANS AT A GLANCE

WATER QUALITY AND QUANTITY ACTION PLAN STRATEGY

GOAL: Improve water quality and the timing, quantity, and distribution of freshwater flow to the estuary.

KEY TO COSTS: $ (< 25 K) $$ (25-99 K) $$$ (100-500 K) $$$$ (500 K - 1 M) $$$$$ (> 1 M)

Objectives	Activities	Timeframe	Collaborators	Projected 5-Year Costs and Funding Sources	Location	Benefits	5-Year Performance Metrics
WQQ-1: Support comprehensive and coordinated surface water and groundwater quality monitoring, assessment, and reporting.	WQ-1.1: Support long-term, coordinated, and timely collection, archiving, analysis, reporting, and quality assurance/quality control of water quality data. Support and enhance timely public communication of water quality monitoring data.	Ongoing	SBEP (Support); County & Municipal Governments; FDOH; FDEP; FWC; SWFWMD; USGS	$$$/SBEP (CWA 320); County & Municipal Governments	SBEP waterbodies and watersheds	Long-term, standardized water quality data that is regularly analyzed and publicly accessible supports identification of waterbody improvements or impairments and management actions to improve water quality.	• Completion of CCMP Monitoring Strategy • Creation of a water quality status and trends communication piece
	WQQ-1.2: Review and evaluate monitoring programs, increase efficiencies, fill water and air quality monitoring gaps, reevaluate estuary circulation models, identify sources of pollution, and update pollutant sources in pollutant load models.	CCMP Monitoring Strategy in 202X	SBEP (Collaborate); Water Quality Consortium; County Governments; Mote Marine Laboratory; FDEP; FDOH; USF; USGS	$$$/SBEP (CWA 320); County & Municipal Governments; SWFWMD; FDEP			
WQQ-2: Develop improvement plans to maintain, attain, or surpass state water quality standards.	WQQ-2.1: Revise and implement watershed management plans and prioritized projects. Include hydrologic improvement planning in watershed management plans.	Update Sarasota Bay Watershed Management Plan in 2020; Update Bowlees Creek Watershed Management Plan in 2020	SBEP (Collaborate); County & Municipal Governments; SWFWMD	$$$$/County & Municipal Governments; SWFWMD	SBEP waterbodies and watersheds	Watershed management plans and projects developed from accurate nutrient pollutant loading models and science-based criteria for water quality indicators, targets, and thresholds result in measurable water quality improvements.	• Establishment of a Water Quality Consortium • Creation of a report detailing water quality indicators and a pathway to remediation • Creation of a prioritized list of water quality projects

	WQQ-2.2: Convene a Sarasota Bay Water Quality Consortium and produce a report detailing water quality indicators and a pathway to remediation.	Convene Water Quality Consortium in 2020.	SBEP (Conduct); County & Municipal Governments; FDEP; Consortium Stakeholders	$$/SBEP (CWA 320); List SBEP partners involved in the Consortium			
WQQ-3: Improve and manage hydrology for a more natural pattern of timing, quantity, and distribution of surface water flows.	WQQ-3.1 Understand historic, current, and projected hydrologic regimes, accounting for projected climate change and the role of beneficial reuse. Identify and prioritize hydrologic improvement projects.	Update Sarasota Bay Watershed Management Plan in 2020	SBEP (Collaborate); County & Municipal Governments; SWFWMD; USGS	$$$/County & Municipal Governments; SWFWMD	SBEP priority hydrologic alteration areas.	Improving hydrology to a more natural state provides multiple benefits for water quality, recreation, habitat, and flood protection.	• Completion of an inventory of prioritized (funded) projects for hydrologic restoration
	WQQ-3.2: Support floodplain management that benefits resiliency to flooding and climate change, stormwater quality and quantity improvement, nutrient reduction, and flowway and floodplain restoration to mimic natural system function.	Ongoing	SBEP (Coordinate); County & Municipal Governments; SWFWMD; FEMA	$$$$$/County & Municipal Governments; SWFWMD			
WQQ-4: Reduce pollutant loading from stormwater.	WQQ-4.1: Support development and adoption of green infrastructure and smart growth standards in comprehensive land-use plans and land development regulations (stormwater rules and design manuals) to reduce stormwater quantity and pollutant loading.	Ongoing	SBEP (Support); County & Municipal Governments	$/County & Municipal Governments; MPO	SBEP watersheds, Stormwater Utility in Manatee County	Reduced pollutant loading from stormwater improves water quality necessary for human uses and healthy aquatic systems.	• Establishment of a Manatee County Stormwater Utility• Creation of an HOA/homeowner BMP manual (or convene a workshop to design manual)
	WQQ-4.2: Install green infrastructure projects to improve stormwater management for efficient pollution reduction and flood control.	Ongoing	SBEP (Coordinate/ Collaborate); County & Municipal Governments; SWFWMD; FDEP; FDOT	$$$$/SWFWMD; FDEP; County & Municipal Governments; FDOT; MPO			
	WQQ-4.3: Establish the fee schedule for the Manatee County stormwater utility and consider utilizing stormwater utility funding for water quality improvement projects, especially green infrastructure.	2021	SBEP (Support); Manatee County	$/Manatee County			
	WQQ-4.4: Evaluate nutrient removal performance and cost-benefits of nutrient removal BMPs. Support development of a HOA/homeowner BMP manual and a model vendor contract supportive of water quality.	[??	SBEP (Collaborate); UF/IFAS Extension; FDEP, Florida Stormwater Association	$$/SBEP (320); UF/IFAS Extension; US EPA			

WQQ-5: Reduce pollutant loading from septic and other onsite sewage treatment and disposal systems.	WQQ-5.1: Continue conversion of septic systems to centralized sewer systems and consolidation of small wastewater treatment plants, prioritized in coastal areas.	Ongoing	SBEP (Support); County & Municipal Governments; private utilities	$$$$$/County & Municipal Governments	SBEP priority watersheds and coastal areas	Improving understanding and management of pollutant loading from septic systems and converting parcels from septic to sewer service will reduce pollutant loading from septic systems.	• Improved inventory of onsite sewage treatment and disposal systems. • Creation of a prioritized list of future septic to sewer service conversions.
	WQQ-5.2: Encourage regular inspection and maintenance of septic systems and installation of supplemental and advanced septic system technologies, prioritized in coastal areas and basins with impaired waters.	Ongoing	SBEP (Support); FDOH; FDEP	$/SBEP (320)			
	WQQ-5.3: Improve inventory and mapping of septic and other onsite treatment systems and increase understanding about septic system capacity to treat nutrient pollution and pathogens under different site conditions, including climate change.	Ongoing; CCMP Monitoring Strategy in [202X	SBEP (Collaborate); FDOH; County & Municipal Governments	$/County & Municipal Governments			
WQQ-6: Reduce pollutant loading from centralized wastewater collection, treatment and disposal systems, including reuse.	WQQ-6.1: Support advanced wastewater treatment or better throughout SBEP watersheds, considering population growth, climate change, and opportunities for beneficial reuse. Improve public understanding of value of AWT.	Ongoing	SBEP (Support); County & Municipal Governments	$/SBEP (320); $$$$$/County & Municipal Governments	SBEP watersheds	Reducing spills and overflows from failing or underperforming centralized wastewater infrastructure, converting WWTPs to advanced treatment, and improving detection and treatment methods for emerging contaminants will reduce pollutant loading from centralized wastewater collection, treatment, and disposal systems, including reuse.	Updated pollutant load model for SBEP bays
	WQQ-6.2: Evaluate and manage impact of reuse storage and distribution on nutrient loading and hydrology, including reuse irrigation in population growth centers and siting of reuse ponds relative to bays and creeks. Develop management plans and BMPS to avoid overflows, releases, and excess nutrient loading.	Ongoing	SBEP (Collaborate); County & Municipal Governments; FDEP	$$$/County & Municipal Governments; FDEP			
	WQQ-6.3: Encourage proactive inspection, maintenance and FOG avoidance, and replacement of failing or underperforming sanitary sewer infrastructure to prevent inflow and infiltration, overflows, and spills. Support improved quantitative public reporting requirements for accidental and emergency sewage discharges.	Ongoing	SBEP (Support); County & Municipal Governments; FDOH; FDEP	$/SBEP (320); $$$/County & Municipal Governments; FDOH; FDEP			
	WQQ-6.4: Review detection and treatment methods for emerging contaminants and pollutants in wastewater such as endocrine disrupters, pharmaceuticals, and plastic microfibers.	Ongoing; CCMP Monitoring Strategy in [202X	SBEP (Collaborate/ Conduct); FDEP; FDOH; Universities; EPA	$$$/FDEP, FDOH; Universities; NOAA			

WQQ-7: Improve understanding of pollutant loading from atmospheric nitrogen deposition.	WQQ-7.1: Evaluate air quality monitoring network and programs to quantify sources, pathways, and contribution of direct and indirect atmospheric deposition to area waters.	CCMP Monitoring Strategy in [202X	SBEP (Coordinate); County & Municipal Governments; FDOH; FDEP; EPA	$$/SBEP (320); FDEP	SBEP waterbodies and watersheds	Improving understanding of pollutant loading from atmospheric deposition will improve management of water quality in SBEP watersheds and bays.	Literature review/analysis of atmospheric nitrogen deposition
	WQQ-7.2: Support initiatives to reduce emissions from vehicles, landscape maintenance equipment, and other mobile sources.	Ongoing	SBEP (Support); County & Municipal Governments; FDEP; UF/IFAS Extension	$/SBEP (320); County & Municipal Governments; FDEP			
WQQ-8: Support measures to better understand, monitor, report, respond to, recover from, mitigate, and reduce harmful algal blooms.	WQQ-8.1: Support development of coordinated, standardized tools for monitoring and reporting HABs, evaluating their impact on the environment, economy, and human health, and improving capacity to mitigate, prepare for, respond to, and recover from them.	Ongoing; CCMP Monitoring Strategy in [202X	SBEP (Support); FWC; FDOH; FDEP; Florida Sea Grant; NOAA; Colleges & Universities; County & Municipal Governments; Mote Marine Laboratory; SWFWMD; TBEP; Science and Environment Council	$$$$/SBEP (320); FWC; FDOH; FDEP; Florida Sea Grant; USF and UF; NOAA; Mote Marine Laboratory; SWFWMD; GCOOS; GOMA; FWC; TBEP, Science and Environment Council	SBEP waterbodies	Improved knowledge about HABs and their impacts on environment, economy, and human health and improved capacity to prepare for, respond to, and recover from them will build public support for water quality improvement and habitat restoration and will increase human and ecosystem resilience to impacts from HABs.	• Improved coordination on HAB monitoring, reporting, and response • Improved HAB communication tools.
	WQQ-8.2: Support research and monitoring to better understand the taxonomic composition, toxicity, severity, extent, and duration of HABs, and the role nutrient sources and climate change play in bloom initiation, growth, maintenance, and termination.	Ongoing; CCMP Monitoring Strategy in [202X	SBEP (Support); FWC; Florida Sea Grant; USF; Colleges & Universities; County & Municipal Governments; Mote Marine Laboratory; NOAA; GCOOS; FDEP	$$$$$/SBEP (320); FWC; NOAA; FDEP; Florida Sea Grant; Colleges & Universities; Mote Marine Laboratory; SWFWMD; USACE			

SBEP Actions	SBEP Engagement	SBEP Staff Time	SBEP (320) Project Funds
Support	Encourage actions that support CCMP implementation.	Yes	No
Coordinate	Convene partnering entities, ensure open communication, and maximize efficiencies.	Yes	Yes, for some meetings
Collaborate	Invest funding and staff time as a partner, but not as the lead agency.	Yes	Yes
Conduct	Invest funding and staff time as the lead agency.	Yes	Yes

WATERSHED HABITATS ACTION PLAN STRATEGY

GOAL: Restore shoreline, wetland, and bay habitats and eliminate future losses.

KEY TO COSTS: $ (< 25 K) $$ (25-100 K) $$$ (100-500 K) $$$$ (500 K - 1 M) $$$$$ (> 1 M)

Objectives	Activities	Timeframe	Collaborators	Projected 5-Year Costs and Funding Sources	Location	Benefits	5-Year Performance Metrics
WH-1: Update and implement the SBEP Five-Year Habitat Restoration Plan	WH-1.1 Update the five-year Habitat Restoration Plan with consideration of local watershed plan priority projects and resiliency strategies; and coordinate, track, and report progress metrics for habitat restoration.	Complete update by 2021	SBEP (conduct); SWFWMD (except beach and dune projects); FDEP; FWC; FDOT; Audubon; County and Municipal governments	$/SBEP (CWA 320)	SBEP watersheds	A science-based approach to identifying and prioritizing restoration projects effectively and efficiently guides program resources to maximize habitat protection and restoration.	Updated and adopted Habitat Restoration Plan
WH-2: Protect, enhance, and restore uplands and freshwater wetlands	WH-2.1 Encourage and support the permanent conservation of natural lands through acquisition and conservation easements, including freshwater wetlands and flowways, corridors, and uplands adjacent to coastal habitats necessary for habitat resilience and migration.	Ongoing	SBEP (support); FWC; SWFWMD; FDEP; FDACS; County & Municipal Governments; NOAA; Conservation Foundation of the Gulf Coast	$$$$$/SBEP; County & Municipal Governments; Conservation Foundation of the Gulf Coast; Landowners; SWFWMD; and USDA-NRCS	SBEP watersheds with a focus on areas recommended in the HRP	Healthy and interconnected, upland and freshwater wetland habitats support the natural processes necessary for a healthy bay.	Increased acreage of conserved, restored, or managed habitat
	WH-2.2 Restore and manage natural lands through prescribed fire, eradication of invasive exotic plants and animals, hydrologic improvement, and reestablishment of threatened and endangered plants.	Ongoing	SBEP (support); FWC; SWFWMD; FDEP; FDACS; County & Municipal Governments; NOAA; Audubon (golf course restoration)	$$$$$/SBEP (CWA 320); County & Municipal Governments; SWFWMD; FWC; FDEP; NOAA; USDA-NRCS; USFWS			

WH-3: Improve tributary habitats with a special emphasis on fisheries	WH-3.1 Create and implement a strategy for restoring habitat in tributaries to: • characterize, delineate, and quantify tributary shoreline and habitat features supportive of fisheries; • prioritize habitat restoration projects that increase critical juvenile fish habitat; and • design restorations of urban creek, canal, and stormwater flowways to mimic natural stream function, including elimination of barriers and hardened shorelines.	Ongoing	SBEP (collaborate); Mote Marine Laboratory; County & Municipal Governments; SWFWMD; FWC; FDEP	$$$$$/SBEP (CWA 320); FDEP; County & Municipal Governments; SWFWMD; FWC; NFWF; Colleges and Universities; NOAA	SBEP tributaries	Improvements to the habitat quality and connectivity of tributaries support water quality and fish populations, while providing flood control and increasing property values.	Increased acreage and linear feet of improved shorelines and tributary habitats
WH-4: Protect, enhance, and restore coastal wetlands and improve shoreline resiliency	WH-4.1 Continue coastal wetland restoration and protection projects prioritized by the Habitat Restoration Plan.	Ongoing	SBEP (conduct); SWFWMD (4.1; confirm with L.G. specifically about 4.2-4.5); FDEP; FWC; Florida Sea Grant; USACE; County and Municipal Governments	$$$$/SBEP (CWA 320); County & Municipal Governments; Landowners; SWFWMD; FWC; FDEP; NOAA; Florida Sea Grant; USACE; WCIND; NFWF; NOAA	SBEP watersheds with a focus on areas recommended in the HRP	Expanded use of softened shorelines in bay and tidal tributary locations improves wildlife habitat, water quality, and resilience to storms and sea level rise. Expanded ecosystem services and non-habitat related benefits.	• Increased acreage and linear feet of created or restored coastal habitat• 10 workshops or consultations with government, waterfront property owners, or marine contractor representatives
	WH-4.2 Continue spoil island restoration and protection. Support establishment of protected managed areas for bay islands.	Ongoing	SBEP (conduct); and County and Municipal Governments (leads); FWC; USACE; Audubon; FDEP	$$$$/SBEP (CWA 320); FWC; USACE; WCIND; NFWF; NOAA; FDEP; RESTORE			
	WH-4.3 Implement shoreline resiliency strategies to: • conserve adjacent uplands; • encourage installation of living shorelines through education, incentives, technical and permitting assistance, workshops, and trainings; and • support consistent policies across jurisdictions regarding rolling easements, coastal construction setbacks, and shoreline alterations that encourage or do not prohibit living shorelines, especially for resiliency and post-disaster planning.	Ongoing	SBEP (conduct); FWC; NOAA; Florida Sea Grant; USACE; County & Municipal Governments; FDEP	$$$$/SBEP (CWA 320); County & Municipal Governments; Landowners; NOAA; FDEP			
WH-5: Protect, enhance, and restore seagrass and other benthic habitats	WH-5.1 Monitor artificial and oyster reef habitat quality, explore optimal placement of new reefs, and establish/enhance oyster and artificial reefs in Sarasota Bay.	Ongoing	SBEP (conduct); County Governments (co-leads); FWC; FDEP; Florida Sea Grant; Mote Marine Laboratory; USACE	$$$/SBEP (CWA 320); SWFWMD; County Governments; FWC; FDEP	SBEP bays	Mapping, monitoring, and enhancing hard bottom and seagrass habitats supports fish and shellfish populations and improves water quality.	• Reporting of acres of extant seagrass and hard-bottom habitats • Net area of hard-bottom habitat created or restored
	WH-5.2 Participate in inventory of benthic and living hard-bottom habitat in Sarasota Bay and nearshore Gulf water and passes.	Begin in 2022	SBEP (collaborate); USGS; Florida Coastal Mapping Program	$$/SBEP (CWA 320); FIO; USF; SWFWMD (living hard bottom only)			

	WH-5.3 Reevaluate seagrass indicators and targets in bay segments. Implement water quality improvement strategies to increase seagrass habitat.	Begin reevaluation in 2020	SBEP (conduct); County & Municipal Governments; FDEP; SWFWMD	$$/SBEP (CWA 320); County & Municipal Governments; SWFWMD; FDEP			
	WH-5.4 Continue seagrass mapping and monitoring and expand seagrass monitoring transects to Manatee County.	Ongoing biennial	SBEP (support); SWFWMD (lead); County Governments	$$$/SWFWMD; County Governments			
WH-6: Protect, enhance, and restore beaches and dunes for wildlife and resiliency	WH-6.1 Restore coastal dunes and encourage protection of beach wrack communities.	Ongoing	SBEP (collaborate); County & Municipal Governments; Audubon; FWC; Mote Marine Laboratory; USACE; DEP; Audubon	$$$/SBEP (CWA 320); FWC; WCIND; USACE	SBEP beaches	Better understanding of impacts of dredge and fill activities on beach and dune habitat improves comprehensive planning and protection of sensitive fish, birds, turtles, and invertebrates.	• Increased acreage of restored dunes • Peer-reviewed and adopted technical report on impacts of dredge and fill activities on beach and bay habitats
	WH-6.2 Curate scientific knowledge of habitat impacts of sand replenishment and movement.	Begin in 2022	SBEP (conduct); Mote Marine Laboratory; Florida Audubon; FWC; FDEP; NOAA	$$/SBEP (CWA 320)			
	WH-6.3 Explore the role of SBEP in regional sediment management planning and monitoring, including coordination with USACE.	Begin in 2022	SBEP (conduct); County & Municipal Governments; USACE; FDEP	$/SBEP (CWA 320)			

SBEP Actions	SBEP Engagement	SBEP Staff Time	SBEP (320) Project Funds
Support	Encourage actions that support CCMP implementation.	Yes	No
Coordinate	Convene partnering entities, ensure open communication, and maximize efficiencies.	Yes	Yes, for some meetings
Collaborate	Invest funding and staff time as a partner, but not as the lead agency.	Yes	Yes
Conduct	Invest funding and staff time as the lead agency.	Yes	Yes

FISH AND WILDLIFE ACTION PLAN STRATEGY

GOAL: Protect, restore, and enhance fish and wildlife in Sarasota Bay.

KEY TO COSTS: $ (< 25 K) $$ (25-99 K) $$$ (100-500 K) $$$$ (500 K - 1 M) $$$$$ (> 1 M)

Objectives	Activities	Timeframe	Collaborators	Projected 5-Year Costs and Funding Sources	Location	Benefits	5-Year Performance Metrics
FW-1: Protect, restore, and enhance the diversity and abundance of native fish.	FW-1.1 Continue fish population monitoring programs to support fisheries management, monitor invasive species, and understand habitat usage through all life stages. Explore opportunities to expand monitoring programs to include a greater diversity of species, tidal creeks and canals, and use of innovative monitoring technologies.	Ongoing	SBEP (Collaborate); FWC; CZS-SDRP; NCF; SCAN; Florida Sea Grant; NOAA; Mote	$$$/SBEP(320); FWC; County & Municipal Governments; NOAA	SBEP bays and tributaries	Native fish are critical components of the ecological integrity of SBEP bays and tributaries.	Continued bimonthly fish population monitoring in priority SBEP estuary segments
	FW-1.2 Support research to fill fisheries data gaps, including habitat connectivity between SBEP tidal tributaries, bays, and the Gulf of Mexico; migration barriers; HAB response and recovery; and projected climate change impacts.	Ongoing	SBEP (Collaborate); Mote; FWC; NCF; Florida Sea Grant; NOAA	$$$/SBEP(320); Grants			
	FW-1.3 Explore capacity and potential effectiveness of protected managed areas, enhanced fishery management actions, and stock enhancement to protect and restore fish diversity, abundance, and resilience.	Ongoing; Explore protected managed areas by 2023	SBEP (Support); FDEP; FWC; Mote	$$$/Grants			
	FW-1.4 Promote ethical angling practices that increase conservation and prevent marine debris, including catch-and-release and monofilament recycling.	Ongoing	SBEP (Collaborate); FDEP; Florida Sea Grant; Sarasota Bay Watch; Mote; FWC; Fishing enthusiast organizations	$$/SBEP(320); Grants			
FW-2: Protect, restore, and enhance the diversity and abundance of native shellfish.	FW-2.1 Monitor native bivalve populations and protect, restore, and enhance their habitats.	Ongoing	SBEP (Conduct); County Governments; Sarasota Bay Watch; Mote; FWC	$$$/SBEP(320); County Governments; FWC; Sarasota Bay Watch; Mote; RESTORE	SBEP bays and tributaries	Native shellfish are critical components of the ecological integrity of SBEP bays and tributaries.	10 acres of reef created or enhanced
	FW-2.2 Support research to understand native shellfish recruitment, habitat needs, and vulnerabilities to climate change impacts.	Ongoing	SBEP (Coordinate); Florida Sea Grant; Shellfish Institute; Mote; FWC	$$/SBEP(320); Grants; FWC			

	FW-2.3 Support research to understand the benefits of native bivalve stock enhancement for improvements to water quality, habitat, and native populations.	Ongoing	SBEP (Coordinate); Florida Sea Grant; Gulf Shellfish Institute; FWC; County Governments	$$/SBEP(320); Grants; FWC			
FW-3: Monitor and protect threatened, endangered, and vulnerable wildlife.	FW-3.1 Support monitoring of threatened, endangered, and vulnerable wildlife.	Ongoing	SBEP (Support); CZS-SDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; Florida Sea Grant	$$$$/CZS-SBDRP; Mote; Audubon; New College of Florida; FWC; NOAA; Turtle Watches; Florida Sea Grant	SBEP bays, tributaries, and watersheds	Healthy native wildlife populations are critical components of the ecological integrity of SBEP bays, tributaries, and watersheds	Continued monitoring of threatened, endangered, and vulnerable wildlife
	FW-3.2 Support protection of threatened, endangered, and vulnerable wildlife, including outreach and education to minimize adverse human-wildlife interactions.	Ongoing	SBEP (Collaborate); CZS-SDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; USFWS; FDEP; Save Our Seabirds	$$$$/SBEP(320); CZS-SBDRP; Mote; Audubon; NCF; FWC; NOAA; Turtle Watches; USFWS; FDEP; Save Our Seabirds			

SBEP Actions	SBEP Engagement	SBEP Staff Time	SBEP (320) Project Funds
Support	Encourage actions that support CCMP implementation.	Yes	No
Coordinate	Convene partnering entities, ensure open communication, and maximize efficiencies.	Yes	Yes, for some meetings
Collaborate	Invest funding and staff time as a partner, but not as the lead agency.	Yes	Yes
Conduct	Invest funding and staff time as the lead agency.	Yes	Yes

COMMUNITY ENGAGEMENT ACTION PLAN STRATEGY

GOAL: Engage, educate, and encourage environmental stewardship of Sarasota Bay and increase community connections to the estuary through low impact recreational use and enjoyment.

KEY TO COSTS: $ (< 25 K) $$ (25-99 K) $$$ (100-500 K) $$$$ (500 K - 1 M) $$$$$ (> 1 M)

Objectives	Activities	Timeframe	Collaborators	Projected 5-Year Costs and Funding Sources	Location	Benefits	5-Year Performance Metrics
CE-1: Reduce recreational use impacts on Sarasota Bay and improve access for communities disconnected from waterways	CE-1.1 Promote and support community-driven public land acquisitions and improvements, including new and expanded trails, blueways, launch points, and bay views, that enhance recreational access for communities disconnected from waterways.	Ongoing	SBEP (Support); County & Municipal Governments; Bay Park Conservancy; Conservation Foundation of the Gulf Coast	$/SBEP; $$$$$/acquisitions	SBEP bays and tributaries	Enhancing managed recreational access for communities disconnected from waterways helps grow watershed awareness and community-wide support for a healthy bay.	15 guided kayak tours, coastal walks, and other recreational opportunities annually with a focus on engaging communities that are traditionally under-represented in bay user groups
	CE-1.2 Educate recreational users about best practices to avoid impacts to bay waters, wildlife, and habitats, including pollution prevention, safe boating, ethical angling, and sustainable tourism.	Ongoing	SBEP (Conduct); FWC; FDEP; SWFWMD; Sarasota Bay Watch; Chicago Zoological Society's Sarasota Dolphin Research Program; Audubon Florida; Save Our Seabirds; Mote Marine Laboratory; Around the Bend Nature Tours; Wayne Adventures; Science and Environment Council	$$/SBEP (320)			
	CE-1.3 Support responsive and adaptive management of bay access points and recreational trails to avert impacts from overuse.	Workshop 2022	SBEP (Coordinate); County & Municipal Governments; Conservation Foundation of the Gulf Coast; Science and Environment Council; NOAA; FWC; FDEP; SWFWMD	$/SBEP (320)			

CE-2: Improve public understanding and action on bay-related issues and expand reach to priority audiences.	CE-2.1 Inform and engage the public about priority environmental issues and the multiple benefits of watershed and estuary and restoration, including climate change adaptation.	Ongoing	SBEP (Conduct); County & Municipal Governments; Florida Audubon; Save Our Seabirds; Conservation Foundation of the Gulf Coast; FDEP; Around the Bend Nature Tours; Florida Native Plant Society; Chicago Zoological Society's Sarasota Dolphin Research Program; Mote Marine Laboratory; UF/IFAS Extension; Florida Sea Grant; Science and Environment Council; Sarasota Bay Watch; FWC; FDEP; SWFWMD	$$/SBEP (320)	SBEP bays and tributaries	Working collaboratively with partners on outreach and education that informs and empowers citizens to take community and individual bay-friendly actions helps sustain a healthy Sarasota Bay.	5 Bay Guardians events annually
	CE-2.3 Support volunteer restoration and citizen science activities that contribute to assessment, monitoring, and restoration of bay and gulf waters, shorelines, wetlands, and other habitats.	Ongoing	SBEP (Conduct); County & Municipal Governments; New College of Florida; Florida Sea Grant; UF/IFAS Extension; Florida Audubon; GCORR; FWC; Sarasota Bay Watch; Mote Marine Laboratory; Longboat Key Turtle Watch; Anna Maria Island Turtle Watch	$/SBEP (320)			
	CE-2.4 Assist and empower citizens to adopt sustainable bay-friendly lifestyles and to lead community initiatives that reduce pollution, conserve water and energy, and promote community health.	Ongoing	SBEP (Conduct); Florida Sea Grant; UF/IFAS Extension; County & Municipal Governments	$/SBEP (320)			
CE-3: Coordinate and support community initiatives that advance CCMP implementation	CE-3.1 Support capacity of non-profit, community, and business partners to educate and engage the public in outreach and stewardship that further CCMP implementation (professional development, workshops, grants).	Ongoing	SBEP (Support and coordinate professional development and workshops; Conduct Bay Partners Grants); County and Municipal Governments; UF/IFAS Extension; Science and Environment Council; Bay Partner Grantees.	$$$/SBEP	SBEP bays, tributaries, and watersheds	CCMP implementation can be improved by increasing the capacity of non-profit, community, and business partners to educate and engage the public about bay issues and solutions.	Fund at least $25,000 in Bay Partners Grants to community organizations annually
	CE-3.2 Connect the value of natural resource protection with preservation of cultural heritage and traditional use of Sarasota Bay through partnerships with cultural heritage organizations.	Ongoing	SBEP (Coordinate); FISH; Historic Spanish Point; NCF Public Archaeology Lab; FPAN	$/SBEP			

CE-4: Ensure coordination of interlocal partners for CCMP implementation	CE-4.1 Implement the Finance and Implementation Plan, including continuation of the Interlocal Agreement and participation in the Florida Estuaries Alliance.	Ongoing	SBEP (Collaborate); USEPA; Town of Longboat Key; City of Bradenton; City of Sarasota; Manatee County; Sarasota County; SWFWMD; FDEP; Coastal and Heartland National Estuary Partnership; Tampa Bay Estuary Program; Indian River Lagoon National Estuary Program; Gulf Coast Community Foundation	$/SBEP (320)	SBEP watersheds	Coordination of partners, projects, and funding for CCMP implementation will leverage resources and create efficiencies to protect and restore SBEP bays, tributaries, and watersheds.	Develop a CCMP performance metric reporting tool for the SBEP website
	CE-4.2 Coordinate multi-partner projects supportive of CCMP objectives and partner reporting of CCMP performance metrics.	Ongoing	SBEP (Collaborate); County and Municipal Governments; SWFWMD; FDEP; NGOs; USEPA; USFWS; NOAA; USACE	$/SBEP (320)			
	CE-4.3 Provide regular updates to policymakers and decisionmakers about priority issues, best available science, and examples of success.	Ongoing	SBEP (Conduct)	$/SBEP (320)			
	CE 4.4 Support and encourage interlocal partners to develop and implement climate vulnerability assessments and adaptation plans. Provide tools and assistance to mitigate and adapt to climate change impacts.	2021-2023	SBEP (Collaborate); County and Municipal Governments	$/SBEP (320); $$$/USEPA; NOAA; USACE; Grants; County and Municipal Governments			
	CE-4.5 Incorporate CCMP objectives and actions in local government comprehensive plans, land development regulations, or ordinances.	2021-2025	SBEP (Coordinate); County and Municipal Governments	$/SBEP (320); $$$/County and Municipal Governments			

SBEP Actions	**SBEP Engagement**	**SBEP Staff Time**	**SBEP (320) Project Funds**
Support	Encourage actions that support CCMP implementation.	Yes	No
Coordinate	Convene partnering entities, ensure open communication, and maximize efficiencies.	Yes	Yes, for some meetings
Collaborate	Invest funding and staff time as a partner, but not as the lead agency.	Yes	Yes
Conduct	Invest funding and staff time as the lead agency.	Yes	Yes

APPENDIX 2: CROSSWALK OF 2014 CCMP OBJECTIVES AND ACTIVITIES TO 2021 CCMP

2014 Action	2014 Action Summary	Status	2021 Objective
WW - Wastewater Treatment & Reclamation			
WW-1.1	Local governments in the Sarasota Bay region should require by ordinance, and appropriate monitoring and enforcement, the wastewater treatment policies outlined in the CCMP.	Revised	WQQ-6
WW-1.2	Educate the public about the need for consistent policies on wastewater treatment and reclamation.	Revised	WQQ-6
WW-2.0	Continue to use excess capacity of the City of Sarasota wastewater treatment facility to provide sewer service to areas with inefficient septic systems and package treatments plants to maximize collection and treatment of wastewater.	Complete	
WW-3.1	Complete septic tank replacement and wastewater treatment plant consolidation in northern Sarasota County.	Revised	WQQ-5, WQQ-6
WW-3.2	Remaining privately owned utilities should upgrade to meet the Wastewater Treatment and Reclamation policies in this Action Plan.	Revised	WQQ-6
WW-4.1	Reconsider a regional program to reclaim treated wastewater.	Completed	
WW-4.2	Explore options for alternative supply, including the use of treated wastewater or potable water, aquifer recharge and protection, and other uses in the Southern Water Use Caution Areas.	Ongoing	WQQ-6
WW-5.1	Set resource-based water quality targets providing a framework for the establishment of site-specific alternative criteria.	Complete	
WW-5.2	Develop and participate in the preparation of Basin Management Action Plans for "impaired" waters or to meet established water quality targets.	Revised	WQQ-2
SW - Stormwater Treatment & Prevention			
SW-1.1	Implement Florida Friendly Landscaping, which emphasizes reduction in use of pesticides and water and encourages broader use of slow-release nitrogen fertilizers.	Ongoing	CE-2, CE-3
SW-1.2	Sediment control: encourage onsite sediment management in the FFL.	Revised	CE-2, CE-3
SW-1.3	Develop and support pollution prevention programs.	Ongoing	WQQ-2, WQQ-4, CE-2, CE-3
SW-2.1	Develop and implement a revised watershed management master plan for the Sarasota Bay region, with priority on the following tributaries: Phillippi Creek, Bowlees Creek, Cedar Hammock Creek, Hudson Bayou and Whitaker Bayou.	Ongoing	WQQ-2
SW-2.2	Implement a stormwater utility with appropriate rate structure and related public education in Manatee County.	Ongoing	WQQ-4
SW-2.3	Focus watershed master plans on reducing toxins, sediment, and nitrogen loads to the Bay while also controlling flooding.	Ongoing	WQQ-2
WE - Freshwater & Saltwater Wetlands			
WE-1.1	Update the five-year Habitat Protection and Restoration Plan and develop a database for tracking progress in habitat restoration	Ongoing	WH-1
WE-1.2	Enhance, restore, and create wetlands throughout the Bay region.	Ongoing	WH-2, WH-4
WE-1.3	Maintain wetland protection in local comprehensive plans, ordinances, and land development regulations. Incorporate wetlands and open space concept in road, bridge, stormwater, wastewater, and other infrastructure projects.	Ongoing	CE-4
WE-1.4	Recognize the importance of adjacent upland areas as buffers in restoring, creating, or protecting wetlands.	Ongoing	WH-4
WE-1.5	Encourage and facilitate wetland protection through public ownership or private conservation easements.	Ongoing	WH-2, WH-4
WE-1.6	Remove exotic noxious plants.	Ongoing	WH-2
WE-1.7	Coordinate wetlands activities with the SBEP, citizen organizations, and existing citizen advisory committees of local governments.	Ongoing	CE-2, CE-3
WE-1.8	Develop and implement policies that are consistent across jurisdictions regarding shoreline alterations such as docks, seawall, or other shoreline protection alternatives.	Revised	WH-4
WE-1.9	Provide cooperative consultations (as requested) to the private and public sectors on development proposals and regulatory issues that impact wetlands.	Retired	CE-2
WE-1.10	Continue to provide technical information to programs to increase public education and citizen involvement in wetlands issues.	Ongoing	CE-3
WE-1.11	Encourage that fines for environmental violations at the regional and local level (from either permitted or unpermitted activities) be directed to environmental enhancement projects within the watershed.	Retired	

WE-2.1	Support an ongoing education program on mangrove protection and care.	Ongoing	WH-4, CE-3
WE-2.2	Encourage citizen groups to restore and protect wetlands through removal of trash and exotic plants	Ongoing	CE-2. CE-3
WE-2.3	Coordinate wetlands activities with the SBEP, citizen organizations, and existing citizen advisory committees of local governments.	Ongoing	CE-2, CE-3
WE-2.4	Continue to promote neighborhood wetlands protection and homeowner shoreline management through the Florida Friendly Landscaping Program.	Ongoing	CE-2
FL - Fisheries & Other Living Resources			
FL-1.1	Identify salinity zones within the tributaries	Ongoing	WQQ-3, WH-3
FL-1.2	Prioritize restoration projects within tributaries as to their potential for increasing critical juvenile habitat (restoring the balance).	Ongoing	WQQ-3, WH-3
FL-1.3	Characterize, delineate, and quantify shoreline features (habitats) within the tributaries.	Ongoing	WH-3
FL-1.4	Develop methods/measures to quantify improvements to juvenile fisheries.	Ongoing	FW-1
FL-2.1	Educate the public on the need for improved fishery habitats	Ongoing	CE-1
FL-2.2	Restore, enhance, and protect the value of freshwater and saltwater wetlands as fishery habitats.	Ongoing	FW-1
FL-2.3	Improve Sarasota Bay tributaries to restore the value of juvenile fisheries habitats.	Ongoing	FW-1
FL-2.4	Install seawall habitat modules along seawalls where appropriate.	Revised	WH-4
FL-2.4.1	Encourage private-sector manufacturing and marketing of the most effective designs for these modules.	Revised	WH-4
FL-2.4.2	Encourage homeowners to volunteer their seawalls and shoreline for projects. Encourage their participation through education, incentives, and permitting assistance.	Revised	WH-4, CE-2
FL-2.4.3	Develop measures to demonstrate restoration effectiveness to increase acceptability by permitting agencies.	Revised	WH-4
FL-2.4.4	Sponsor a workshop to review research, share ideas, develop criteria, and discuss permitting issues.	Revised	WH-4, CE-2
FL-2.5	Explore opportunities for living shorelines throughout the Sarasota Bay area.	Ongoing	WH-4
FL-2.5.1	Sponsor community workshops on living shorelines.	Revised	WH-4, CE-2
FL-3.1	Establish a conservation area near Sister Keys with limited access or activity.	Revised	FW-1
FL-3.2	Promote catch-and-release and other angling practices to increase conservation.	Ongoing	FW-1, CE-1
FL-3.3	Seek designation of Sarasota Bay as a test area for enhanced fisheries management measurement measures combined with careful monitoring. Establish a baseline for relative fish abundance and diversity within Sarasota Bay.	Revised	FW-1
FL-4.1	Reduce levels of contaminants in tributaries and restore natural stream flows to creeks and streams to restore and enhance shellfish populations and their habitats.	Ongoing	FW-2
FL-4.2	Establish oyster reefs in appropriate locations in Sarasota Bay.	Ongoing	FW-2, CE-2
FL-4.3	Support the reestablishment of bay scallops with appropriate monitoring. Continue bay scallop seeding where water quality has improved.	Ongoing	FW-2, CE-3
FL-4.4	Educate the public about the regulations regarding shellfish harvesting.	Ongoing	CE-1
FL-5.1	Improve channel marking on the Intracoastal Waterway and connector channels to protect seagrasses from scarring by boat propellers.	Ongoing	WH-5, CE-1
FL-6.1	Establish or exceed seagrass targets and meet water quality targets for the maintenance of seagrass acreage in designated areas.	Ongoing	WH-5
FL-6.2	Implement water quality improvement strategies to increase productive seagrass habitat.	Ongoing	WH-5
FL-6.3	Using appropriate techniques, restore seagrass habitat in selected areas of disturbed excavated Bay bottom by using dredge material as applicable, to elevate the bottom to within six feet of mean sea level, pending outcome of demonstration project.	Revised	WH-5
FL-6.4	Enforce boat speed limits in Sarasota Bay watershed to reduce turbidity.	Revised	WH-5C CE-1
FL-6.5	Repair seagrass scarring where appropriate.	Revised	WH-5
FL-8.1	Reexamine the artificial reef master plan every five years.	Revised	WH-5
FL-8.2	Document reef habitat quality.	Revised	WH-5
FL-8.3	Establish targets for artificial reefs.	Revised	WH-5
RU - Recreational Use			
RU-1.1	Promote enforcement for boat speeds and no-wake zones in Sarasota Bay.	Revised	CE-1
RU-2.1	Promote channel marking to protect threatened marine areas such as seagrasses	Ongoing	CE-1
RU-2.2	Promote posting markers to discourage boats from approaching bird rookeries.	Ongoing	FW-3, CE-1

RU-2.3	Discourage deliberate feeding of seabirds and marine mammals through education and signage.	Ongoing	FW-3, CE-1
RU-2.4	Support fishing catch-and-release activities.	Ongoing	FW-1, CE-1
RU-2.5	Promote disposal of fishing line and other marine debris in appropriate containers.	Ongoing	FW-1, CE-1
RU-2.6	Promote enhanced enforcement of all boating, fishing, and other waterborne rules and laws.	Revised	CE-1
RU-2.7	Encourage marinas and other waterfront businesses to follow safe, non-polluting practices.	Ongoing	CE-3
RU-2.8	Encourage and support coastal cleanup initiatives.	Ongoing	CE-1, CE-2, CE-3
RU-3.1	Facilitate neighborhood-initiated improvements for visual access to the Bay through the Florida Friendly Landscaping Program.	Revised	CE-2
RU-3.2	Enhance recreational use of publicly owned Bayfront land.	Ongoing	CE-1
RU-3.3	Acquire undeveloped Bay shoreline for public recreation, Bayfront parks, or low-impact preserves.	Ongoing	CE-1
RU-3.4	Identify Bay vista points in local comprehensive plans and consider them in landscaping, roadbuilding, and other construction.	Retired	
RU-3.5	Fully implement and expand the Sarasota Heritage Trail and Blueways System.	Revised	CE-1
RU-4.1	Work with appropriate organizations to increase enrollment in boater education programs to promote better protection of Bay resources.	Ongoing	CE-3
RU-4.2	Develop an educational program for target audiences, including youths, tourists, and visitors, to improve awareness and sensitivity about the Bay.	Revised	1&2
RU-5.1	Continue to develop and market a system of integrated recreational opportunities.	Revised	CE-1
RU-5.2	Promote litter prevention throughout the Sarasota Bay region.	Ongoing	CE-1, CE-2, CE-3
GO - Governance to Oversee Implementation			
GO-1.1	Implement the CCMP utilizing the Interlocal Agreement and appropriate committee structure and staff.	Ongoing	CE-4
GO-1.2	Conduct an independent strategic assessment of program performance at intervals not to exceed three years subsequent to approval by Florida's governor and the US EPA administrator.	Retired	
GO-2.1	Support Clean Water Act reauthorization for continuing appropriation for CCMP implementation.	Ongoing	CE-4
GO-2.2	Maintain the designation of Sarasota Bay (in 1995) as a State of Florida Surface Water Improvement and Management program priority water body.	Ongoing	CE-4
GO-2.3	Continue and expand grant writing to benefit Sarasota Bay and fund specific projects in the CCMP.	Ongoing	CE-4
GO-2.4	The SBEP encourages an independent foundation to further support the goals of the CCMP.	Completed	CE-4
GO-2.5	Implement the Southwest Florida Regional Ecosystem Restoration Plan.	Revised	CE-4
GO-3.0	Expand environmental education programs, with an emphasis on boaters	Ongoing	CE-1, CE-2, CE-3
GO-4.0	Implement Land Use and Environmental Permitting policy.	Revised	CE-4, WQQ-4
CP - Citizens Participation			
CP-1.1	Promote the Florida Yards and Neighborhood Program.	Ongoing	CE-2
CP-1.2	Promote Climate Friendly Landscaping guidelines.	Ongoing	CE-2
CP-1.3	Encourage gardens and native plants.	Ongoing	CE-2
CP-2.1	Promote the use of Low Impact Development principles in development and redevelopment.	Ongoing	WQQ-4
CP-2.2	Promote and educate the community on the benefits of best management practices for roofs.	Revised	CE-2
CP-2.3	Promote smart growth principles for coastal and waterfront communities.	Revised	WQQ-4
CP-3.1	Encourage use of rainwater collection systems for reuse, including rain barrels and cisterns.	Ongoing	CE-2
CP-3.2	Educate households and businesses regarding smart water use choices, including pervious surfaces, outdoor water use, and energy-efficient appliances.	Ongoing	CE-2
CP-3.3	Participate in, and actively promote, area conferences and public events which highlight water conservation, energy efficiency, and watershed health.	Ongoing	CE-2, CE-3
CP-4.1	Identify the economic impact that natural capital has on the local economy.	Completed	
CP-4.2	Promote natural capitalism as a strategy for economic development.	Completed	
CP-4.3	Promote ecotourism to create local jobs while protecting important environmental values.	Revised	CE-2
CP-5.1	Encourage citizen engagement in environmental monitoring.	Ongoing	CE-2
CP-5.2	Assess and measure behavioral changes that indicate positive impact on Sarasota Bay and its tributaries.	Ongoing	CE-1, CE-2
CP-6.1	Complete an estuary-wide vulnerability assessment that will serve as a framework for future land acquisition, research, and monitoring efforts.	Ongoing	CE-4

CP-6.2	Identify critical areas to be addressed related to adaptation for the Sarasota Bay area.	Ongoing	CE-4
CP-6.3	Develop local tools to address climate change, such as best management practices for habitat restoration design, that will be resilient and achieve success in the face of a changing climate.	Ongoing	CE-4, WH-1
CP-6.4	Encourage communities to mitigate and adapt to the effects of climate change.	Ongoing	CE-2, CE-4

Key:

Ongoing - continuing activity that is largely unchanged or only slightly modified

Revised - continuing activity that is modified, reorganized, or reconceived

Completed – the objective or activity has been accomplished

Retired – the activity is no longer a program priority or the activity is no longer feasible

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ACRONYMS

ASR	Aquifer Storage and Recovery
AWT	Advanced Wastewater Treatment
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CCMP	Comprehensive Conservation and Management Plan
CE	Community Engagement Action Plan
CRE	Climate Ready Estuaries
CWA	Clean Water Act
CWA	Critical Wildlife Area
CZS-SDRP	Chicago Zoological Society's Sarasota Dolphin Research Program
DO	Dissolved oxygen
ELAP	Environmental Land Acquisition Program
FCMaP	Florida Coastal Mapping Program
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FIM	Fisheries Independent Monitoring
FISH	Florida Institute for Saltwater Heritage
FLWMI	Florida Water Management Inventory
FPAN	Florida Public Archaeology Network
FW	Fish and Wildlife Action Plan
FWC	Florida Fish and Wildlife Conservation Commission
GCOOS	Gulf of Mexico Coastal Ocean Observing System
GCORR	Gulf Coast Oyster Recycling and Renewal
HAB	Harmful Algal Bloom
HABSOS	Harmful Algal Bloom Observing System
HOA	Homeowner Association
HRP	Habitat Restoration Plan
INBS	Index Nesting Beach Survey
LID	Low Impact Development or Low Impact Design
MPA	Marine Protected Area
MPO	Metropolitan Planning Organization
MRRP	Monofilament Recovery and Recycling Program
MS4	Municipal Separate Storm Sewer System
NCF	New College of Florida
NEP	National Estuary Program

NEPORT	National Estuary Program On-line Reporting Tool
NGO	Non-governmental organization
NMFS	National Marine Fishery Service
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPP	Neighborhood Parklands Acquisition Program
OIMMP	Oyster Integrated Mapping and Monitoring Program
OSTDS	Onsite Sewage Treatment and Disposal Systems
PALS	Passive Acoustic Listening Stations
PAR	Photosynthetically Active Radiation
PIER	Protection, Involvement, Education, and Restoration
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
SBEP	Sarasota Bay Estuary Program
SCAN	Sarasota Coast Acoustic Network
SGCN	Species of Greatest Conservation Need
SNBS	Statewide Nesting Beach Survey
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management Plan
SWRWRF	Southwest Regional Water Reclamation Facility
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UF	University of Florida
UF IFAS	University of Florida Institute of Food and Agricultural Sciences
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USF	University of South Florida
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WH	Watershed Habitats Action Plan
WIN	Watershed Information Network
WQQ	Water Quality and Quantity Action Plan
WWTP	Wastewater Treatment Plant