Tampa Bay

Surface Water Improvement and Management (SWIM) Plan Update

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Southwest Florida Water Management District

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Lizanne Garcia
Lead Project Manager
Surface Water Improvement and Management (SWIM) Program
Southwest Florida Water Management District

Chris J. Anastasiou, Ph.D.
Chief Water Quality Scientist
Surface Water Improvement and Management (SWIM) Program
Southwest Florida Water Management District

Doug Robison, PWS
Principal Scientist
Environmental Science Associates, Inc.

CITATION: To be updated upon completion

Executive Summary

In 1987, the Florida Legislature created the Surface Water Improvement and Management (SWIM) Act to protect, restore, and maintain Florida's most threatened surface water bodies. Under this act, the state's five water management districts identified a list of priority water bodies within their authority and implemented Surface Water Improvement and Management (SWIM) Plans to improve and/or protect them.

With an open water area of 400 square miles, Tampa Bay is Florida's largest open water estuary. In 1988, the Florida State Legislature designated Tampa Bay the District's first SWIM Priority Waterbody. Today there are 12 SWIM Priority Waterbodies across the District's 16-county area of West-Central Florida. Each SWIM Priority Waterbody has its own SWIM Plan, living documents with adaptive management at their core. Each plan is designed to preserve or improve a waterbody's overall ecological health by outlining specific management actions, initiatives, and projects within the purview of the SWIM Program.

The Tampa Bay SWIM Plan draws heavily on the Tampa Bay Estuary Program's (TBEP) Comprehensive Conservation and Management Plan (CCMP), the Tampa Bay Nitrogen Management Consortium Reasonable Assurance Plan, and other relevant documents. In response to Tampa Bay being designated an "estuary of national significance" by the United States Congress in 1990, the TBEP was established in 1991 as a local, state, and federal partnership of which the District is both a member and a funding partner. The TBEP CCMP was last updated in 2017 and serves as a community blueprint for action over a 10-year planning horizon. The CCMP synthesizes decades of scientific research into the bay's most pressing problems and reflects broad-based input from citizens, stakeholders, and communities with a common interest in a healthy bay as the cornerstone of a prosperous economy. The Tampa Bay SWIM Plan does not duplicate the TBEP's CCMP, rather it uses the CCMP as a reference to identify those elements that align with SWIM's core missions of water quality and natural systems. The first Tampa Bay SWIM Plan was published in 1988 before the TBEP was established and was based on the 1985 Tampa Bay Management Study Commission. The SWIM plan was updated in 1992, 1999, and most recently in 2023.

One of the primary ways of assessing the overall ecological health of Tampa Bay is through aerial mapping of the bay's seagrass habitats. The District is a leader in seagrass mapping and has been conducting biennial surveys of Tampa Bay since 1988. Seagrasses are flowering marine plants with blades that form dense meadows in shallow, sheltered areas along coastlines. In Tampa Bay, seagrass habitat is ecologically and economically important. Approximately 70% of the recreationally and commercially important species of fish, crabs, and shrimp in the Gulf of Mexico spend at least a portion of their lives in seagrass meadows. Seagrasses are also a major source of food for both manatees and sea turtles. And they help maintain good water quality and clarity by filtering out particles from the water column and holding sediments in place. Seagrasses are also very sensitive to changes in water quality and are therefore monitored to "take the pulse" of Tampa Bay's ecological health. Stressors like excess nutrients, red tide, and hurricanes all have profound impacts on seagrass resiliency, and over time can leave seagrasses more susceptible to future impacts.

From 1988 to 2016, Tampa Bay enjoyed a prolonged period of seagrass recovery gaining 18,376 acres over this 28-year period. With expanding seagrass coverage and improving water quality, Tampa Bay was heralded as one of the few examples in the world of successful coastal ecosystem restoration, despite unprecedented urbanization and population growth across the watershed (Greening et al. 2014). By 2016, however, conditions began to change. Between 2016 and 2023, the bay lost more than 11,000 acres of seagrass, largely in the upper bay segments of Old Tampa Bay and Hillsborough Bay.

Concurrent with the loss in seagrass acreage was an increase in the amount of drift and attached macroalgae, a phenomenon not limited to Tampa Bay but seen in other estuaries like Sarasota Bay, Charlotte Harbor, and Indian River Lagoon. Water quality has remained relatively stable and, in some cases, has even improved since the last SWIM Plan update. Seagrass loss at a time when water quality data suggest conditions are favorable for seagrass is of concern and is receiving much attention by the environmental resource management community, including the SWIM Program.

This SWIM Plan Update takes a slightly different approach from previous SWIM Plan Updates by acknowledging the need to reexamine some of the fundamental management paradigms that have been successful until the last 5 to 7 years. While scientific research to reexamine these long-held paradigms is necessary, and a major focus of this plan, SWIM also supports and will continue to identify projects focused on natural systems restoration and nutrient reduction. Tampa Bay, along with other estuaries in Florida, and across the world, are facing uncertain times, but this plan along with the TBEP CCMP is forging the way forward to ensure the future of Tampa Bay remains bright. The table below outlines overarching Water Quality and Natural Systems goals to be completed.

Water Quality
Update nutrient reduction goals for each bay segment using a revised seagrass-nutrient management paradigm.
Propose new bay-segment specific seagrass light targets.
Reduce nutrient loads through the implementation of cost-effective SWIM projects in cooperation with District partners.
Natural Systems Protection and Restoration
Support the District Seagrass Mapping Program and complete Tampa Bay biennial seagrass maps.
Support the establishment of a drift macroalgae monitoring network.
Support the 2030 habitat protection and restoration targets outlined in the TBEP 2020 Habitat Master Plan.

To achieve the above referenced goals, this SWIM Plan Update identifies management actions that if implemented, would help achieve these goals.

For Water Quality, management actions include:

Monitoring and Research
Support reevaluation of the seagrass-nutrient management paradigm with special emphasis on Old Tampa Bay and Hillsborough Bay.
Support reevaluation of seagrass light requirements and propose revised bay-segment specific targets for each bay segment.
Support research to better understand linkages between nitrogen loads, macroalgae abundance, and seagrass loss.
Support research to forecast ecological shifts in the Tampa Bay estuary in the face of climate change and sea-level rise and identify ways to increase coastal resiliency.
Evaluate water quality monitoring data gaps and identify opportunities to minimize monitoring redundancies across all program areas.
Better understand nutrient sources and sinks.
Water Quality Protection and Restoration
Support development of stormwater master plans.
Implement stormwater BMPs in urban areas in partnership with local, regional, and state agencies.
Promote green infrastructure designs and practices for stormwater treatment and management.

Education and Outreach
Continue to support Florida-Friendly landscaping principles.
Continue the District's FARMS program to assist agricultural stakeholders in conserving water and protecting water quality through outreach and implementation of BMPs.

For Natural Systems, management actions include:

Monitoring and Research
Continue the District's Seagrass Mapping Program and evaluate improvements to map quality by incorporating new/emerging technology while maintaining data continuity.
Continue to partner with TBEP to collect and analyze seagrass transect data at fixed locations in Tampa Bay.
Improve understanding of the ecology and habitat utilization of seagrass beds and macroalgae in Tampa Bay.
Monitor filamentous macroalgae accumulation and distribution in areas of concern in Tampa Bay.
Support evaluation of potential linkages between red tide events and the occurrence of filamentous macroalgae blooms.
Support the assessment and ranking of priority tidal tributaries for restoration projects.
Improve understanding of how rainfall patterns, climate drivers, and sea level rise affect estuarine habitats.
Natural Systems Conservation and Protection
Continue to support land acquisition for conservation of priority natural systems in the Tampa Bay watershed.
Continue to support water conservation strategies related to natural system protection through implementation of the District's Water Use Caution Area.
Support the adoption and reevaluation of minimum flows and levels (MFLs) for priority waterbodies in the Tampa Bay watershed.
Natural Systems Restoration
Support the assessment of restoration opportunities on open and disturbed lands.
Support programs and projects in Tampa Bay 2020 Habitat Master Plan Update (HMPU).
Explore opportunities for urban stream restoration and/or enhancement including drainage ditches to multi-stage channels.

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Introduction

The SWIM Act and SWIM Priority Waterbodies

In recognition of the need to place additional emphasis on the restoration, protection, and management of the surface water resources of Florida, the Florida Legislature, through the Surface Water Improvement and Management (SWIM) Act of 1987, directed the state's water management districts to "design and implement plans and programs for the improvement and management of surface water" (Section 373.451, Florida Statutes). The SWIM legislation requires the water management districts to protect the ecological, aesthetic, recreational, and economic value of the state's surface water bodies, keeping in mind that water quality degradation is frequently caused by point and non-point source pollution, and that degraded water quality can cause both direct and indirect losses of natural systems.

Under the act, water management districts identify water bodies for inclusion in the SWIM program based on their regional significance and their need for protection and/or restoration. This process is carried out in cooperation with the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FFWCC or FWC), the Florida Department of Agriculture and Consumer Services (FDACS) and local governments.

In accordance with the SWIM Act, once a water body is selected, a SWIM plan must be approved by the water management district's governing board. Before the SWIM plan can be adopted, it must undergo a review process involving the required state agencies. The purpose of this Tampa Bay SWIM Plan is to set forth a course of action by identifying the quantity, scope, and required effort of projects appropriate for the system while considering the levels of funding.

The District has partnered with state and local governments to identify issues and management actions to protect and restore Tampa Bay, since the first Tampa Bay SWIM plan was published in 1985 and updated in 1992 and 1999. The process and partnerships for this update to the SWIM plan are essentially the same as the previous plan.

The Tampa Bay Estuary Program Comprehensive and Conservation Management Plan

Tampa Bay was identified by the Legislature, in the SWIM Act, as the District's number one ranked priority waterbody. This ranking was built on years of work by local government and state officials who recognized the environmental and economic importance of this outstanding resource. Given the state and local support for protecting Tampa Bay, Congress designated Tampa Bay as an "estuary of national significance" in 1990. This led to the formation of the Tampa Bay Estuary Program (TBEP) in 1991.

The TBEP is an intergovernmental partnership of federal, state, and local government agencies, who have committed to achieving science-based goals outlined in the document "Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay" (TBEP 2017). The District is a member of the TBEP Policy Board and provides staff support and funding to carry out annual workplans in support of the Comprehensive Conservation and Management Plan (CCMP).

This update of the Tampa Bay SWIM Plan compliments the 2017 TBEP CCMP Action Plans for Water and Sediment Quality, Bay Habitats, Fish and Wildlife, Invasive Species and Public Education, and Involvement and Climate Change. The SWIM plan, like the CCMP, is a living document meant to be a guide to help navigate the 21st century challenges facing Tampa Bay. This SWIM plan update identifies

Goals, Management Actions, and projects to address the major focus areas of Water Quality and Natural Systems Protection and Restoration.

SWIM Plan Geographic Setting

Located on the Gulf Coast of west-central Florida, Tampa Bay is the largest open water estuary in the state. The bay is divided into seven management segments in this plan and is consistent with the Tampa Bay Estuary Program's Comprehensive Conservation and Management Plan (CCMP).

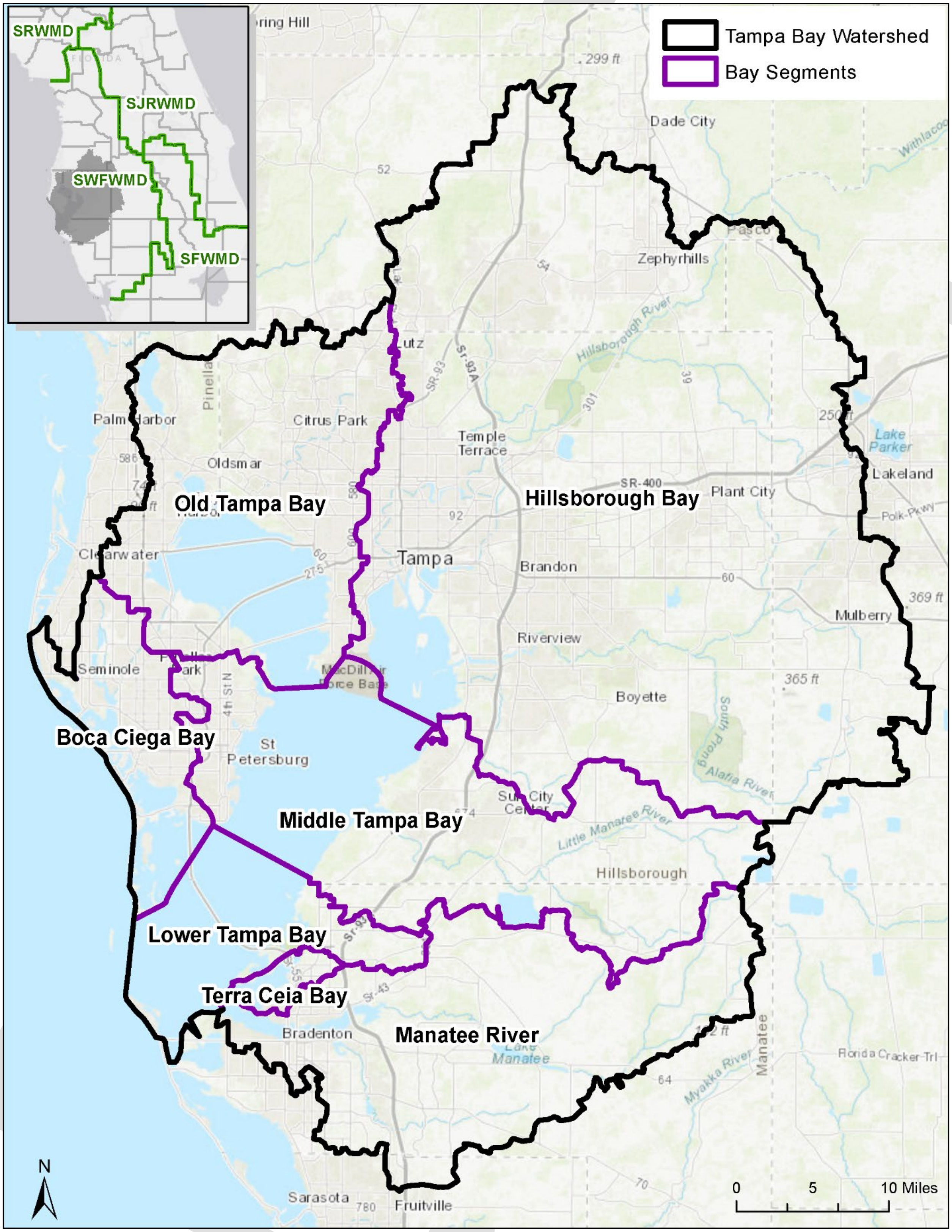
Tampa Bay includes seven bay segments described in the sections below and a connected group of smaller estuaries and embayments (Figure 1). Its seaward limit is arbitrarily given as a line connecting the barrier beaches of Boca Ciega Bay and Anna Maria Sound; its upstream limit is approximately the transition of shoreline vegetation from tidal to freshwater forms; and its upland limit is that line above which terrestrial landforms and vegetation occur. The estuary has a total area of about 400 square miles including all intertidal wetlands. The entire Tampa Bay watershed is approximately 2,200 square miles (TBEP 2017). Tampa Bay has an average depth of 11 feet with a maximum depth of 43 feet in the main shipping channel and the salinity ranges from 20 to 35 parts per thousand in the Bay Proper (TBEP 2017).

Major rivers flowing into Tampa Bay include the Hillsborough, Alafia, Little Manatee and Manatee Rivers. Another major river, the Palm River, once drained lands between the Hillsborough and Alafia Rivers. This system was completely channelized as part of the US Army Corps of Engineers Four Rivers Project. The river system became part of the Tampa Bypass Canal (TBC) which has been maintained by the District since 1971. The TBC empties into McKay Bay, a small embayment within Hillsborough Bay. Other large man-made canals that discharge into the bay are the Lake Tarpon Outfall Canal and Channels A and G which flow into Old Tampa Bay.

The 35-mile shipping channel was widened and deepened as part of a federal dredging project which began in 1976 (Goodwin 1987). Approximately 70 million cubic yards of benthic bay material was either deposited in submerged disposal areas or to create islands. Besides channel dredging, other types of dredging have impacted the bay including maintenance dredging, shell dredging, and dredging for landfill construction (Lewis 1976). Due to dredging, changes in tidal flow, circulation, and flushing occurred affecting the ecological health of the system. Moreover, dredging causes suspended and deposited sediments resulting in loss of habitat, nutrient sorption and release, and disruption to the benthic community. Consequently, landfill construction caused 44% of original marine wetlands bordering Tampa Bay to be lost (Lewis 1976).

The climate of the Tampa Bay watershed is humid subtropical with temperatures that vary between 65° and 95° Fahrenheit (Zhang 2020). From May to October is a hot and wet season with the majority of annual rainfall occurring from June to September while November through April is a milder and drier season (Zhang 2020).

The Bay's seven segments include: Old Tampa Bay; Hillsborough Bay; Middle Tampa Bay; Lower Tampa Bay; Boca Ciega Bay; Terra Ceia Bay and Manatee River (Figure 1). The following sections describe each bay segment and the land use within its watershed. Additionally, notable natural systems restoration and water quality projects completed by the District with our partners are highlighted. A full list and map of SWIM natural systems restoration and water quality projects are located in the Annual Report at https://www.swfwmd.state.fl.us/projects/swim.



Source: SWFWMD Mapping and GIS Section

Figure 1 – Tampa Bay Segments and Basin Boundaries

Old Tampa Bay

The Old Tampa Bay watershed is located within Hillsborough and Pinellas counties with a small portion in Pasco County (Figure 2). Lake Tarpon is in the northern part of the Old Tampa Bay watershed. There are several creek systems that drain into Old Tampa Bay, including Cabbagehead Bayou, Rocky Creek, Double Branch, Allen's Creek, and Long Branch. Cross Bayou Canal connects Old Tampa Bay and Boca Ciega Bay. Several man-made alterations have changed the hydrology of this bay segment throughout the years.

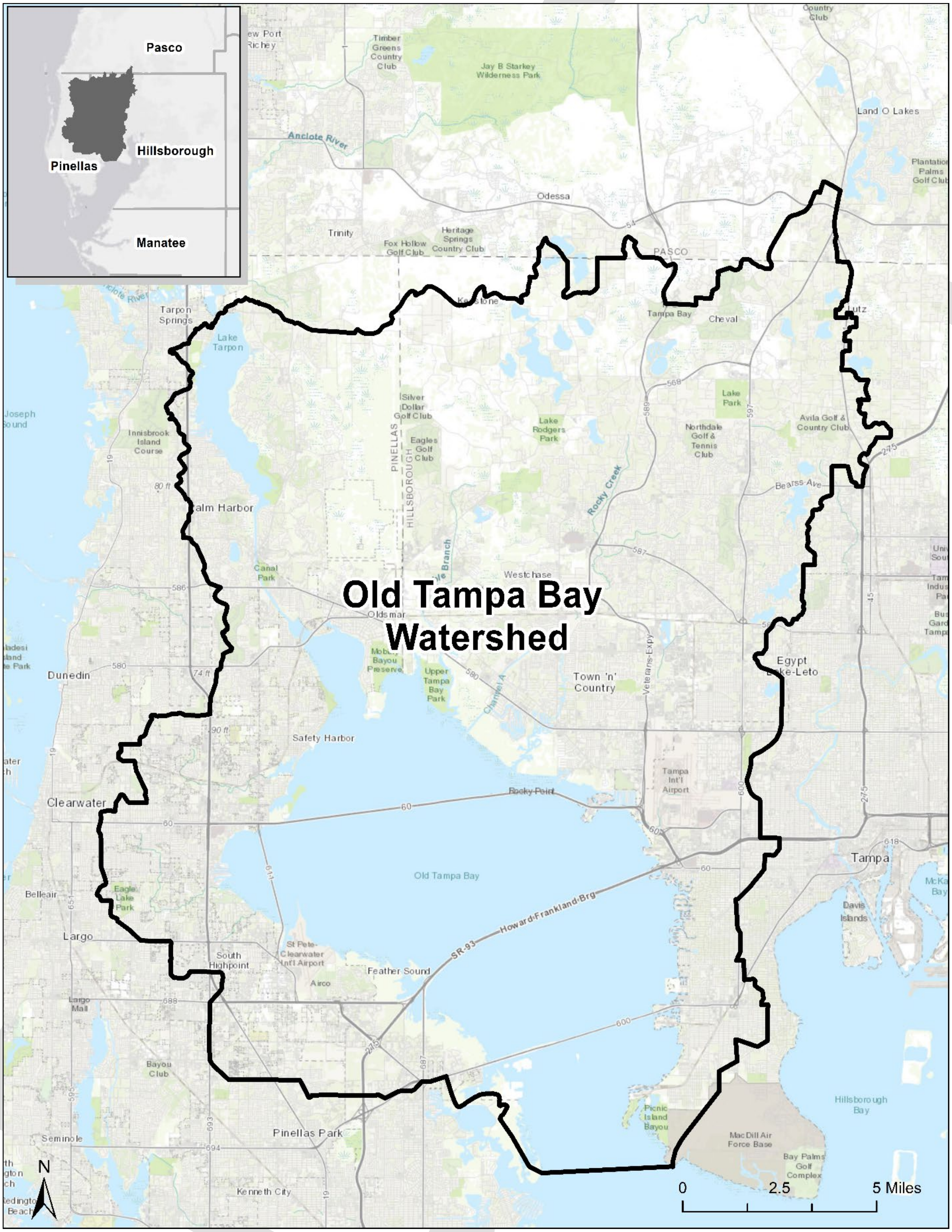
On Lake Tarpon, located at the northern end of Old Tampa Bay, two major engineering projects in the late 1960s profoundly impacted both the lake and Old Tampa Bay, impacts that are still seen today. Prior to 1969, Lake Tarpon was not hydraulically connected to Old Tampa Bay, aside from occasional flooding and overflows to the bay (Wood 2018). The only outflow from the lake was via a conduit between Spring Bayou, in nearby Tarpon Springs, and the Lake Tarpon Sink, located on the west shore of Lake Tarpon approximately 60 feet from the shore (Westerhall 1965; Dooris and Bartos 1980; Wood 2018). This conduit periodically reversed flow at high tide bringing saltwater (chloride concentrations of about 18 ppm) into Lake Tarpon (Westerhall 1965). In 1969, to control saltwater inflow to the lake, the District constructed an earthen dike around the Lake Tarpon Sink severing the lake's connection with the Gulf of Mexico. In 1967, the District and the US Army Corps of Engineers began construction of the Lake Tarpon Outfall Canal to provide for more reliable management of lake levels, and to control flooding following the disconnection of the Lake Tarpon Sink (Wood 2018). The canal and associated control structure were completed in 1971 making the Lake Tarpon to Old Tampa Bay connection the only direct outflow for the lake (Dooris and Bartos 1980; Wood 2018).

As part of the Upper Tampa Bay Watershed Management Plan, two conveyance channels for freshwater storage were created by the Hillsborough County Soil Conservation District. Channel A was constructed in 1967 and to prevent saltwater intrusion into the channel a salinity barrier was completed in 1977. Channel G was constructed between 1965 and 1967, and the Channel G salinity barrier was completed in 1977. Both salinity barriers were placed into operation in 1978. Over time, studies were conducted to monitor the response of the system with the salinity gates open. Studies found that the vegetation and fish responded positively and concluded that the salinity gates should remain open. Therefore, the salinity barrier gates were removed in 2021.

Construction of shipping channels in Tampa Bay between 1972 and 1985 resulted in minor flow reductions to Old Tampa Bay (Goodwin 1987). Additionally, residual water transport was impacted in Old Tampa Bay due to construction of causeways, dredge and fill activities, and port-facility construction (Goodwin 1987).

Three major bridges cross (generally east/west) the open water segment of Old Tampa Bay, connecting Hillsborough County to Pinellas County. They are Courtney Campbell Causeway, Howard Frankland, and Gandy Bridges. A fourth bridge, the Bayside Bridge, crosses the western lobe of Old Tampa Bay from north to south connecting Clearwater and Largo in Pinellas County. Feather Sound is southeast of Bayside Bridge and due to circulation impacts from the bridges, this area has experienced a low degree of sediment transport and deposition resulting in Feather Sound being significantly shallower (Julian and Estevez 2009).

The Courtney Campbell Causeway is the northernmost bridge and upon completion of the original two-lane road in 1934, it was one of longest over-water fill causeways in the country. Water quality north of the Causeway has been a concern for some time due to the decreased circulation. In 2018, the Florida Department of Transportation completed construction of a 230-foot section of bridge near Rocky Point to provide a direct tidal connection in this area of the bay.



Source: SWFWMD Mapping and GIS Section

Figure 2 – Basin Boundary of the Old Tampa Bay Watershed

The Old Tampa Bay segment had been identified as an area of primary concern through several District and TBEP research initiatives and TBEP Technical Advisory Committee (TAC) recommendations. By 2010, Old Tamp Bay had lagged in its recovery compared to other bay segments. The TAC and its partners identified the following primary ecological issues of concern in OTB (Sherwood et al. 2016):

- Organic sediment (muck) accumulation in the upper portions of OTB;
- Limited seagrass expansion in distinct, poor circulation areas of OTB;
- Alteration of freshwater inflows from managed channels discharging to OTB; and
- Periodic occurrence of nuisance algal blooms (*Pyrodinium bahamense*).

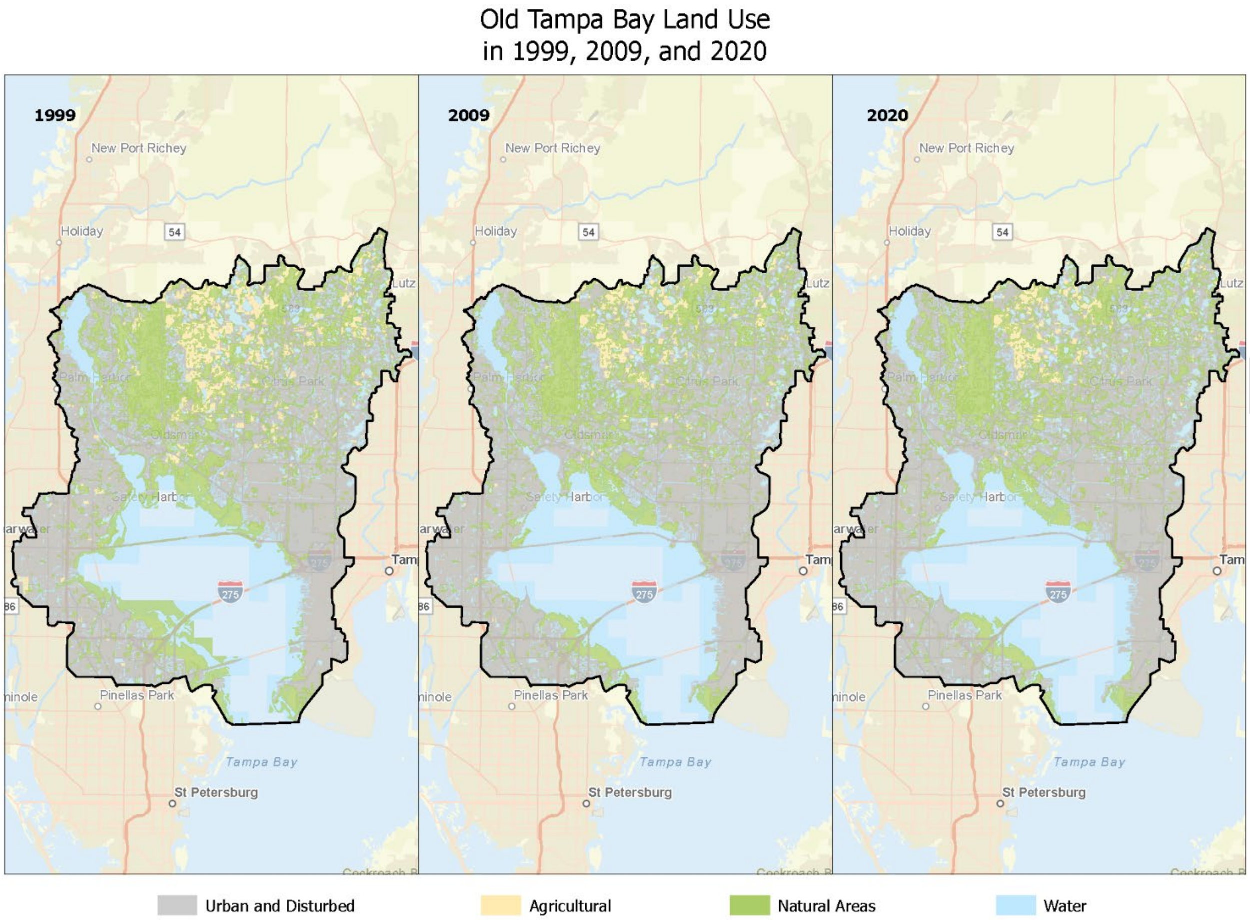
In response, the TBEP, in partnership with the Southwest Florida Water Management District (SWFWMD), sought to develop an integrated ecosystem model to determine potential management actions that could further enhance OTB's recovery and address the primary issues outlined above (Sherwood et al. 2016). In 2011, the TBEP and the District partnered to develop an integrated model to evaluate management actions to improve the ecology of Old Tampa Bay. The goal of the Old Tampa Bay (OTB) Model, completed in 2015, was to simulate changes in OTB ecology in response to future implementation of large-scale management actions, which included point and non-point source nutrient reductions and structural alterations of bridges and causeways to improve circulation. The net environmental benefits of these management actions on the ecology of OTB were evaluated and management actions that produced the greatest simulated improvements relative to costs were identified for further evaluation (Janicki Environmental Inc. 2015).

SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Old Tampa Bay watershed including but not limited to: Brooker Creek Hydrologic Restoration, Mobbly Bay, Bower Tract, Feather Sound, Gateway Tract, and Tappan Tract. Other natural areas within the watershed include local parks and nature preserves such as Picnic Island Park, Cypress Point Park, Philippe Park, and Mobbly Bayou Preserve. These open spaces may provide opportunities for natural systems enhancement and restoration projects.

Old Tampa Bay Land Use/Land Cover

The Old Tampa Bay watershed is 188,965 acres and is largely characterized by urban and disturbed land use. In 1999, the natural areas and open water made up 23.8% (45,039 acres) and 17.7% (33,472 acres) of the watershed, respectively (Figure 3).

Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture over the same period (Table 1). In 1999, 52.2% of the watershed was classified as urban and disturbed, whereas in 2020 that percentage increased to 57.1%. Conversely, the watershed saw a decrease in natural areas from 23.8% of the watershed in 1999 to 21% in 2020. Agricultural land use decreased from 6.2% in 1999 to 2.4% in 2020.



Source: SWFWMD Mapping and GIS Section

Figure 3 – Old Tampa Bay Land Use in 1999, 2009, and 2020

Old Tampa Bay						
	1999		2009		2020	
Use	**Acres**	**Percentage**	**Acres**	**Percentage**	**Acres**	**Percentage**
Urban & Disturbed	98,727	52.2%	106,199	56.2%	107,873	57.1%
Agricultural	11,726	6.2%	5,654	3.0%	4,597	2.4%
Natural Areas	45,039	23.8%	37,707	20.0%	36,802	19.5%
Water	33,472	17.7%	39,404	20.9%	39,693	21.0%
Totals	***188,965***	***100.0%***	***188,965***	***100.0%***	***188,965***	***100.0%***

Source: SWFWMD Mapping and GIS Section

Table 1 – Land Use Change by Acres and Percent for Old Tampa Bay

Hillsborough Bay

The Hillsborough Bay watershed consists of portions of Hillsborough, Polk, and Pasco counties (Figure 4). Tributaries that discharge directly to this bay segment include the Alafia River, Palm River, and Hillsborough River. The Tampa Bypass Canal flows to Six Mile Creek which turns into Palm River. Within the watershed, the North Prong, South Prong, Turkey Creek, Fishhawk Creek, Bell Creek, and Rice Creek flow to the Alafia River. Second to rainfall, Hillsborough River is the largest freshwater input to Tampa Bay (Zarbock et al. 1995). Many creeks feed into the Hillsborough River, including, but not limited to: Cypress Creek, Curiosity Creek, Clay Gully, Trout Creek, and Bassett Branch. Lake Thonotosassa, Hillsborough County's largest natural lake, discharges to Flint Creek and is located in the headwaters of the Hillsborough River. Little Bullfrog Creek flows to Bullfrog Creek which discharges in the southeast portion of Hillsborough Bay. Alterations to this bay segment, in addition to urbanization of the watershed include Port Tampa Bay and the Tampa Bypass Canal.

The Tampa Bypass Canal was constructed between 1966 and 1981 to relieve flooding within the Hillsborough River basin (Stoker et al. 1996). Water can flow from the downstream control structure in the bypass canal to Palm River which discharges to Hillsborough Bay. During dry seasons, to enhance flow in the Hillsborough River, water can be pumped from the bypass canal to the river.

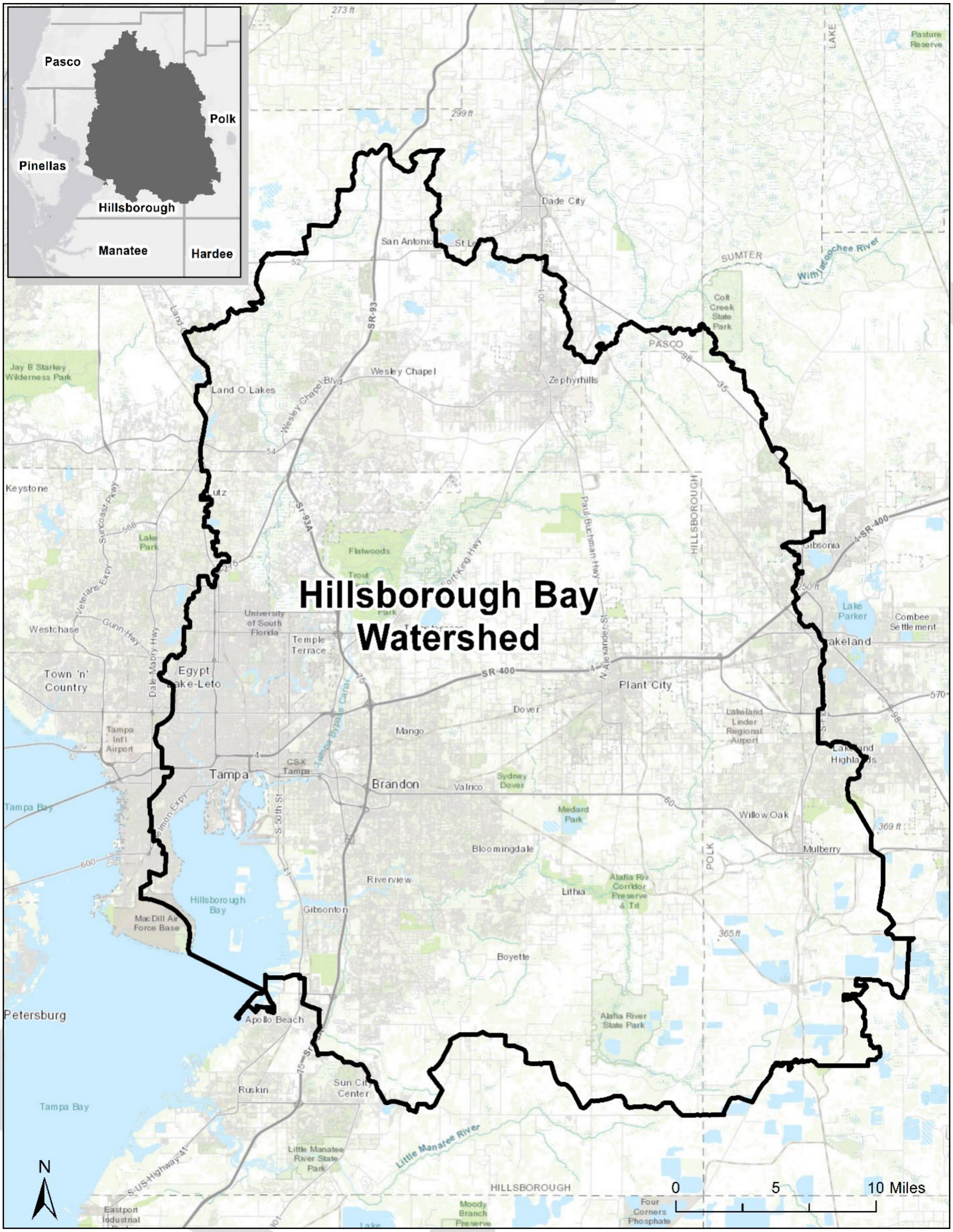
Hillsborough Bay, Florida, underwent extensive physical changes between 1880 and 1972 because of the construction of islands, channels, and shoreline fills. These changes resulted in a progressive reduction in the quantity of tidal water that enters and leaves the bay. Dredging and filling also changed the magnitude and direction of tidal flow in most of the bay (Goodwin 1987).

SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Hillsborough Bay watershed including but not limited to: Lake Thonotosassa Marsh Restoration, River Garden, Ulele Spring, Palm River Restoration, Ekker Preserve, Schultz Preserve, and Balm Boyette Habitat Restoration.

Additional opportunities exist for natural systems restoration and enhancement on the open spaces within this watershed. There are three large state parks located within the Hillsborough Bay watershed. Approximately 640 acres of the Colt Creek State Park is in the northeastern portion of this watershed. The Alafia River State Park is over 7,000 acres of former phosphate mine lands that were donated to the state in 1996. Flowing through Alafia State Park is the forested south prong of the Alafia River. As of 1935, Hillsborough River State Park officially became part of the Florida state park system with over 3,300 acres which is divided by the Hillsborough River.

The nearly 16,000-acre Lower Hillsborough Floodplain Detention Area (LHFDA) supports the Four Rivers Basins flood control project and encompasses approximately 13 miles of the Hillsborough River (SWFWMD 2005). These lands are owned by the District and local governments manage several parks within these lands, including Dead River, Trout Creek, and Flatwoods and Morris Bridge Parks.

There are several springs located in the Hillsborough Bay watershed that are within existing public lands including Hillsborough County's Lithia Springs Conservation Park which flows into the Alafia River and Eureka Springs Conservation Park, a spring and botanical garden in the Florida park system. Also, Sulphur Springs is located within the City of Tampa and flows to the Hillsborough River. Reservoirs within this bay segment include the C.F. Bill Young, Hillsborough River, and Medard.

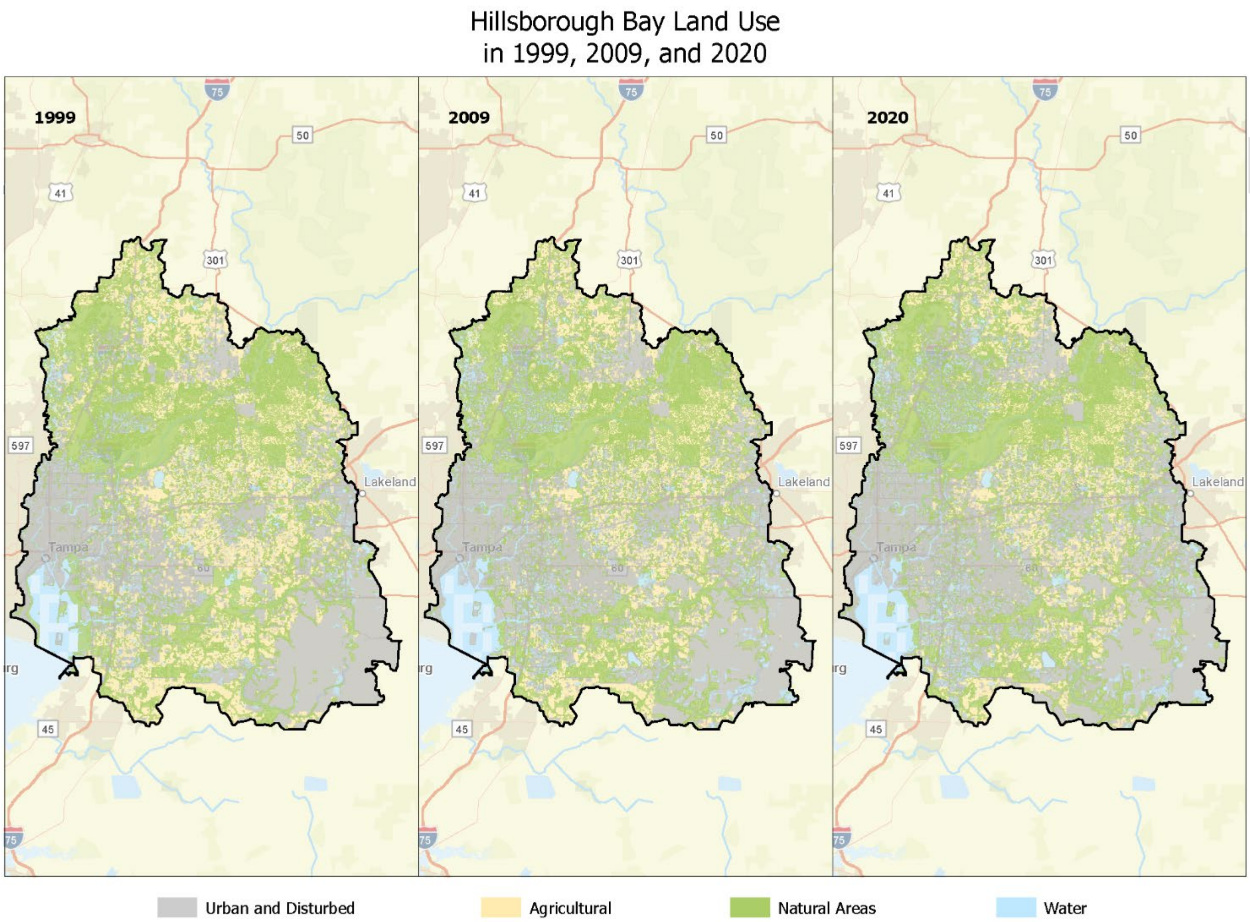


Source: SWFWMD Mapping and GIS Section

Figure 4 – Basin Boundary of the Hillsborough Bay Watershed

Hillsborough Bay Land Use/Land Cover

The Hillsborough Bay watershed is the largest in the Tampa Bay system encompassing an area of approximately 793,787 acres and is characterized by urban and disturbed land use. In 1999, the natural areas and open water made up 29.8% (236,604 acres) and 4.1% (32,242 acres) of the watershed, respectively (Figure 5).



Source: SWFWMD Mapping and GIS Section

Figure 5 – Hillsborough Bay Land Use in 1999, 2009, and 2020

Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture over the same period (Table 2). In 1999, 40% of the watershed was classified as urban and disturbed, whereas in 2020 that percentage increased to 50.5%. Conversely, the watershed saw a decrease in natural areas from 29.8% of the watershed in 1999 to 28.1% in 2020. Agricultural land use decreased from 26.1% in 1999 to 16% in 2020.

Hillsborough Bay						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	317,696	40.0%	383,721	48.3%	400,483	50.5%
Agricultural	207,245	26.1%	146,255	18.4%	126,771	16.0%
Natural Areas	236,604	29.8%	223,427	28.1%	223,343	28.1%
Water	32,242	4.1%	40,384	5.1%	43,190	5.4%
Totals	***793,787***	***100.0%***	***793,787***	***100.0%***	***793,787***	***100.0%***

Source: SWFWMD Mapping and GIS Section

Table 2 – Land Use Change by Acres and Percent for Hillsborough Bay

Middle Tampa Bay

Middle Tampa Bay is bounded by portions of Hillsborough, Pinellas, and Manatee counties (Figure 6). Lands within public ownership include Little Manatee River State Park and Cockroach Bay Preserve State Park, Weedon Island Preserve, Sawgrass Lake Park and Boyd Hill Nature Preserve. The MacDill Air Force Base and the Manatee Viewing Center are also in Middle Tampa Bay. Hydrologic features within this bay segment include Booker Creek, Carlton Lake, Cypress Creek, Dug Creek, Lake Maggiore, Newman Branch, Lake Parrish, and Sawgrass Lake.

SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Middle Tampa Bay watershed including but not limited to: Newman Branch, E.G. Simmons Park, and Bartlett Park. South of the Little Manatee River is the Rock Ponds Ecosystem Restoration Project. Rock Ponds was completed in 2015 by the SWIM section in cooperation with Hillsborough County and with over 1,000 acres restored is the largest coastal restoration project completed by SWIM.

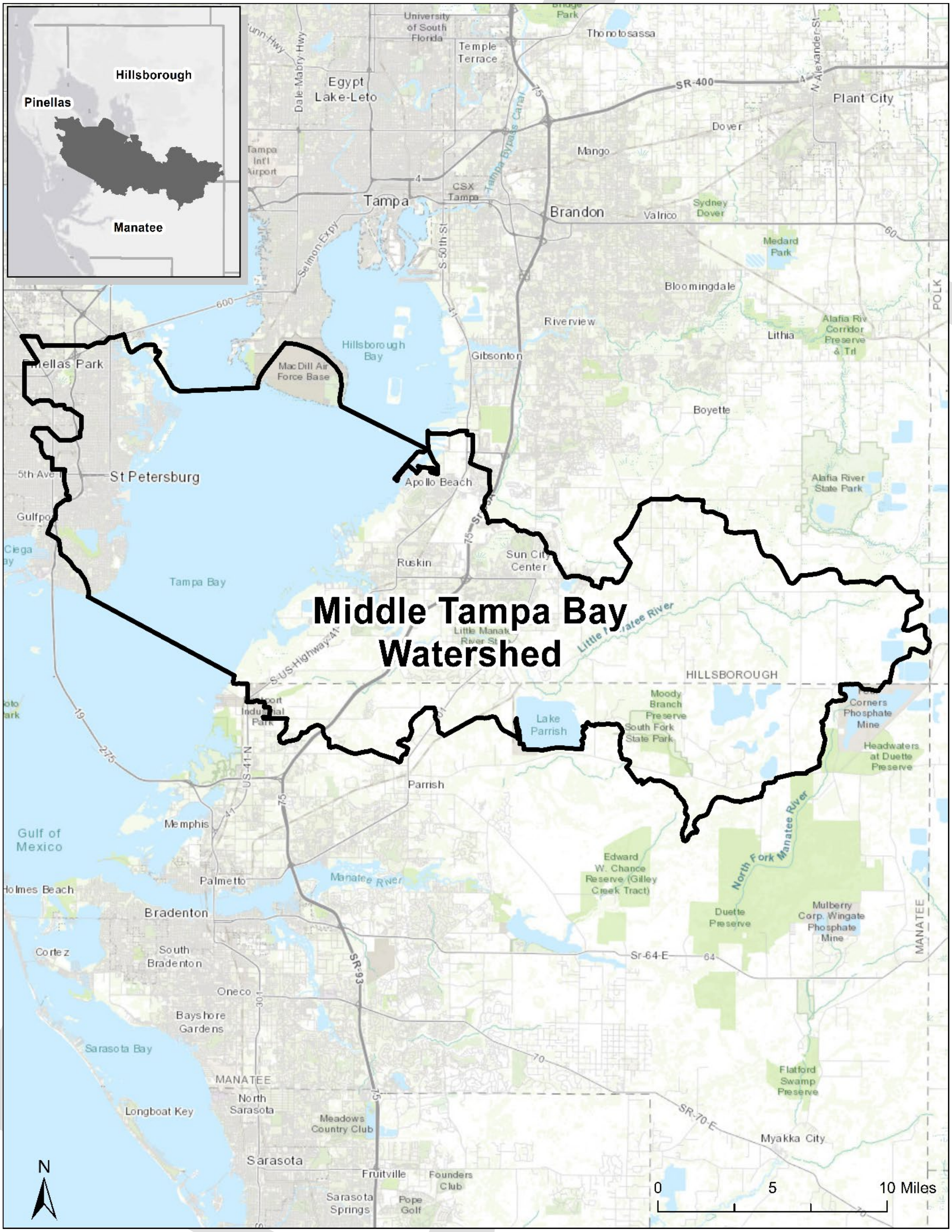
Middle Tampa Bay Land Use/Land Cover

The Middle Tampa Bay watershed is 209,568 acres and is largely characterized by urban and disturbed land use. In 1999, agriculture made up 38.6% (80,935 acres) of the watershed while natural areas made up 27.8% (58,263 acres) (Figure 7). Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture over the same period (Table 3). From 1999 to 2020, the urban and disturbed land use class had the greatest percent change, increasing from 24.1% in 1999 to 34.7% in 2009 to 41% in 2020. Conversely, the watershed saw a decrease in natural areas from 27.8% of the watershed in 1999 to 23.3% in 2020. Agricultural land use within the watershed had the greatest decrease from 38.6% in 1999 to 23.4% in 2020.

Middle Tampa Bay						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	50,406	24.1%	72,718	34.7%	85,856	41.0%
Agricultural	80,935	38.6%	62,126	29.6%	49,098	23.4%
Natural Areas	58,263	27.8%	49,997	23.9%	48,918	23.3%
Water	19,965	9.5%	24,727	11.8%	25,696	12.3%
Totals	***209,568***	***100.0%***	***209,568***	***100.0%***	***209,568***	***100.0%***

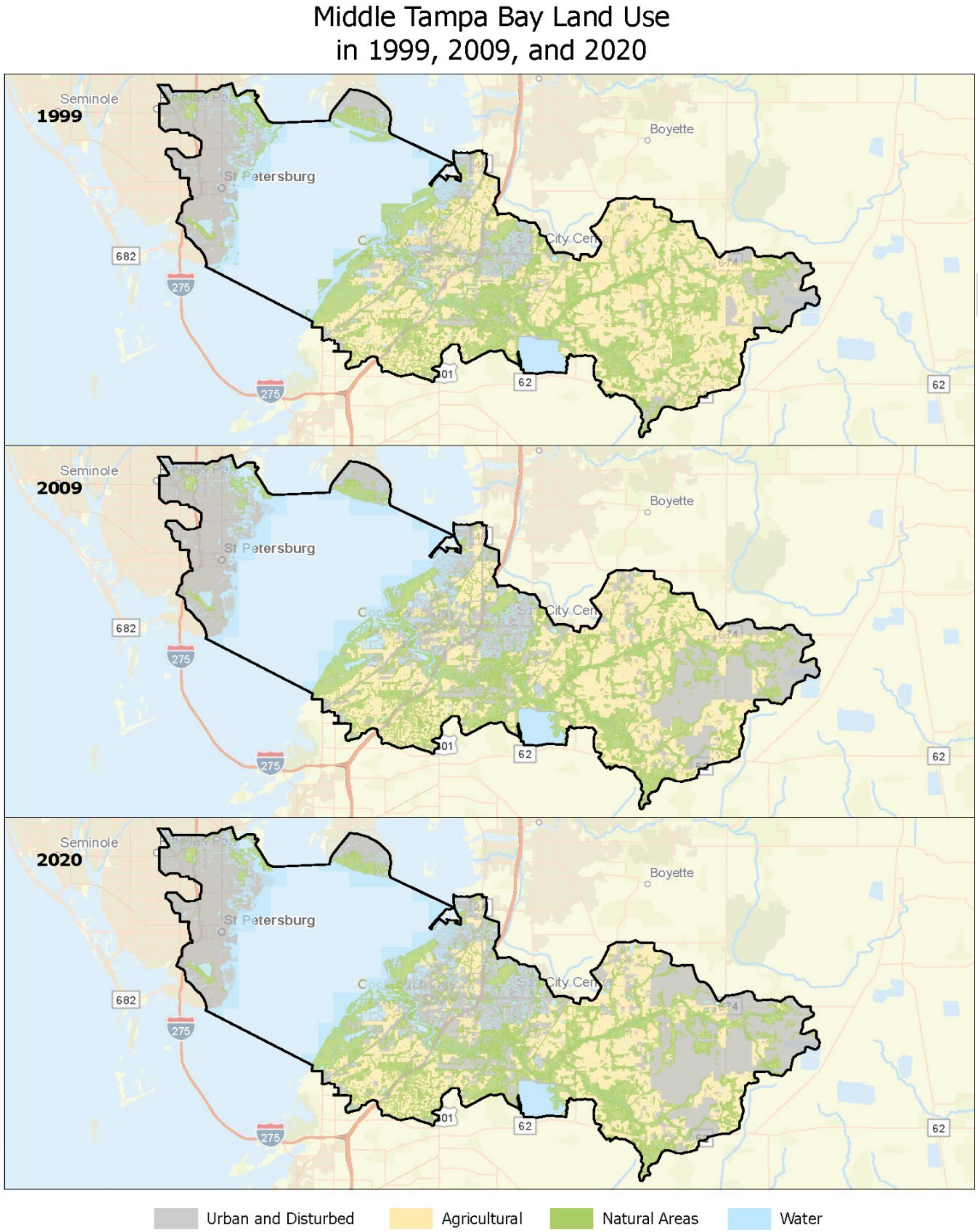
Source: SWFWMD Mapping and GIS Section

Table 3 – Land Use Change by Acres and Percent for Middle Tampa Bay



Source: SWFWMD Mapping and GIS Section

Figure 6 – Basin Boundary of Middle Tampa Bay Watershed



Source: SWFWMD Mapping and GIS Section

Figure 7 – Middle Tampa Bay Land Use in 1999, 2009, and 2020

Lower Tampa Bay

Lower Tampa Bay is bounded by Manatee, Hillsborough, and Pinellas counties (Figure 8). Within this bay segment are Port of Manatee, Anna Maria, Holmes Beach, and a few state parks including portions of the Terra Ceia Preserve State Park and the Skyway Fishing Pier State Park. The Sunshine Skyway (Interstate 275) Bridge crosses over Tampa Bay connecting Pinellas and Manatee counties. Notable waterbodies in Lower Tampa Bay are Buffalo Creek, Cabbage Slough, Frog Creek, and Redfish Creek. SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Lower Tampa Bay watershed. In fact, the first SWIM restoration project was Hendry Delta in Lower Tampa Bay. Furthermore, Terra Ceia Preserve State Park is within this watershed and was completed by the District in a partnership with FDEP restoring over 800 acres as part of the Terra Ceia Phase 1 project.

Lower Tampa Bay Land Use/Land Cover

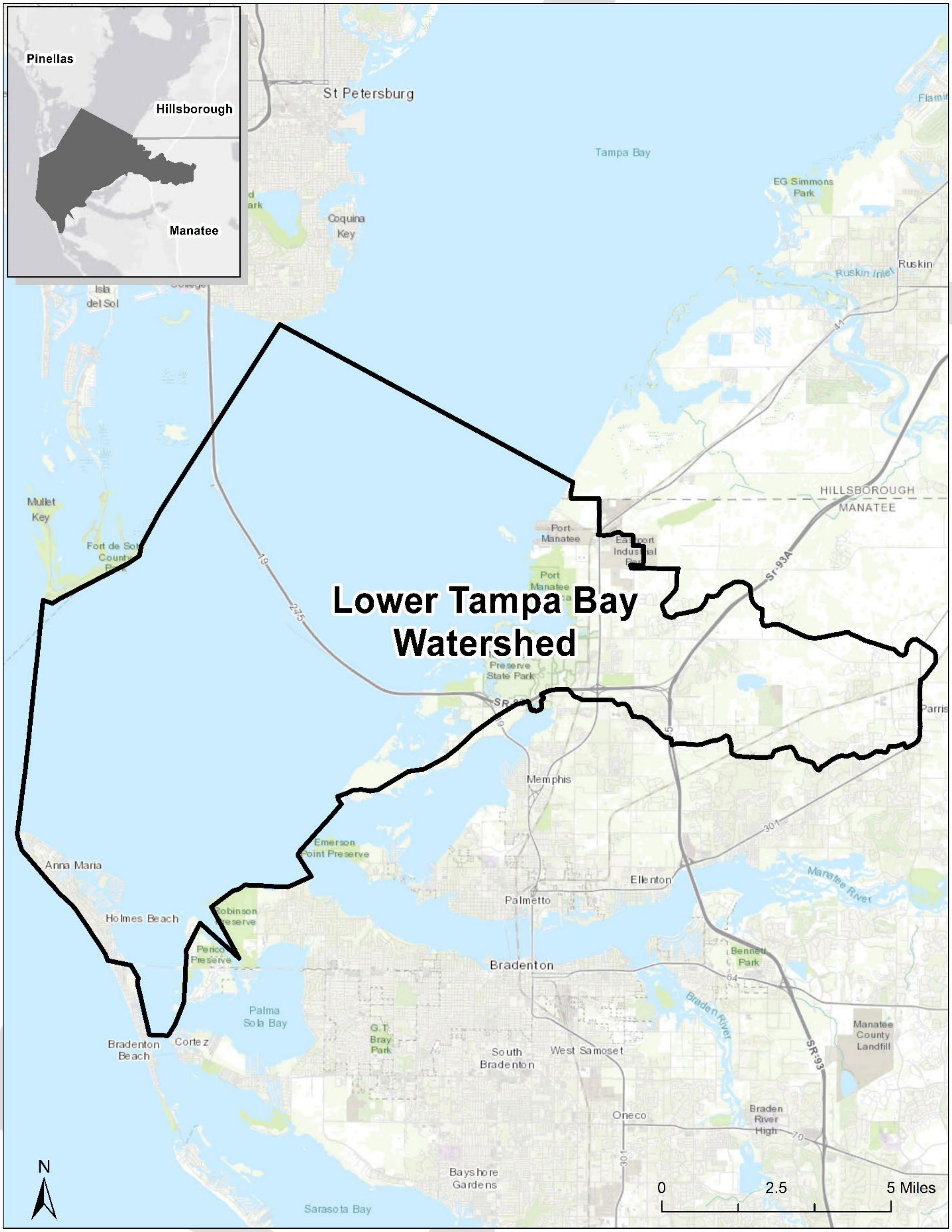
The Lower Tampa Bay watershed is the second smallest watershed by area in the Tampa Bay system encompassing approximately 39,197 acres. Lower Tampa Bay is largely characterized by natural areas and open water. In 1999, the natural areas and open water made up 20.9% (8,174 acres) and 43.9% (17,221 acres) of the watershed, respectively (Figure 9).

Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture over the same period (Table 4). In 1999, 15.3% (5,979 acres) of the watershed was classified as urban and disturbed, whereas in 2020 that percentage increased to 24.4% (9,580 acres). Conversely, the watershed saw a decrease in natural areas from 20.9% (8,174 acres) of the watershed in 1999 to 16.4% (6,410 acres) in 2020. Agricultural land use decreased from 20% (7,823 acres) in 1999 to 11.5% (4,493 acres) in 2020.

Lower Tampa Bay						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	5,979	15.3%	8,393	21.4%	9,580	24.4%
Agricultural	7,823	20.0%	5,712	14.6%	4,493	11.5%
Natural Areas	8,174	20.9%	6,509	16.6%	6,410	16.4%
Water	17,221	43.9%	18,584	47.4%	18,714	47.7%
Totals	***39,197***	***100.0%***	***39,197***	***100.0%***	***39,197***	***100.0%***

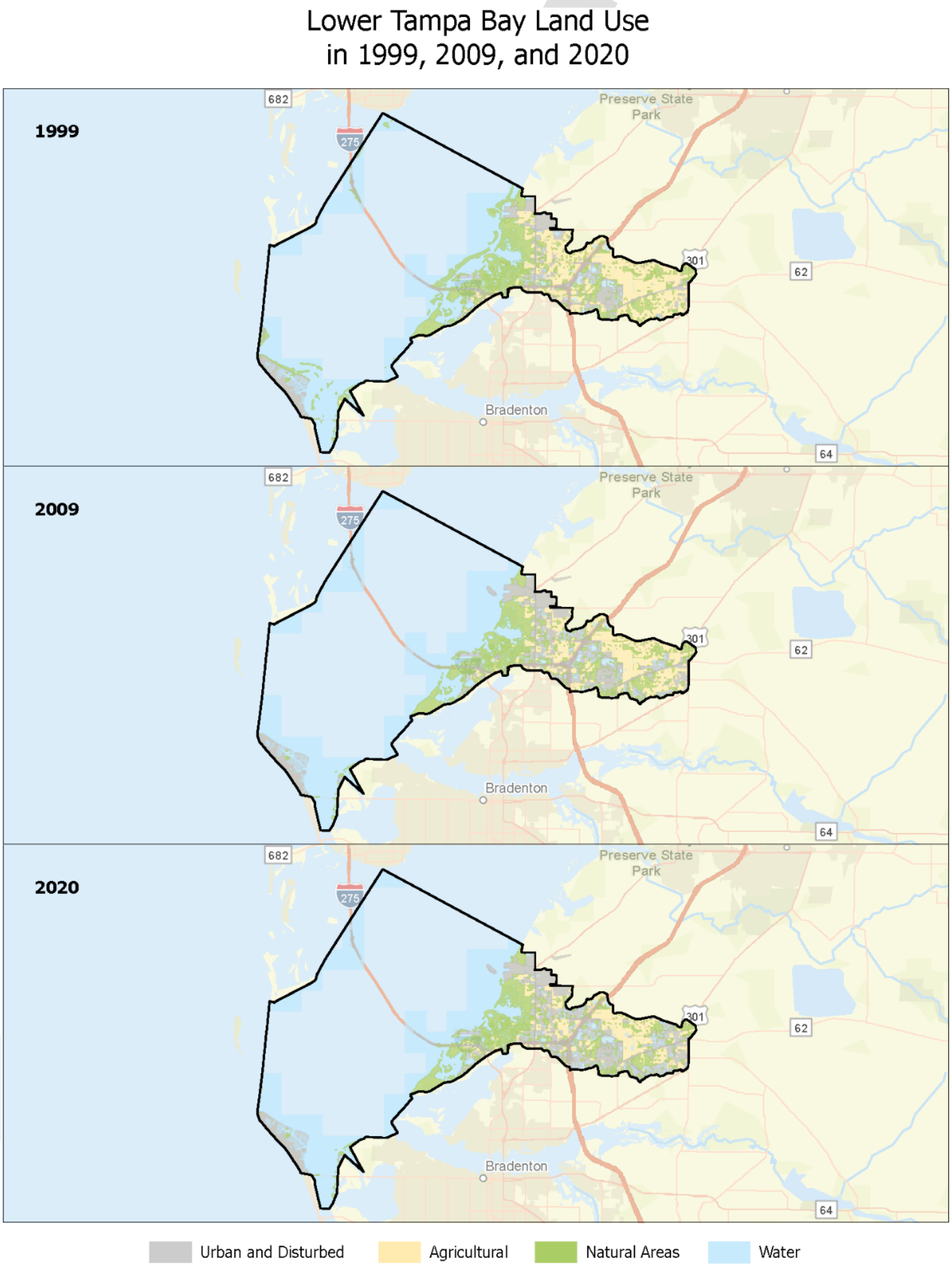
Source: SWFWMD Mapping and GIS Section

Table 4 – Land Use Change by Acres and Percent for Lower Tampa Bay



Source: SWFWMD Mapping and GIS Section

Figure 8 – Basin Boundary of Lower Tampa Bay Watershed



Source: SWFWMD Mapping and GIS Section

Figure 9 – Lower Tampa Bay Land Use in 1999, 2009, and 2020

Boca Ciega Bay

Boca Ciega Bay is located between the barrier islands along the Pinellas County gulf coast and mainland Pinellas County (Figure 10). The Boca Ciega Bay watershed is in Pinellas County. Waterbodies within this watershed include Clam Bayou, Long Bayou, Cross Bayou Canal, Lake Seminole, Seminole Bypass Canal, Saint Joes Creek.

SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Boca Ciega Bay watershed including Jungle Prada Park, Clam Bayou, and Lake Seminole Aquatic Life Enhancement. Additionally, Pinellas County's Fort Desoto and Lake Seminole Parks are located within the watershed of this bay segment and SWIM in cooperation with Pinellas County has completed projects to improve water quality and natural systems within these parks.

Boca Ciega Bay Land Use/Land Cover

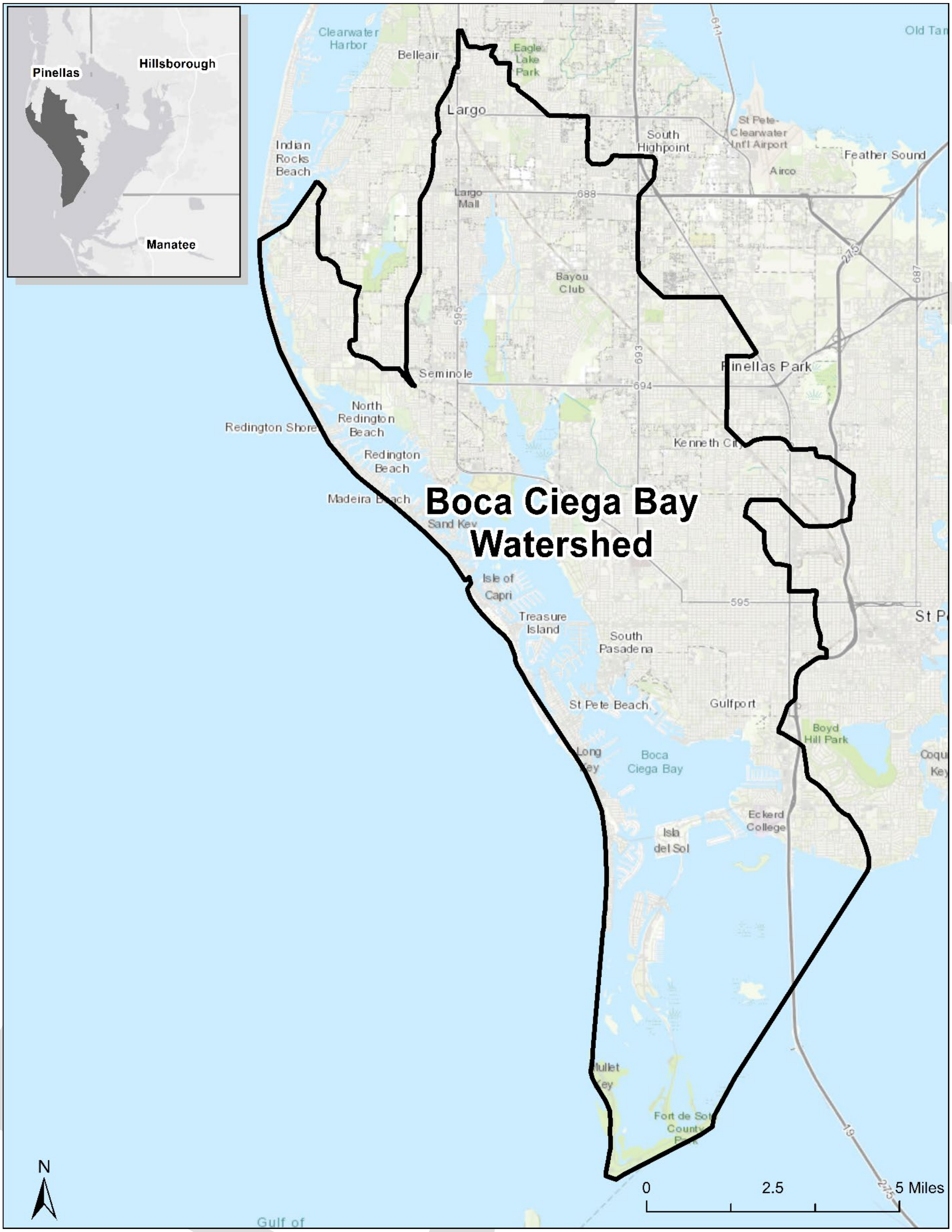
The Boca Ciega Bay watershed is 70,897 acres and is characterized by urban and disturbed land use (Figure 11).

Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture during the same period (Table 5). In 1999, 66% of the watershed was classified as urban and disturbed, and in 2020 that percentage increased to 67.3%. Conversely, natural areas decreased from 5.5% of the watershed in 1999 to 3.7% in 2020. Between 1999 and 2020, agricultural land use decreased from 231 acres to 24 acres, respectively.

Boca Ciega Bay						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	46,805	66.0%	47,643	67.2%	47,708	67.3%
Agricultural	231	0.3%	54	0.1%	24	0.0%
Natural Areas	3,885	5.5%	2,606	3.7%	2,600	3.7%
Water	19,976	28.2%	20,593	29.0%	20,565	29.0%
Totals	***70,897***	***100.0%***	***70,897***	***100.0%***	***70,897***	***100.0%***

Source: SWFWMD Mapping and GIS Section

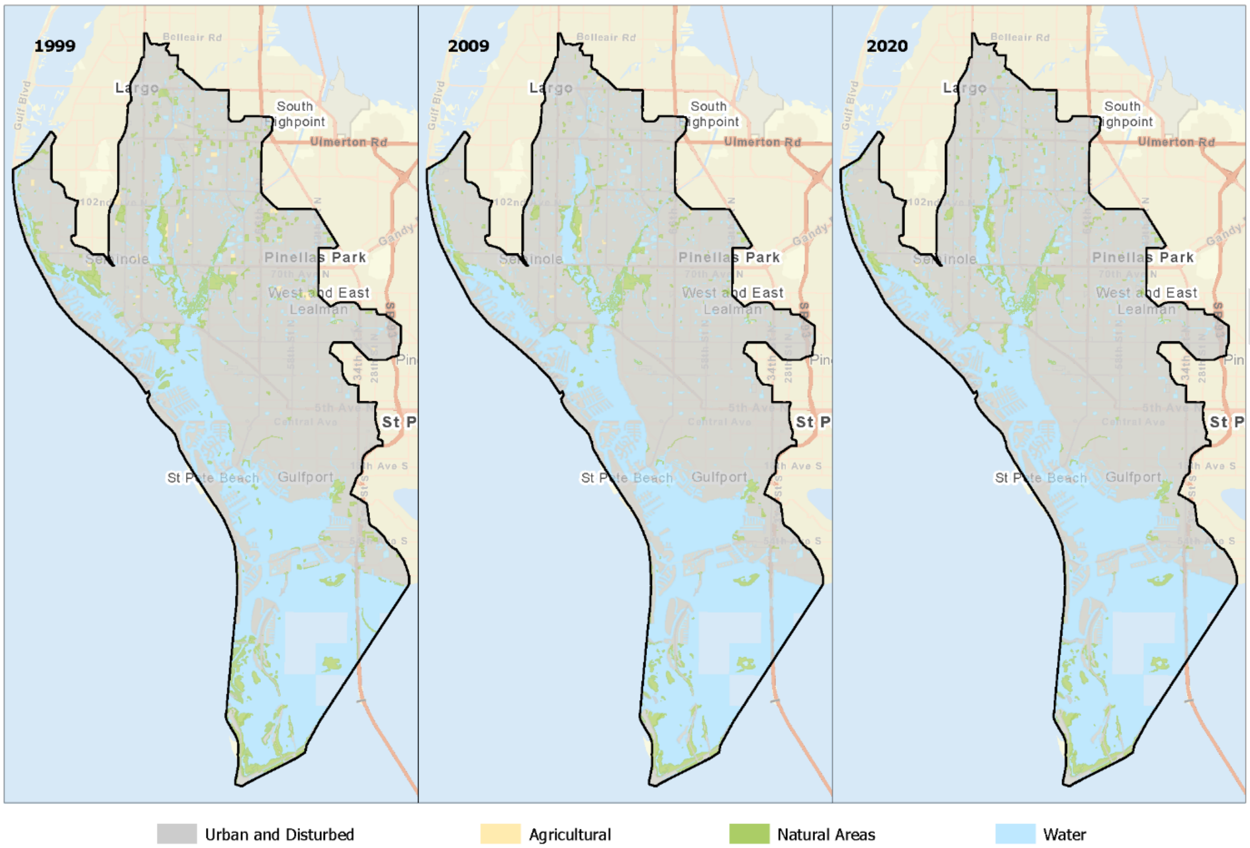
Table 5 – Land Use Change by Acres and Percent for Boca Ciega Bay



Source: SWFWMD Mapping and GIS Section

Figure 10 – Basin Boundary of Boca Ciega Bay Watershed

Boca Ciega Bay Land Use
in 1999, 2009, and 2020



Source: Florida Department of Environmental Protection

Figure 11 – Boca Ciega Bay Land Use in 1999, 2009, and 2020

Terra Ceia Bay

Terra Ceia Bay watershed is in Manatee County, north of Manatee River and includes McMullen Creek and Terra Ceia Bay (Figure 12). Water quality and natural systems restoration projects completed in this watershed by SWIM and its partners include Rubonia Subdivision Stormwater Management Improvements, and Emerson Point Phases 1 and 2. The Emerson Point restoration project is located on Snead Island in the southern region of this watershed. The Emerson Point project restored intertidal and freshwater wetlands along with uplands and estuarine marsh habitats.

Terra Ceia Bay Land Use/Land Cover

The Terra Ceia Bay watershed is 10,798 acres and is largely characterized by natural areas and water. In 2020, the natural areas and open water made up 13.6% (1,466 acres) and 37.4% (4,041 acres) of the watershed, respectively (Figure 13). The relatively large proportion in natural areas is due in part to the presence of the Terra Ceia Aquatic Preserve, and Emerson Point Preserve.

Since 1999, there has been a slight increase in urban and disturbed land use and an associated decrease in natural areas and agriculture of the same period (Table 6). In 1999, 30.4% of the watershed was classified as urban and disturbed, whereas in 2020 that percentage increased to 36.5%. Conversely, the watershed saw a decrease in natural areas from 15.6% of the watershed in 1999 to 13.6% in 2020. Agricultural land use decreased from 17.4% in 1999 to 12.5% in 2020.

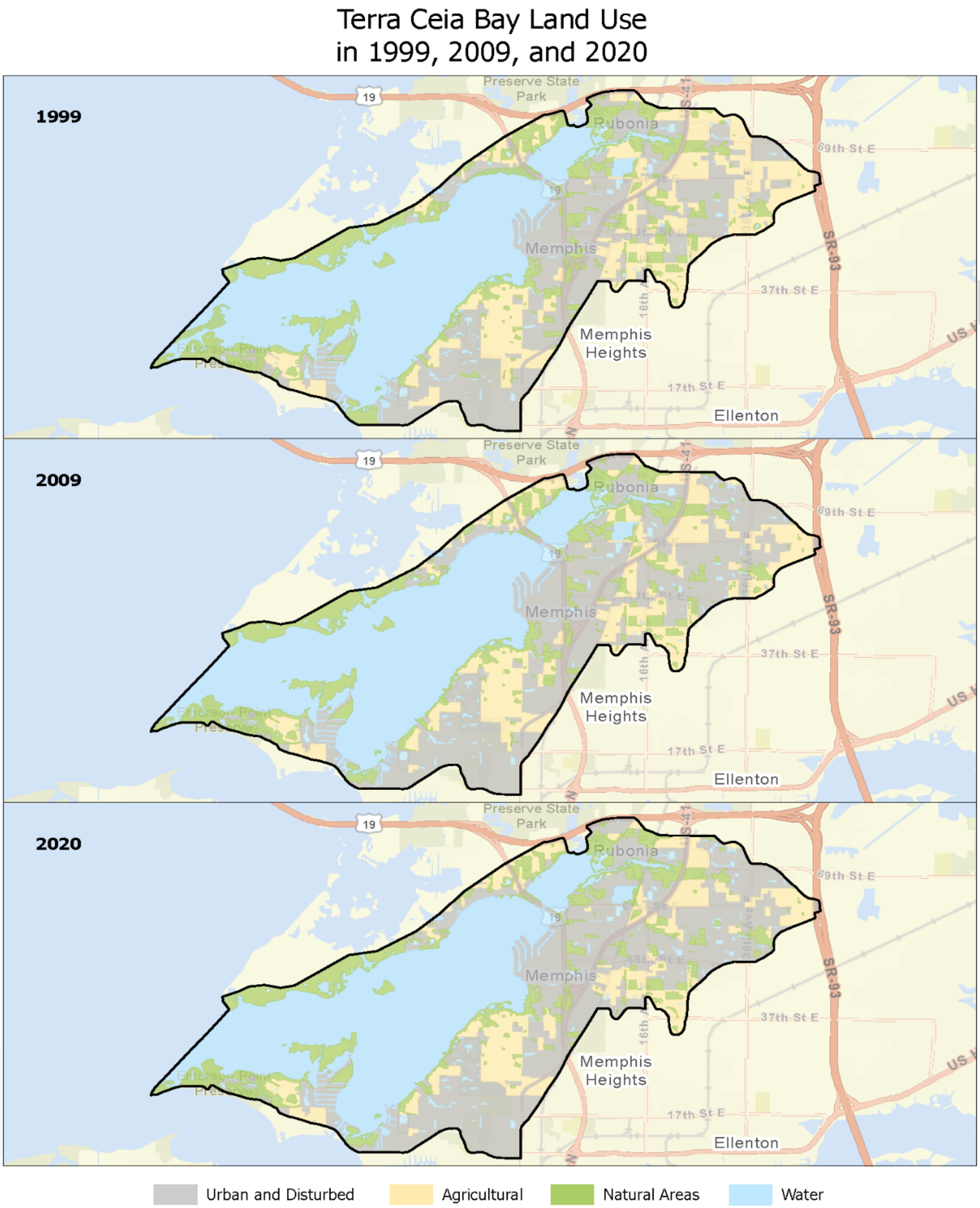
Terra Ceia Bay						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	3,287	30.4%	3,693	34.2%	3,937	36.5%
Agricultural	1,884	17.4%	1,570	14.5%	1,353	12.5%
Natural Areas	1,684	15.6%	1,502	13.9%	1,466	13.6%
Water	3,942	36.5%	4,032	37.3%	4,041	37.4%
Totals	***10,798***	***100.0%***	***10,798***	***100.0%***	***10,798***	***100.0%***

Source: SWFWMD Mapping and GIS Section

Table 6 – Land Use Change by Acres and Percent for Terra Ceia Bay

Source: SWFWMD Mapping and GIS Section

Figure 12 – Basin Boundary of Terra Ceia Bay Watershed



Source: Florida Department of Environmental Protection

Figure 13 – Terra Ceia Bay Land Use in 1999, 2009, and 2020

Manatee River

Just north of Sarasota Bay is the Manatee River watershed. The Manatee River watershed is predominantly within Manatee County with a small portion in Sarasota County (Figure 20). The Manatee and Braden Rivers are the main water features in the watershed.

SWIM, in coordination with other stakeholders, has completed several natural systems restoration projects within the Manatee River watershed such as Ballard Restoration, Bradenton Riverwalk Restoration, Palmetto Estuary Phases 1 and 2, Tom Bennett Park, and Braden River Phases 1 and 2. Conservation lands include the 21,000-acre Duette Preserve which encompasses the headwaters of Manatee River. The District's Edward W. Chance Preserve also is a large natural area within this watershed.

Manatee River Land Use/Land Cover

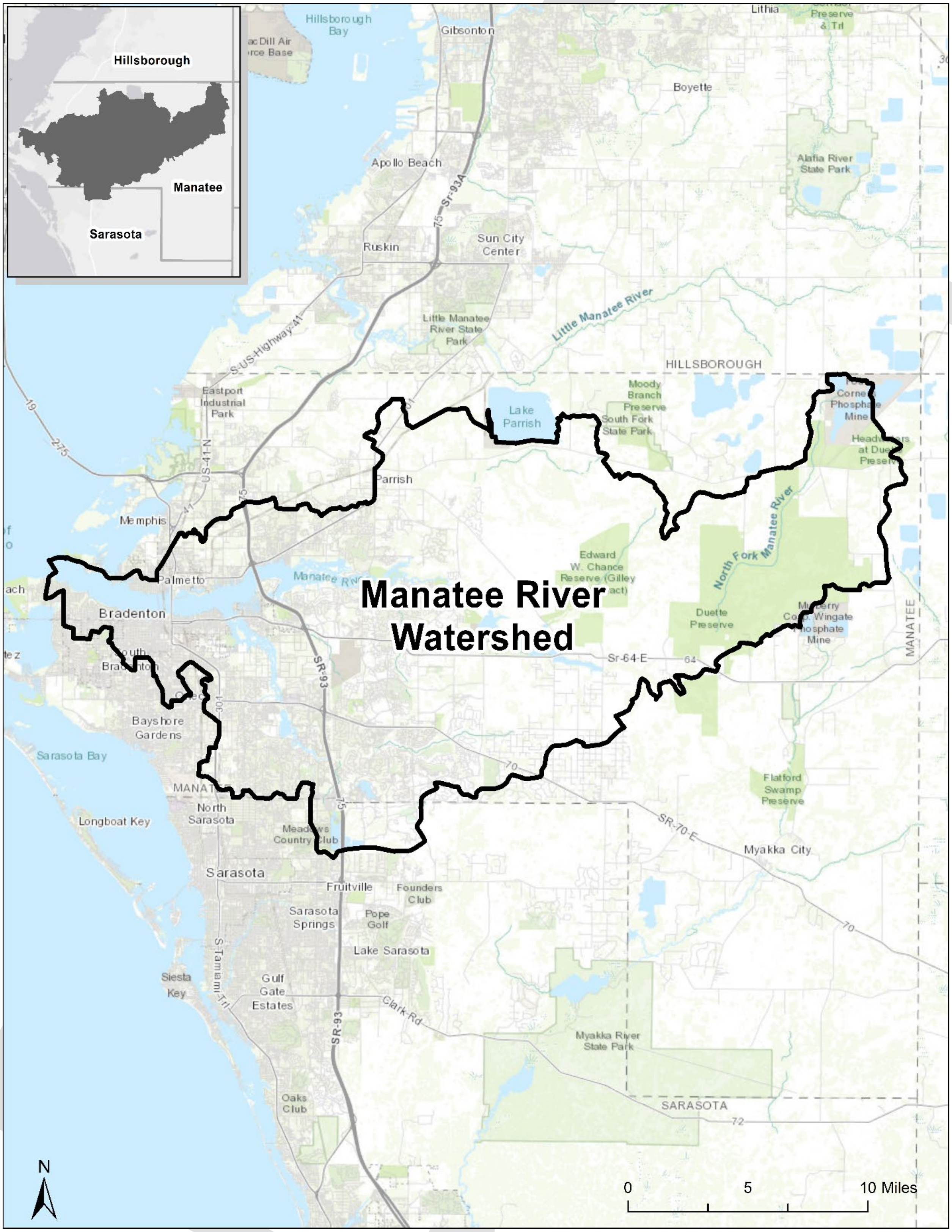
The Manatee River watershed is 224,875 acres and is largely characterized by natural areas and open water. In 1999, the natural areas and open water made up 35.5% (79,876 acres) and 5.6% (12,617 acres) of the watershed, respectively (Table 7). The relatively large proportion in natural areas is due in part to the presence of the Manatee River, Duette Preserve, Robinson Preserve, and Gilley Creek Tract.

Since 1999, there has been an increase in urban and disturbed land use and an associated decrease in natural areas and agriculture over the same period (Table 7). In 1999, 20.3% of the watershed was classified as urban and disturbed, whereas in 2020 that percentage increased to 33.1%. Conversely, the watershed saw a decrease in natural areas from 35.5% of the watershed in 1999 to 31.9% in 2020. Agricultural land use decreased from 38.6% in 1999 to 27.0% in 2020.

Manatee River Watershed						
	1999		2009		2020	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	45,607	20.3%	63,257	28.1%	74,452	33.1%
Agricultural	86,775	38.6%	70,913	31.5%	60,731	27.0%
Natural Areas	79,876	35.5%	75,130	33.4%	71,638	31.9%
Water	12,617	5.6%	15,574	6.9%	18,054	8.0%
Totals	***224,875***	***100.0%***	***224,875***	***100.0%***	***224,875***	***100.0%***

Source: SWFWMD Mapping and GIS Section

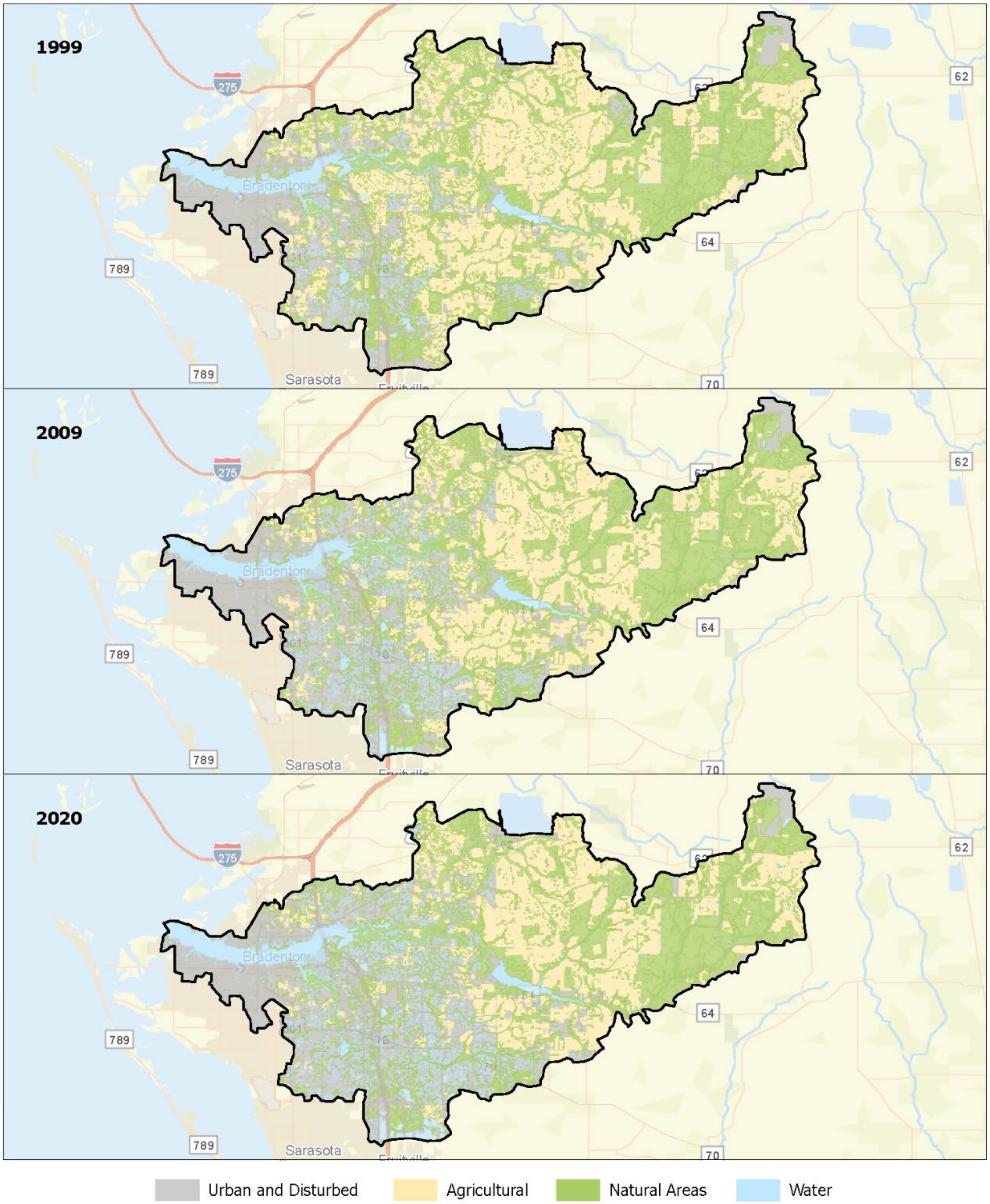
Table 7 – Land Use Change by Acres and Percent for Manatee River



Source: SWFWMD Mapping and GIS Section

Figure 14 – Basin Boundary of Manatee River Watershed

Manatee River Land Use in 1999, 2009, and 2020



Source: Florida Department of Environmental Protection

Figure 15 – Manatee River Watershed Land Use in 1999, 2009, and 2020

Issues and Drivers

Water Quality

The 1999 Tampa Bay SWIM Plan update explored the status and trends in Bay water quality and established the following goals:

- Cap nitrogen loadings to Tampa Bay at existing levels (1992–1994 average) to encourage the regrowth of an additional 12,350 acres of seagrass.
- Protect relatively clean areas of the bay from increases in toxic contamination and minimize risks to marine life and humans associated with toxic contaminants to impacted areas.
- Establish a Pollutant Load Reduction Goal (PLRG) to reduce nitrogen concentration in Tampa Bay by 7% by 2010, or about 17 tons per year or as necessary to offset loadings to the bay because of population growth.

These goals were established in partnership with regional stakeholders and drew heavily on the Tampa Bay Estuary Program's CCMP. The TBEP CCMP was last updated in 2017 and serves as a community blueprint for action over a 10-year planning horizon. The CCMP synthesizes decades of scientific research into the bay's most pressing problems and reflects broad-based input from citizens, stakeholders, and communities with a common interest in a healthy bay as the cornerstone of a prosperous economy. The Tampa Bay SWIM Plan does not duplicate the TBEP's CCMP, rather it uses the CCMP as a reference to identify those elements that align with SWIM's core missions of water quality and natural systems.

The 1999 SWIM Plan PLRG was replaced in 2002 by the Tampa Bay Reasonable Assurance (RA) Plan. The TBEP in cooperation with EPA, FDEP and other Tampa Bay regional stakeholders including the District developed the RA Plan as the foundation for reasonable assurance that the designated uses of waterbody segments within the Tampa Bay basin would be maintained or restored. The RA Plan was developed by the TBEP Nitrogen Management Consortium (NMC) that is comprised of local governments and private industries who have been working together since 1996 to help address nitrogen management issues in Tampa Bay (Nitrogen Management Consortium - Tampa Bay Estuary Program (tbep.org)).

The underlying scientific basis of the NMC RA Plan is the Tampa Bay Nitrogen Management Paradigm that links watershed nitrogen loads to phytoplankton-derived chlorophyll concentrations; chlorophyll concentrations to light attenuation (the loss of light with depth); and light attenuation to seagrass coverage (Figure 16), Seagrass coverage based largely on the District's Seagrass Mapping Program, described in detail in the following section, is a widely accepted key indicator of overall estuarine health throughout the world. The underlying assumption of the Nitrogen Management Paradigm is that seagrass coverage is driven primarily by light limitation which in Tampa Bay is primarily influenced by the density of phytoplankton algae in the water column. In the early 1990s, the TBEP TAC agreed that the range of target light requirements was generally between 20% and 25% of incoming solar radiation reaching the bottom. Therefore, to increase seagrass coverage, the paradigm dictates that nitrogen loads from the watershed must be minimized. For most of the bay, this paradigm has worked very well and has been the cornerstone of successful seagrass recovery in Tampa Bay until 2016.

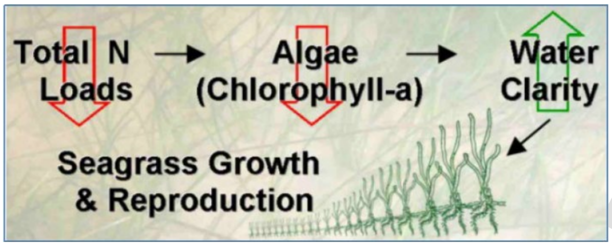


Figure 16 – Tampa Bay Nitrogen Management Paradigm

Beginning in 2016 the Bay began seeing significant declines in seagrass coverage. As of 2022, Tampa Bay seagrass coverage (30,137 acres) has fallen below the TBEP's bay-wide recovery goal (40,000 acres) with most of the loss over the 2016–2022 period occurring in the upper Tampa Bay segments of Old Tampa Bay, Middle Tampa Bay, and Hillsborough Bay. In addition to these unprecedented seagrass losses were noticeable increases in both attached and drift macroalgae. Further, Old Tampa Bay exceeded the water column chlorophyll-a target in four of the last five years. All this points to increased eutrophication. However, despite the loss of seagrass, increase in attached and drift macroalgae, and exceedance of the chlorophyll-a target, nitrogen concentrations remain below the adopted numeric nutrient criteria. The NMC has proposed corrective actions to be taken during the 2022–2026 RAP implementation period. These corrective actions include a re-assessment of the assimilative capacity for Old Tampa Bay, investigations into remediation strategies to address water column phytoplankton blooms, and an investigation of factors contributing to recent seagrass losses and the development of strategies to correct recent seagrass coverage trends. The SWIM Program is a major partner in the development of the TBEP NMC RA Plan and is committed to implementing actions, projects, and initiatives that align with the SWIM Program's core mission. The RA Plan is routinely reviewed and updated having gone through several iterations since 2002. The latest update was completed in December 2022 and approved by the FDEP in February 2023 (FINAL_2022_RA_Update_20221229.pdf – Google Drive).

In addition to the SWIM-specific actions, projects, and initiatives outlined in this plan, Senate Bill 64, passed by the Florida Legislature and approved by the Governor in June 2021, will protect water quality and associated natural systems in Tampa Bay. This bill requires domestic wastewater utilities that dispose of effluent, reclaimed water, or reuse water by surface water discharge to eliminate nonbeneficial surface discharge by January 1, 2032. While this falls outside of SWIM's core mission, the District's Water Supply Section within the Water Resources Bureau does, among other things, coordinate projects that provide potable water supply and resource alternatives including beneficial reuse of reclaimed water. This Bill further encourages investment in potable reuse projects and makes available certain funds toward achieving that goal. These projects have the potential to help reduce the total nitrogen load into Tampa Bay ultimately improving the Bay's water quality and estuarine habitats.

Water Quality Status and Trends

Tampa Bay has a robust water quality monitoring network led by Hillsborough County Environmental Protection Commission and Pinellas County, among other partners. These data are collected and analyzed by the TBEP and presented as part of the TBEP's annual State of the Bay water quality report card.

Because Tampa Bay is such a large estuary, it is subdivided into seven smaller bay segments (Figure 1). These segments were established in the 1990s. The SWIM Program uses a very similar segmentation scheme for reporting biennial seagrass mapping acreage results. Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay are referred to as the "major" bay segments. These are the segments the TBEP reports on in their annual water quality report card and are the bay segments used to track RA Plan compliance. The remaining bay segments of Boca Ciega Bay, Terra Ceia Bay, and the Manatee River are considered "minor" bay segments and are not included in the TBEP's reporting, though all bay segments have Total Nitrogen (TN) and Total Phosphorus (TP) targets.

The primary water quality parameters of concern addressed in this SWIM Plan update are TN, TP, chlorophyll-a (Chl-a), and Secchi Depth (SD). TN and TP are essential to algal and plant productivity and form the basis of the food web. In most segments of Tampa Bay TN is the limiting nutrient for phytoplankton growth. Excess TP in estuaries can also be important as TP can affect nitrogen and silica availability potentially increasing nuisance algal blooms (Howarth and Marino 2006). The two response variables based on the Nitrogen Management Paradigm, are Chl-a, a proxy for water column algal biomass, and SD, used to estimate water clarity. In Tampa Bay, which has relatively low concentrations of inorganic suspended material (e.g., suspended sediments), water clarity is reduced primarily by light attenuating planktonic growth.

As part of the initial 2002 Tampa Bay RA Plan, targets were developed and formally adopted for each of the four major bay segments. For the minor bay segments targets were developed later based on additional studies and supplemental analyses and incorporated in subsequent RA updates. Table 8 shows the water quality targets currently used by the TBEP.

Bay Segment	TN (mg/l)	TP (mg/l)	Chl-a (ug/l)	SD (m)
Old Tampa Bay	0.93	0.31	8.5	1.79
Hillsborough Bay	1.01	0.45	13.2	1.02
Middle Tampa Bay	0.87	0.29	7.4	1.79
Lower Tampa Bay	0.74	0.10	4.6	2.92
North Boca Ciega Bay	0.57	0.11	7.7	NC
South Boca Ciega Bay	0.54	0.12	6.2	NC
Terra Ceia Bay	0.69	0.20	7.5	NC
Manatee River	0.65	0.20	7.3	NC

Sources: Janicki and Wade 1996; Janicki Environmental Inc. 2011a-c; Sherwood 2022
Note: NC = no criteria

Table 8 – Tampa Bay Segment-Specific Water Quality Targets

As part of this SWIM Plan update water quality data acquired since the 1999 SWIM Plan, and covering the period from 1999 to 2020, for the four primary water quality parameters were retrieved from the Florida Department of Environmental Protection (FDEP) Impaired Water Rule database and analyzed for status and trends. To assess the status, data summaries were compared to the TBEP targets for the period 2017–2019, the most recent years with complete datasets available at the time of the analysis.

Based on this analysis all bay segments were on target or better than target for all four parameters during this period. The one exception was TN concentrations in North Boca Ciega Bay, where conditions exceeded the target. The cause(s) of this exceedance is not currently known and warrants further investigation.

To assess trends in water quality conditions, data that met a statistical analysis threshold was utilized. This data included the full 1999–2020 study period and the most recent 6-year block of 2015–2020 available at the time of the analysis. Seasonal Kendall trend tests were run for two time periods (Table 9). Statistically significant trends were identified if the p-value was less than or equal to 0.05 and are indicated by an up (↑) or down (↓) arrow. The up arrows indicate a statistically significant increasing trend, while down arrows indicate a statistically significant decreasing trend, in the measured parameter values. For TN, TP, and Chl-a, a decreasing trend indicates improving water quality conditions, whereas for SD a decreasing trend indicates worsening water quality conditions. Adverse trends are denoted by red arrows. Cells with shading indicate occurrences where the 1999–2020 trend was different than the 2015–2020 trend.

Bay Segment	TN		TP		Chl-a		SD	
	1999–2020	2015–2020	1999–2020	2015–2020	1999–2020	2015–2020	1999–2020	2015–2020
Old Tampa Bay	↓	↓	↓	↓	↓	—	—	↓
Hillsborough Bay	↓	↓	↓	↓	↓	—	—	—
Middle Tampa Bay	↓	↓	↓	↓	↓	↓	↓	↓
Lower Tampa Bay	↓	↓	↓	—	↓	↓	↑	—
North Boca Ciega Bay	—	↑	—	—	—	—	↓	—
South Boca Ciega Bay	↓	↑	↓	—	↓	↓	↓	↓
Terra Ceia Bay	↓	↓	↓	—	↓	—	↓	↓
Manatee River	↓	↓	↓	↓	↓	↑	↓	↑

Table 9 – Water Quality Trend Analysis for 1999–2020 and 2015–2020 Periods

The results of the trend analysis indicate that Boca Ciega Bay (North and South) had a significant increasing trend in TN concentration during the period 2015–2020, as well as a significant decreasing trend in water clarity (SD). In addition, both Middle Tampa Bay and Terra Ceia Bay had significant decreasing trends in SD during both the 1999–2020 and 2015–2020 periods, and Old Tampa Bay a significant decreasing trend in SD during the 2015–2020 period.

Methods and results for the water quality status and trends analysis are provided in Appendix A.

Nitrogen Loadings

As part of the Tampa Bay Reasonable Assurance Plan development, the TBEP NMC also investigated the relationships between TN loads and chlorophyll-a to better understand how the bay responds to varying nitrogen loads. Numeric TN loading targets were developed for each of the bay segments (Table 10). These criteria were expressed as annual TN loads normalized to hydrologic loads (e.g., tons TN/million cubic meters of inflows), referred to as "nitrogen delivery ratios" (Janicki Environmental Inc. 2011b).

Bay Segment	Nitrogen Delivery Ratio (tons TN/million m^3 inflow)
Old Tampa Bay	1.08
Hillsborough Bay	1.62
Middle Tampa Bay	1.24
Lower Tampa Bay	0.97
Remainder of Lower Tampa Bay	1.59
Boca Ciega Bay North	1.54
Boca Ciega Bay South	0.97
Terra Ceia Bay	1.10
Manatee River	1.80

Source: https://TBEP.org/Tampa-Bay-nitrogen-loads

Table 10 – Adopted Tampa Bay Annual TN Loading Targets

Figure 17 shows estimated TN loadings for each of the four main bay segments, plus all segments combined (minus Boca Ciega Bay North), expressed as nitrogen delivery ratios for the period 1985–2020 (TBEP 2021). On each plot the respective annual TN loading target for each segment is shown as a threshold (dashed lines). It should be noted that Boca Ciega Bay South, Terra Ceia Bay, and the Manatee River segments are included in the Lower Tampa Bay remainder category.

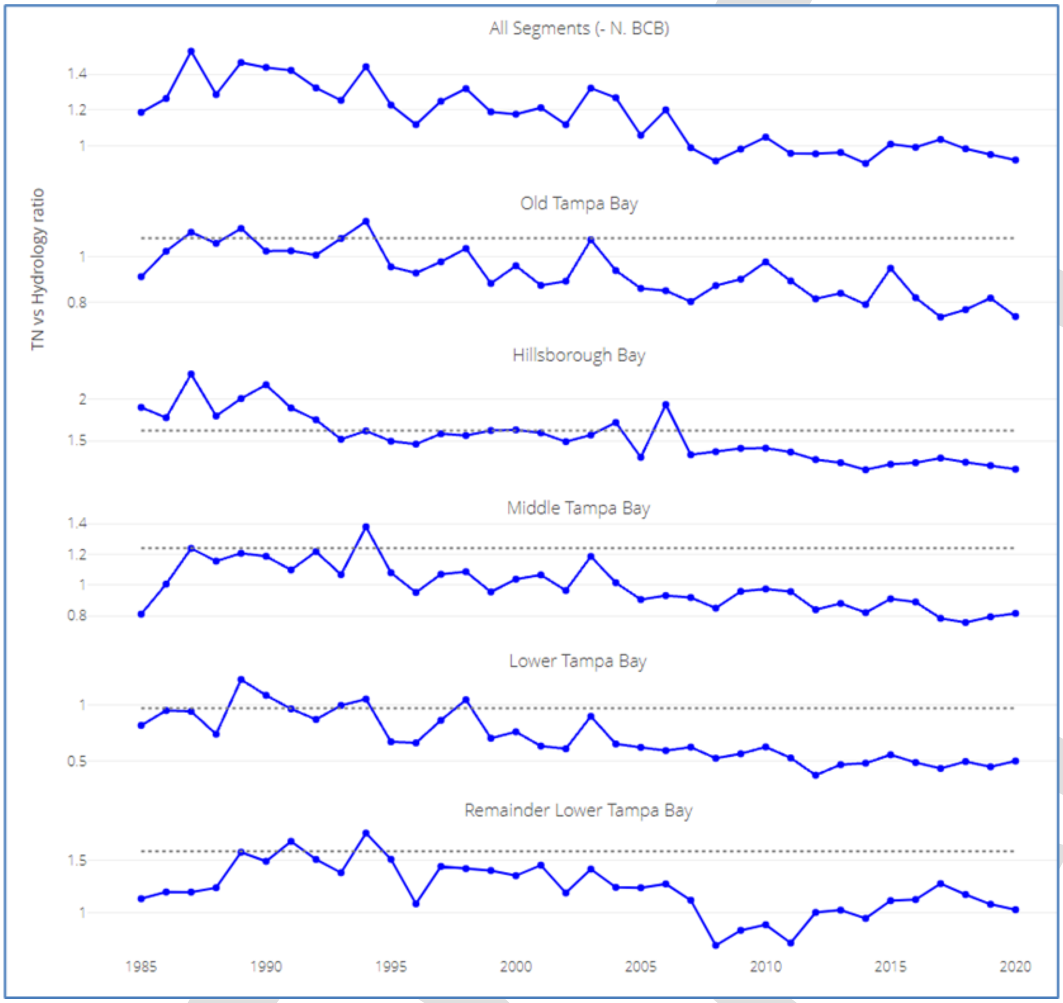


Figure 17 – Estimated Nitrogen Delivery Ratios by Bay Segment for the Period 1985–2020

As shown in these plots, TN loads in all four main bay segments have remained below their respective target loads, and there has been a slight decreasing trend in loads (except for the remainder of Lower Tampa Bay), since the mid-2000s. These load reductions are commensurate with the observed decreasing trends in TN concentrations in the four main bay segments during the past decade.

Natural Systems Protection and Restoration

The 1999 Tampa Bay SWIM Plan incorporated goals from the Tampa Bay National Estuary Program's CCMP which were based on "Restoring the Balance" which included very specific goals for estuarine and freshwater wetland habitats, and coastal uplands. For this update of the SWIM plan, the natural system restoration and protection activities are related to implementation of the TBEP Habitat Restoration Master Plan update (August 2020) that was cooperatively funded by the District.

The major habitat types in the Tampa Bay watershed can be described and organized pursuant to their relationship to tidal influence. Subtidal habitats include those that are submerged all or most of the time. Intertidal habitats include those that are submerged during high tides but exposed during low tides, and supratidal habitats include those that occur above the high tide line. In addition to natural habitats, constructed habitats—including living shorelines and artificial reefs—now constitute important components of the mosaic of Tampa Bay habitats. Moving from the open bay to the headwaters and uplands of the Tampa Bay watershed, the habitats of interest are classified as follows:

- Subtidal Habitats
  - Hard bottom
  - Seagrasses
  - Tidal flats
  - Oyster bars
  - Artificial reefs
- Intertidal Habitats
  - Mangrove forests
  - Salt marshes
  - Salt barrens
  - Tidal tributaries
  - Living shorelines
- Supratidal Habitats
  - Freshwater wetlands (including spring runs)
  - Native forested uplands
  - Coastal uplands.

For this SWIM Plan update the assessment of habitat status and trends relied upon the extensive analysis provided in the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020) published by the TBEP, and co-funded by the District. For the majority of subtidal, intertidal, and supratidal habitats addressed in that document, primary data derived from two routine spatial assessment programs conducted by the District were utilized.

The data source used to estimate the most recent areal coverage of the three subtidal habitats in Tampa Bay—seagrasses, tidal flats, and oysters—was the *Seagrass in 2020* geodatabase published by the District (SWFWMD 2020). Since the completion of the *Tampa Bay 2020 Habitat Master Plan Update* the District released the results of the 2020 seagrass and subtidal habitat mapping effort, and those results are included herein. This database classifies subtidal habitat types, photo-interpreted from aerial photography, collected between November 1, 2019, and February 28, 2020.

The source data used to estimate and map the most current areal coverage of various land use and habitat cover types in the Tampa Bay watershed were the *District Land Use Land Cover 2017* (SWFWMD 2019) geodatabase. This database classifies the land use and cover types, photo-interpreted from 2017 aerial photography pursuant to the Florida Land Use Cover and Forms Classification System, commonly known as FLUCCS (SWFWMD 2014). The land use/cover mapping program began in 1990 and is updated every 2 to 3 years. The results were used to track trends in intertidal and supratidal habitats including emergent tidal wetlands, freshwater wetlands, and native upland habitats.

Habitat Status

Table 11 summarizes the most recent estimates of the extent (e.g., acres or linear feet) of Tampa Bay habitats of interest. The data year is the year(s) from which the data were derived.

Habitat Type	Current Extent	Data Year	Data Source(s)
Subtidal Habitats			
Hard Bottom	423 acres	2017–2019	Kaufman 2017; CSA Ocean Sciences 2019
Seagrasses	30,137 acres	2022	SWFWMD 2022
Tidal Flats	2,379 acres	2020	SWFWMD 2020
Oyster Bars	195 acres	2020	SWFWMD 2020
Artificial Reefs	166 acres	2019	EPCHC 2020; ESA 2020
Intertidal Habitats			
Mangrove Forests	15,300 acres	2017	SWFWMD 2017
Salt Marshes	4,557 acres	2017	SWFWMD 2017
Salt Barrens	496 acres	2017	SWFWMD 2017
Tidal Tributaries	387 miles	2019	Janicki Environmental Inc. and Mote Marine Lab 2016
Living Shorelines	11.3 miles	2020	ESA 2020; Tampa Baywatch 2020
Supratidal Habitats			
Forested Freshwater Wetlands	152,132 acres	2017	SWFWMD land use/cover mapping
Non-Forested Freshwater Wetlands	67,587 acres	2017	SWFWMD land use/cover mapping
Native Uplands (Non-Coastal)	140,600 acres	2017	SWFWMD land use/cover mapping
Coastal Uplands	3,619 acres	2017	ESA 2020

Table 11 – Summary of Current Extent of Tampa Bay Habitats

Habitat Trends

The term "trend" is being used herein to qualitatively characterize changes in habitat extent and percentage over time and is not used in the context of statistical trend analysis and significance testing. Temporal trends in the Tampa Bay habitats of interest are discussed below. Subtidal habitat trends were assessed over the period 1982–2020, whereas intertidal and supratidal habitats were assessed over the period 1990–2017. The results of these analyses are summarized below.

Seagrasses

The District recognizes the importance of seagrass habitat to a healthy estuary and has been committed to mapping the aerial extent of seagrasses in Charlotte Harbor and Lemon Bay on a biennial basis since 1988. This mapping effort is part of a larger effort by the District to map seagrass in estuaries along the entire west-central Florida coast from Waccasassa Bay to the District boundary within Charlotte Harbor and represents one of the most comprehensive and long-term synoptic mapping of seagrass habitat anywhere in the world.

Seagrass habitats are mapped by collecting digital georectified and orthorectified imagery from an aircraft (Figure 18). Images are then photo-interpreted, and polygons are drawn to represent areas with seagrass. A rigorous field verification process occurs independent of the photointerpretation prior to the District accepting the map product.

Figure 18 – District Seagrass Mapping Based on Photointerpretation of Aerial Imagery

An aircraft is flown at an altitude of 8,000 to 10,000 feet. Imagery is collected using a digital camera mounted on the aircraft. Photo-interpreters then draw polygons on the imagery delineating areas of seagrass using a modified Florida Land Use Cover Classification Scheme (FLUCCS).

For Tampa Bay, seagrass coverage in acres from 1988 through 2022 is shown in Figure 19. Acreages are estimated based on aerial imagery collected over the winter months from November of the preceding year through February of the year shown on the x-axis. Bay-wide seagrass coverage for 2022 was 30,137 acres, 6,858 acres more than was mapped in 1988. Seagrass coverage reached a record high of 41,655 acres in 2016 followed by repeated declines in seagrass coverage. Between 2016 and 2022, the bay lost 11,518 mapped acres or 28% of the total seagrass coverage. These losses were driven mostly by Old Tampa Bay which saw a 61% decrease in mapped seagrass from the record high of 11,147 acres in 2016 to a record low of 4,183 acres in 2022. Declines in seagrass coverage between the 2020 and 2022 mapping cycles were widespread across all bay segments but at varying magnitudes (Table 12). Old Tampa Bay had the largest acreage loss (-2,518) while Hillsborough Bay had the greatest percent loss (-51%). Boca Ciega Bay and Lower Tampa Bay were relatively unchanged with a 1% and 3% loss, respectively.

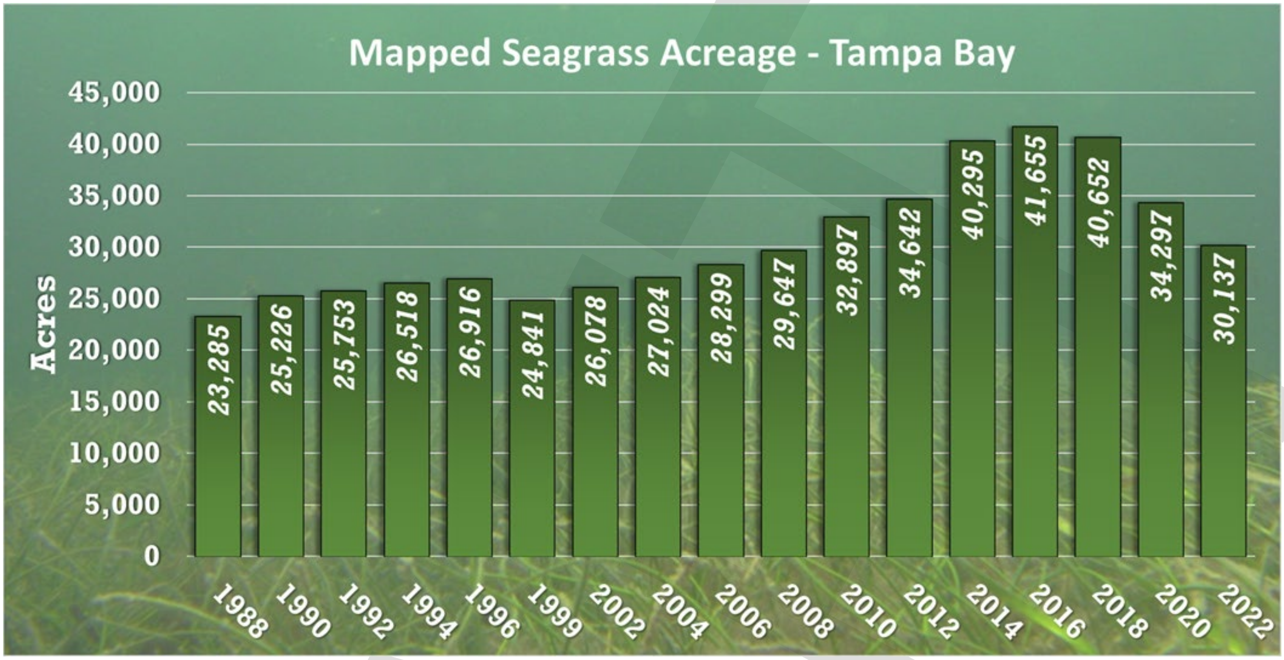


Figure 19 – Tampa Bay Seagrass Trends, 1988–2022

Segments	2020	2022	Δ Acres	% Change
Boca Ciega Bay	8,799	8,740	-59	-1%
Hillsborough Bay	837	409	-428	-51%
Lower Tampa Bay	7,888	7,625	-263	-3%
Manatee River	570	461	-109	-19%
Middle Tampa Bay	8,424	7,726	-698	-8%
Old Tampa Bay	6,701	4,183	-2,518	-38%
Terra Ceia Bay	1,079	992	-87	-8%
Tampa Bay Total	***34,298***	***30,137***	***-4,161***	***-12%***

Table 12 – Change in Seagrass Coverage by Bay Segment between 2020 and 2022

Seagrass coverage is a major indicator of overall bay health and these losses since 2016 are of concern to the resource management community. The cause of these recent losses is complex as are the corrective management actions to reverse these trends. Some of these actions are within the District's core mission areas and are addressed in this SWIM Plan update.

Emergent Tidal Wetlands

The suite of emergent tidal wetlands includes mangrove forests, salt marshes, and salt barrens, which exist in a dynamic equilibrium controlled by factors such as storm surge and flood damage, periodic freezes, and sea level rise (Robison 2010). Over the 27-year period of record, the suite of emergent tidal wetlands experienced a net gain of 1,791 acres (10%).

Freshwater Wetlands

The suite of freshwater wetlands includes natural streams, waterways, and lakes; wetland hardwood forests (e.g., bay swamps); wetland coniferous forests (e.g., cypress swamps); wetland forested mixed; and vegetated non-forested wetlands (e.g., freshwater marshes). Over the 27-year period of record, the suite of freshwater wetlands (exclusive of open water) has experienced a net gain of 6,040 acres (3%). The results also indicate that there has been a substantial increasing trend in vegetated non-forested freshwater wetlands since 1990, with a gain of 13,183 acres (24%), while forested freshwater wetlands have decreased by 7,144 acres (4%).

Native Uplands

The suite of native upland habitats includes dry prairies; shrub and brushland (native grasslands); mixed rangeland; upland coniferous forests (e.g., pine flatwoods) and upland hardwood forests (e.g., oak hammocks). Over the 27-year period of record, the suite of native upland habitats has experienced a net loss of 91,055 acres (39%) with the greatest losses observed in Upland Coniferous Forest (e.g., pine flatwoods – 55% loss), Upland Hardwood Forests (e.g., oak hammocks – 22% loss), and Shrub and Brushland (e.g., native grasslands – 44% loss) classifications.

Habitat Status and Trends Summary

The most significant and meaningful trends in the Tampa Bay habitats of interest over the periods of record examined include (1) the 47% gain in seagrasses between 1988 and 2020; (2) the recent 18% decline in seagrasses between 2016 and 2020; (3) the slight gains in both emergent tidal wetlands (10% gain) and freshwater wetlands (2% gain) since 1990; and (4) the 39% loss in native upland habitats since 1990.

The increasing long-term trend in seagrass coverage is a testament to improved bay water quality resulting from focused reductions in both point and non-point sources of pollution. Improved domestic wastewater treatment by local government utilities—as required by Florida Statutes Section 403.086—was responsible for the most significant improvements in Tampa Bay water quality. Pollutant load reduction commitments made by industrial point source permittees in association with the TBEP Nitrogen Management Consortium have also led to additional improvements in bay water quality (Greening et al. 2016). The causes of the recent seagrass declines are not yet fully understood; however, recent increases in precipitation, algal blooms, red tide events, and storm events are likely contributing factors.

The observed gains in both emergent tidal wetlands and freshwater wetlands are likely a reflection of (1) the effectiveness of state and federal wetland regulatory programs and (2) the cumulative gains resulting from publicly funded habitat restoration projects and, to a lesser extent, regulatory mitigation. Gains in emergent tidal wetlands are also likely due to the landward expansion of the complex suite of these habitats associated with climate change and sea level rise. Also, since 1990 there has been a significant and disproportionate gain in vegetated non-forested freshwater wetlands, reversing disproportionate losses in this habitat type between circa 1950 and 2007. This shift may be related to the clearing of forested wetlands associated with development, mining, and silviculture followed by the creation of herbaceous mitigation areas and surface water management system features (e.g., ponds and swales).

The decreasing trend in native upland habitats is clearly the result of continued urban development in the Tampa Bay watershed., Federal and state regulations related to listed species management impart some protection to certain rare upland habitats (e.g., scrub jay habitat); however, common, and historically abundant native upland habitats, such as pine flatwoods, are left largely unprotected. The responsibility for protecting native upland habitats resides mostly with local governments through the implementation of their planning, zoning, and land development regulations.

Previous Habitat Restoration Activities

The Tampa Bay watershed has been the focus area of substantial publicly funded habitat restoration and enhancement projects over the past 40 years. However, accurately documenting these projects and activities has been difficult. As part of the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020), various sources of information regarding past and current habitat restoration and enhancement activities in the Tampa Bay area were compiled, reviewed, and consolidated into a single geospatial database. This database only includes publicly funded restoration/enhancement projects, and specifically excluded mitigation and mitigation banks. The results of this effort are summarized in Table 13.

Habitat Type	No. of Projects	Enhancement		Restoration
		Acres	Linear Feet	Acres
Estuarine	228	3,147.6	99,501	2,074.0
Freshwater	53	449.1	23,156.8	1,191.1
Mixed	60	5,924.5	0	1,195.4
Upland	119	22,428.6	17,710	426.9
Totals	***460***	***31,949.8***	***140,367.8***	***4,887.3***

Table 13 – Summary of Completed Habitat Restoration/Enhancement Projects in Tampa Bay

Based on this analysis a total of 460 completed or ongoing projects, resulting in 4,887 acres of restoration and enhancement, have been documented over the period 1990–2020. Of these totals, the District (primarily SWIM) has been the lead partner responsible for 79 projects resulting in 2,541 acres of restoration and enhancement; by far the greatest single contributor to these accomplishments. The habitat change analysis summarized above indicates that emergent tidal wetlands have increased by a total of 2,152 acres since 1990. This total is consistent with the estimated 2,074 acres of estuarine habitats restored through publicly funded habitat restoration activities and constitutes 96% of the total gain in emergent tidal wetlands since 1990. While no geospatial analysis was conducted as part of this project to determine if the gains in emergent tidal wetlands directly correspond to documented restoration projects, it is reasonable to conclude that publicly funded restoration activities account for a significant percent of these gains.

While the data synthesis and analysis for the HMPU represents the best estimate of habitat restoration and enhancement efforts compiled as of 2020 for the Tampa Bay watershed, there are gaps and inconsistencies in the way this information is documented and reported. The District has developed a program to address these issues for projects where the District and/or its cooperator was the lead. The District's program incorporates a geodatabase to better account for restoration projects and acreages, including the development of project area polygons. In addition, the TBEP is developing an improved reporting platform and web-based dashboard to monitor habitat restoration progress throughout the watershed.

Tampa Bay SWIM Plan Goals

From 1988 to 2016, Tampa Bay enjoyed a prolonged period of seagrass recovery gaining 18,376 acres over this 28-year period. With expanding seagrass coverage and improving water quality, Tampa Bay was heralded as one of the few examples in the world of successful coastal ecosystem restoration, despite unprecedented urbanization and population growth across the watershed (Greening et al. 2014). By 2016, however, conditions began to change. Between 2016 and 2023, the bay lost more than 11,000 acres of seagrass, largely in the upper bay segments of Old Tampa Bay and Hillsborough Bay. Concurrent with the loss in seagrass acreage was an increase in the amount of drift and attached macroalgae, a phenomenon not limited to Tampa Bay but seen in other estuaries like Sarasota Bay, Charlotte Harbor, and Indian River Lagoon. Water quality has remained relatively stable and, in some cases, has even improved since the last SWIM Plan update. Seagrass loss at a time when water quality data suggest conditions are favorable for seagrass is of concern and is receiving much attention by the environmental resource management community, including the SWIM Program.

This SWIM Plan Update takes a slightly different approach from previous SWIM Plan Updates by acknowledging the need to reexamine some of the fundamental management paradigms that have been successful for the last 5 to 7 years. While scientific research to reexamine these long-held paradigms is necessary, and a major focus of this plan, SWIM also supports and will continue to identify and implement projects with our partners for natural system restoration and nutrient reduction. Tampa Bay, along with other estuaries in Florida, and across the world, is facing uncertain times, but this plan along with the TBEP CCMP is forging the way forward to ensure the future of Tampa Bay remains bright. Table 14 outlines overarching Water Quality and Natural Systems goals to be completed during this SWIM Plan Update period.

Water Quality
Update nutrient reduction goals for each bay segment using a revised seagrass-nutrient management paradigm.
Propose new bay-segment specific seagrass light targets.
Reduce nutrient loads through the implementation of cost-effective SWIM projects in cooperation with District partners.
Natural Systems Protection and Restoration
Support the District Seagrass Mapping Program and complete Tampa Bay biennial seagrass maps.
Support the establishment of a drift macroalgae monitoring network.
Support the 2030 habitat protection and restoration targets outlined in the TBEP 2020 Habitat Master Plan.

Table 14 – Water Quality and Natural Systems Goals

Management Actions

One of the goals of this SWIM plan is to identify strategic initiatives that will address the major issues and drivers and provide management actions that will improve and maintain the ecological health of Tampa Bay. The management actions listed in this section are grouped into the focus areas of water quality and natural systems (Table 15 and Table 16), though it is recognized that a focus area is not necessarily independent of the others. For example, water quality management actions may have direct impacts on achieving the natural systems seagrass targets for a particular Bay segment. Monitoring and research actions are included for each of the focus areas and are essential elements to adaptive management.

Water Quality

Monitoring and Research
Support reevaluation of the seagrass-nutrient management paradigm with special emphasis on Old Tampa Bay and Hillsborough Bay.
Support reevaluation of seagrass light requirements and propose revised bay-segment specific targets for each bay segment.
Support research to better understand linkages between nitrogen loads, macroalgae abundance, and seagrass loss.
Support research to forecast ecological change in the Tampa Bay estuary in the face of climate change and sea-level rise.
Evaluate water quality monitoring data gaps and identify opportunities to minimize monitoring redundancies across all program areas.
Better understand nutrient sources and sinks.
Water Quality Protection and Restoration
Support development of stormwater master plans.
Implement stormwater BMPs in urban areas in partnership with local, regional, and state agencies.
Promote green infrastructure designs and practices for stormwater treatment and management.
Education and Outreach
Continue to support Florida-Friendly landscaping principles.
Continue the District's FARMS program to assist agricultural stakeholders in conserving water and protecting water quality through outreach and implementation of BMPs.

Table 15 – Water Quality Management Actions

Natural Systems Protection and Restoration

Monitoring and Research
Continue the District's Seagrass Mapping Program and evaluate improvements to map quality by incorporating new/emerging technology while maintaining data continuity.
Continue to partner with TBEP to collect and analyze seagrass transect data at fixed locations in Tampa Bay.
Improve understanding of the ecology and habitat utilization of seagrass beds and macroalgae in Tampa Bay.
Monitor filamentous macroalgae accumulation and distribution in areas of concern in Tampa Bay.
Support evaluation of potential linkages between red tide events and the occurrence of filamentous macroalgae blooms.
Support the assessment and ranking of priority tidal tributaries for restoration projects.
Improve understanding of how rainfall patterns, climate drivers, and sea level rise affect estuarine habitats.
Natural Systems Conservation and Protection
Continue to support land acquisition for conservation of priority habitats in the Tampa Bay watershed.
Continue to support water conservation strategies related to natural system protection through implementation of the District's Water Use Caution Area.
Support the adoption and reevaluation of minimum flows and levels (MFLs) for priority waterbodies in the Tampa Bay watershed.
Natural Systems Restoration
Support the assessment of restoration opportunities on open and disturbed lands.
Support programs and projects in Tampa Bay 2020 Habitat Master Plan Update (HMPU).
Explore opportunities for urban stream restoration and/or enhancement including drainage ditches to multi-stage channels.

Table 16 – Natural Systems Management Actions

Projects and Initiatives

Projects and initiatives for Tampa Bay identified in this plan address specific management actions as outlined in the previous section. However, not every management action has a specific project associated with it. The SWIM Plan is meant to be a living document with adaptive management at its core. It is anticipated that this section will be updated to include additional projects and initiatives as needed.

The proposed projects and initiatives listed below are broken out into the three major focus areas of Water Quality, Hydrologic Restoration, and Natural Systems Protection and Restoration. This plan recognizes that each of these focus areas are not mutually exclusive. Therefore, some projects may contain elements that overlap across focus areas.

Water Quality

Monitoring and Research

Support re-evaluation of the Tampa Bay nutrient management paradigm.

Partners: District, TBEP

1. Investigate the relationships among TN/Chl-a/light attenuation and seagrass distribution, with an emphasis on Old Tampa Bay and Hillsborough Bay.
2. Re-evaluate Chlorophyll-a (Chl-a) targets for both major and minor bay segments.
3. Support *Pyrodinium bahamense* research in Old Tampa Bay with a focus on increasing sea surface temperatures and impacts on seagrass distribution.

Improve understanding of the ecological responses to nutrient enrichment and reductions.

Partners: District, TBEP, counties, local governments

1. Investigate recent TN increases in Boca Ciega Bay and identify potential causes and ecological responses.
2. Supporting the update and application of the Old Tampa Bay Integrated Model and identifying projects to improve circulation in the Bay.

Better understand nutrient sources and sinks.

Partners: District, TBEP, FWRI, Universities

1. Identify localized nutrient load sources (i.e.: groundwater and internal nutrient cycling) near areas of significant seagrass loss and areas of drift and attached macroalgae.
2. Improve quantitative estimates of bay nitrogen loadings from reclaimed water use in the Tampa Bay watershed.
3. Track beneficial uses of reclaimed water and evaluate cumulative effects on ground and surface water quality/quantity.

Natural Systems Hydrologic Restoration Projects

Hydrologic Restoration Projects

Explore opportunities for urban stream restoration and/or enhancement including drainage ditches to multi-stage channels.

Partners: District, TBEP, Local Governments

1. Continuation of ongoing program to assess and monitor benefits of salinity barrier removal (e.g., Channels A, G).
2. Continue to develop and implement salinity barrier removal/modification projects where feasible and beneficial to water quality and fish passage.

Support the assessment of restoration opportunities on open and disturbed lands.

Partners: District, TBEP, TBW, Cities, and Counties

Restoration priorities to support the following:

1. Connection or restoration of historic tributaries
2. Landscape buffering of existing tributaries
3. Opportunities to connect or enhance natural systems corridors

Support the adoption and reevaluation of MFLs for priority waterbodies in the Tampa Bay watershed.

Lead entity: District

Natural Systems Protection and Restoration

Monitoring and Research
Biennial Seagrass Mapping **Partners:** District, TBEP, and others 1. Biennial seagrass mapping 2. Support additional efforts to map hard bottom habitat using existing aerial imagery used to map seagrass. This is an ongoing project that maps seagrass and other benthic habitat via aerial photography throughout Tampa Bay. Mapping seagrass is done through photointerpretation of aerial photographs collected specifically for the purpose of benthic mapping. The District has been mapping seagrass in these systems since 1988 and biennially (every other year) since 1992. Part of this project involves testing new and emerging technologies and methods. For example, the District is considering the use of a semi-automated classification process which may greatly enhance the ability to map seagrass by relying less on the artistic license of a photo interpreter. The District will continue to work closely with its partners via the TBEP and the Southwest Florida Seagrass Working Group to provide feedback and peer review of the map products.
Collect Seagrass Transect Data **Partners:** District, TBEP Annually collect seagrass transect data at select, fixed locations in Tampa Bay.
Improve understanding of the ecology and habitat utilization of seagrass beds and macroalgae in Tampa Bay. **Partners:** District, TBEP Assess community structure, habitat value, and successional dynamics of macroalgae (e.g., Caulerpa) vs. seagrass.
Natural Systems Conservation
Land Acquisition **Partners:** District, other state and federal Governments, NGOs 1. Identify general priorities for land acquisition (e.g., low-lying coastal uplands) as well as specific parcels for acquisition. 2. Leverage HMPU to develop a list of priority habitat types for recommendation to Florida Forever and work with state, local governments (e.g., ELAPP) and NGOs to develop priority lists. This initiative continues to promote District-wide efforts to conserve natural lands using both conservation easements and fee land acquisitions. Relevant Florida Statutes authorize the Governing Boards of the water management districts to acquire the fee or certain other interests in lands necessary for flood control, water storage, water management, conservation and protection of water resources, aquifer recharge, water resource and water supply development, and preservation of wetlands, streams and lakes, and this authority is a powerful tool in conservation efforts aimed at natural systems. The District will continue to develop and implement strategies to identify priority wetland and upland parcels of opportunity for acquisition throughout the Tampa Bay watershed.
Natural Systems Restoration
Assess restoration potential and develop priority restoration projects. **Partners:** District, TBEP, FDEP and Local Governments 1. Assess restoration potential on existing publicly owned conservation lands. 2. Assess restoration potential on private lands (conservation easements). 3. Assess restoration potential on reclaimed mined lands. 4. Leverage HMPU analysis where restorable habitats on existing conservation land have been identified.
Support programs and projects in Tampa Bay 2020 Habitat Master Plan Update (HMPU). **Partners:** District, TBEP, Local Governments 1. Identify, scope, and implement priority salt marsh and mangrove restoration projects. 2. Mangrove projects to address mosquito ditching impacts and mangrove die offs (e.g., Snead Island). 3. Develop and implement priority intertidal wetland restoration projects in Tampa Bay.

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APPENDICES

Appendix A: Technical Assessments of Issues and Drivers Affecting the Tampa Bay System

Technical Memorandum

date	January 4, 2022
to	Lizanne Garcia, SWIM Section, Southwest Florida Water Management District
cc	Chris Anastasiou, Ph.D., SWIM Section, Southwest Florida Water Management District
from	Doug Robison, ESA Emily Keenan, ESA
subject	Tampa Bay SWIM Plan Update – Task 4.4 Technical Memorandum: Summary of Water Quality Status and Trends

Introduction

This Technical Memorandum provides a summary of water quality status and trends in Tampa Bay, as specified in Task 4.4 of Task Work Assignment No. 19TW0002731 between the District and ESA. It is anticipated that the material presented below will be included in a chapter of Tampa Bay SWIM Plan Update. This Technical Memorandum was provided for review and comment by the Tampa Bay SWIM Plan technical stakeholders.

Summary of Water Quality Status and Trends

Bay Segmentation

The Tampa Bay estuarine system encompasses the main reach of Tampa Bay as well as other smaller embayments, tidal rivers, and coastal lagoons; and water quality conditions can vary significantly between the various segments of the system. Therefore, as shown in **Figure 1**, Tampa Bay has been subdivided into seven bay segments to facilitate a more focused management approach for each segment. Due to their large surface areas, Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay are referred to as the "major" bay segments; whereas Boca Ciega Bay, Terra Ceia Bay, and the Manatee River are referred to as the "minor" bay segments. The management boundaries and segmentation of the Tampa Bay SWIM water body have not changed since the 1999 SWIM Plan and are consistent with those used by the Tampa Bay Estuary Program (TBEP).

In the water quality status and trends summaries presented below, water quality data were compiled for each bay segment for the period 1999–2020. The date range represents the period from the last Tampa Bay SWIM Plan update to current conditions. Water quality conditions in each bay segment are characterized, and segment-specific management issues are identified and discussed. As available, respective water quality targets established by the TBEP are provided for comparison. It should be noted that the Boca Ciega Bay segment was further sub-divided into North and South sub-segments consistent with the boundaries used for the development of associated water quality targets.

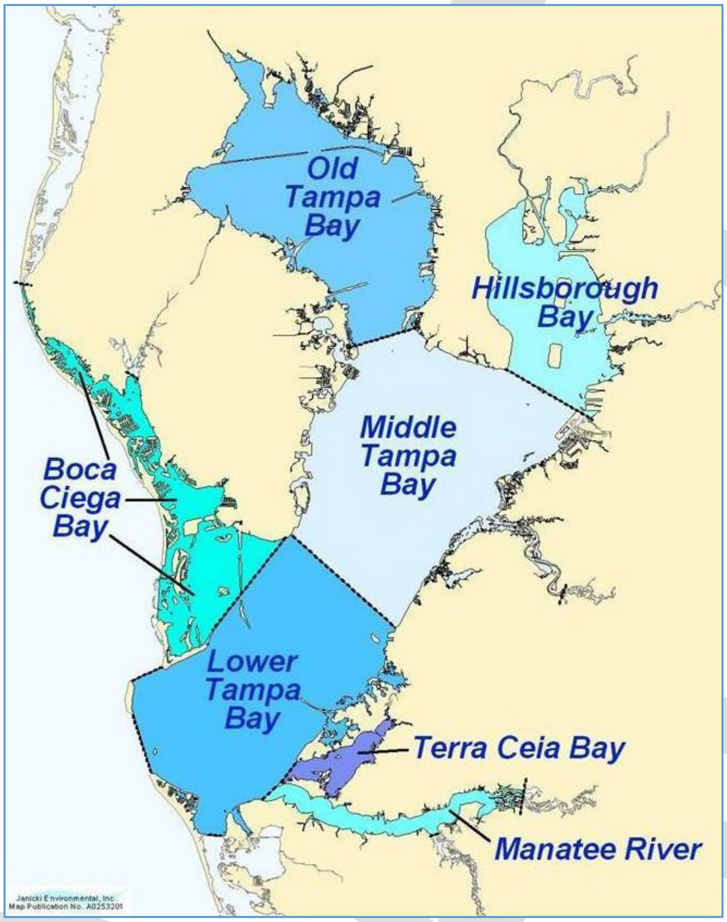

Figure 1
Tampa Bay Segmentation Scheme

Water Quality Parameters of Interest

With respect to environmental and public health protection, the term "water quality" encompasses four major types of criteria: (1) aquatic life, (2) biological, (3) human health, and (4) microbial/recreational (EPA 2021). Each of these criterion types have a corresponding range of parameters for which standards have been developed at the federal and/or state level.

Prior to the development of the first Tampa Bay SWIM Plan local technical stakeholders identified seagrasses as the most important habitat for fish and shellfish populations (Lewis et al. 1982) and identified the decline of seagrasses from historical conditions to be the most critical resource management issue threatening the continued health of the Tampa Bay estuary. In addition, the first Comprehensive Conservation and Management Plan (CCMP) prepared by the Tampa Bay National Estuary Program (TBNEP 1996) identified seagrasses as the key resource indicator of ecological health, and cited water quality improvement as the primary management strategy to recover seagrasses and attain the established restoration target of 38,000 acres.

With respect to seagrass recovery the primary water quality parameters of concern are those related to eutrophication—the process of nutrient enrichment leading to excessive algal growth and reduced water clarity. The reduction of nutrient loads (primarily nitrogen), leading to decreased phytoplankton (measured as chlorophyll-a concentrations) and increased water clarity, was adopted by TBEP as the guiding paradigm of their seagrass recovery strategy (TBEP 1996). This paradigm is illustrated in **Figure 2**.

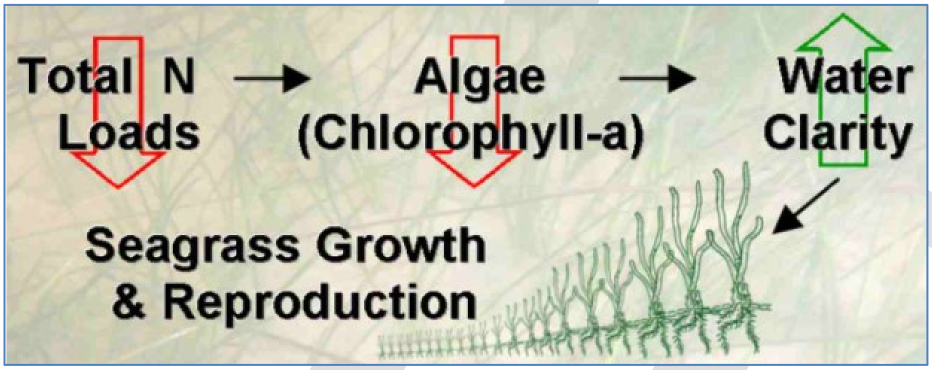

Figure 2
Tampa Bay Seagrass Recovery Paradigm

Therefore, the primary water quality parameters of concern addressed in this SWIM Plan update include two causative enrichment variables: total nitrogen (TN) and total phosphorus (TP). These nutrients are essential to algal and plant production and are the base of the food chain that supports all other life in the system. In most segments of Tampa Bay TN is the nutrient most limiting to phytoplankton growth; however, excess TP in estuaries can interact with the availability of nitrogen and silica to adversely affect phytoplankton community structure, potentially favoring nuisance algal blooms (Howarth and Marino 2006).

Also included are two initial response variables which are typically the first indicators of a biological growth reaction to enrichment. One is chlorophyll-a (Chl-a), a proxy for phytoplankton production; the other is Secchi disk depth (SD), a measure of water clarity. In Tampa Bay, which has relatively low concentrations of inorganic suspended material (e.g., suspended sediments), water clarity is reduced primarily by light attenuating planktonic growth. A secondary response variable is dissolved oxygen (DO), which is reduced by bacterial respiration associated with the breakdown of excessive biomass production. Reductions in DO can result in the loss of benthic invertebrate communities and fish kills. As part of the data analyses conducted for this Technical Memorandum DO data collected throughout Tampa Bay from 1999 through 2020 were examined, and it was determined that all bay segments are well oxygenated and in compliance with the current DO state water quality standard. Therefore, DO trends are not presented herein.

Other potentially important water quality parameters not addressed in this SWIM Plan update include microbial pollutants (e.g., fecal coliform bacteria) and toxic contaminants (e.g., metals and organics). Elevated waterborne concentrations of microbial pollutants may limit recreational uses of the bay in localized areas after high rainfall and/or sewage overflow events, whereas toxic contaminants are primarily a concern with regard to bay sediments. Bacterial impairments and toxic contaminant issues are managed primarily by the Florida Department of Environmental Protection. With respect to the District's authority under the SWIM Act, the management of eutrophication and seagrass recovery in Tampa Bay is the highest water quality priority, and the primary focus of the Water Quality Action Plan.

Data Sources and Methods

For the study period of 1999 to 2020 (data acquired since the 1999 Tampa Bay SWIM Plan update) water quality data specific to the Water Body Identification Numbers (WBID's) corresponding to the seven Tampa Bay segments were retrieved from the Florida Department of Environmental Protection (FDEP)

Impaired Water Rules database (IWR Run 61), which is a comprehensive data warehouse containing data from local, state and federal data providers. Raw data were evaluated to address qualifiers consistent with FDEP data screening methods applied prior to impaired waters evaluation (i.e., "U" qualified data were reported as half the minimum detection limit, "I" qualified data were reported at the minimum detection limit).

The daily average was calculated for each parameter by sampling station and sampling date to remove potential duplicate data entries. Reported chlorophyll-a data incorporates both corrected, and uncorrected, chlorophyll-a data. Due to changes in laboratory methods, corrected chlorophyll data were used exclusively after July 3, 2012. The distribution of daily averages for each year for the period 1999–2020 were summarized as "box and whisker" plots which show the mean, median, intra-quartile range (IQR = the distance between the 25th and 75th percentiles), the upper and lower extremes up to 1.5 times the IQR, and any outliers. Taller data ranges indicate greater annual variability. **Figure 3** illustrates how to interpret the box and whisker plots presented below.

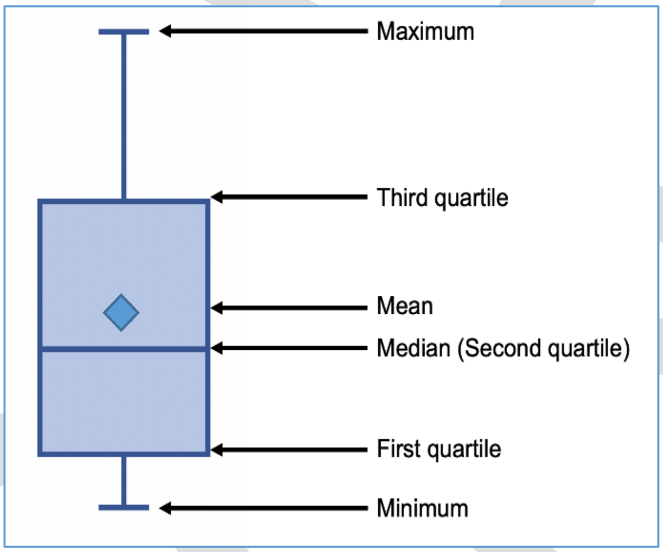

Figure 3
Interpretation of Box and Whisker Plots

Applicable Water Quality Criteria

In 2002, the FDEP accepted the initial Reasonable Assurance Plan (RAP) for Tampa Bay. This plan provided the foundation for reasonable assurance that the designated uses of waterbody segments within the Tampa Bay basin would be maintained or restored for nutrient attainment. The plan also provided supporting documentation for site-specific alternative chlorophyll-a thresholds that apply to bay segments and that accurately reflect conditions beyond which an imbalance of flora and fauna may occur.

The TBEP and the Tampa Bay Nitrogen Management Consortium (TBNMC) recommended to the U.S. Environmental Protection Agency (EPA) numeric nutrient criteria as segment-specific annual total nitrogen and total phosphorus loads. The recommended nutrient loads were accepted, but EPA also requested that numeric nutrient criteria for Tampa Bay be developed as TN and TP concentrations. In response to this request the TBEP subsequently recommended numeric nutrient and chlorophyll-a concentration criteria for the seven bay segments (Janicki Environmental Inc. 2011a, 2011b, 2011c).

The TBEP initially developed relationships between depth of seagrass growth, water column light attenuation, and chlorophyll-a concentrations (Janicki and Wade 1996). These relationships formed the technical basis for the seagrass recovery paradigm shown in Figure 2 above. In addition, these relationships were used to develop chlorophyll-a and light attenuation coefficient (K_D) targets and thresholds.

Using these relationships, as well as a reference period approach, target chlorophyll-a concentrations were developed for each bay segment. Although statistically significant relationships between chlorophyll-a and light attenuation were observed in the data, these relationships left a considerable amount of variability unexplained. Therefore, a reference period approach was used to develop initial chlorophyll-a targets (Janicki and Wade 1996; Janicki Environmental Inc. 2011b, 2011c). Appropriate reference periods were selected for each bay segment—contiguous years during which water clarity was stable or improving and seagrasses were expanding. Mean annual chlorophyll-a concentrations during the applicable reference periods for each segment were adopted as targets.

With respect to water clarity, the TBEP developed light attenuation targets, but never converted those values to SD targets. The measurement of K_D values in the field requires specialized instrumentation, and for this reason light attenuation is not routinely monitored.

The TBEP developed clarity targets based on the minimum light requirement of the seagrass *Thalassia testudinum* (Janicki and Wade 1996). Light availability may be expressed as a light attenuation coefficient (K_D), which is an estimate of light reduction with depth. K_D is calculated using either Secchi disk depth (SD) or photosynthetically active radiation (PAR) measurements. Conversely, if K_D is known, one can calculate the corresponding Secchi disk depth. Since SD depth is easier to measure and understand, this Technical Memorandum converts K_D targets for the major bay segments to SD values. These SD values are then compared with the screened IWR Run 61 dataset compiled for the Tampa Bay segments.

Janicki and Wade (1996) proposed K_D targets for the minor bay segments of Boca Ciega Bay, Little Manatee River, and Terra Ceia Bay but these targets were never adopted by the TBEP because of lack of adequate data at that time. To date, a significant amount of data has been collected in these minor bay segments over the years and revisiting these proposed targets has been identified as a research need. For this Technical Memo, we use these proposed K_D targets (converted to SD) for descriptive purposes only.

Table 1 shows the water quality targets used to assess water quality conditions in each bay segment. The appropriate target values are shown on the box and whisker plots provided in the bay segment data analyses that follow. It should be noted that the term "exceedance" indicates measured values that are greater than the target value. With respect to TN, TP, and Chl-a targets an exceedance indicates undesirable conditions, as higher concentrations of these parameters are associated with increased eutrophication. However, with respect to SD, an exceedance indicates measured values less than the target value (reduced water clarity).

Table 1
Tampa Bay Segment-Specific Water Quality Targets

Bay Segment	TN (mg/l)	TP (mg/l)	Chl-a (ug/l)	SD (m)
Old Tampa Bay	0.93	0.31	8.5	1.79
Hillsborough Bay	1.01	0.45	13.2	1.02
Middle Tampa Bay	0.87	0.29	7.4	1.79
Lower Tampa Bay	0.74	0.10	4.6	2.92
North Boca Ciega Bay	0.57	0.11	7.7	NC
South Boca Ciega Bay	0.54	0.12	6.2	NC
Terra Ceia Bay	0.69	0.20	7.5	NC
Manatee River	0.65	0.20	7.3	NC

Note: NC = no criteria

Water Quality Summaries by Bay Segment

In the following subsections data summaries are presented for the parameters of concern in each of the seven bay segments, as well as a brief discussion of any notable conditions or issues of concern in each segment. Any obvious temporal trends that are discernible in the plots are noted in the discussions; however, the results of statistical trend analysis are presented in Table 2 below.

Old Tampa Bay

Figure 4 provides a panel of box and whisker plots for the parameters of interest in Old Tampa Bay for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in Old Tampa Bay have remained fairly consistent since the mid-2000's, typically well below the target value of 0.93 mg/l. Since 2017, TN concentrations have declined slightly, but have become more variable, possibly indicating pulsed events. Median TP concentrations in Old Tampa Bay have remained well below the target value of 0.31 mg/l and have declined since 2015.

Median Chl-a concentrations in Old Tampa Bay have remained below the target value of 8.5 ug/l throughout the study period; however, mean Chl-a concentrations exceeded the target value in 14 of the 22 years. The target value was also exceeded every year on a seasonal basis, with only three years during which the 75th percentile did not exceed the target. Median SD depths in Old Tampa Bay have been greater than the translated target value of 1.79 meters in every year in the study period of record, indicating consistently good water clarity throughout this period.

It should be noted that the upper reaches of Old Tampa Bay present a unique set of environmental conditions that are conducive to summer blooms of the dinoflagellate *Pyrodinium bahamense*. Old Tampa Bay is characterized by restricted tidal circulation and flushing due to flow constrictions caused by causeways and shoals, resulting in longer water mass residence times. Unlike Hillsborough Bay, which receives inputs from two major rivers, Old Tampa Bay is fed by several small, nutrient-rich and tannic creeks and drainage/discharge canals (e.g., Lake Tarpon outfall canal; Channel A). The combination of long residence times and rainfall induced pulses of nutrients from local inflows may provide the ideal environment for large and persistent nuisance phytoplankton blooms. The disproportionate seagrass declines in Old Tampa Bay since 2018 are likely related to these conditions.

Hillsborough Bay

Figure 5 provides a panel of box and whisker plots for the parameters of interest in Hillsborough Bay for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in Hillsborough Bay have remained below the target value of 1.01 mg/l throughout the study period; however, the target was also exceeded every year on a seasonal basis. Since 2015, TN concentrations have been declining. Median TP concentrations in Hillsborough Bay have remained well below the target value of 0.45 mg/l and have also been declining since 2015.

Median Chl-a concentrations in Hillsborough Bay have remained below the target value of 13.2 ug/l throughout the study period; however, the target value was also exceeded every year on a seasonal basis, with only three years during which the 75th percentile did not exceed the target. Median SD depths for all years during the period of record were at or slightly greater than the 1.02 meters translated target value throughout the study period. There are no obvious trends in either Chl-a concentrations or SD depths in Hillsborough Bay.

Hillsborough Bay receives tannin-rich freshwater discharges from the Hillsborough River and Alafia River, and experiences turbidity spikes associated with ship traffic in the Tampa Port shipping channel—both of which are factors that could periodically reduce water clarity. Like Old Tampa Bay, Hillsborough Bay experienced a substantial loss of seagrasses between 2018 and 2020. In terms of acres, Old Tampa Bay lost 4,040 acres of seagrasses compared to 627 acres in Hillsborough Bay; however, the percentage loss was greater in Hillsborough Bay (-43%) compared to OTB (-38%).

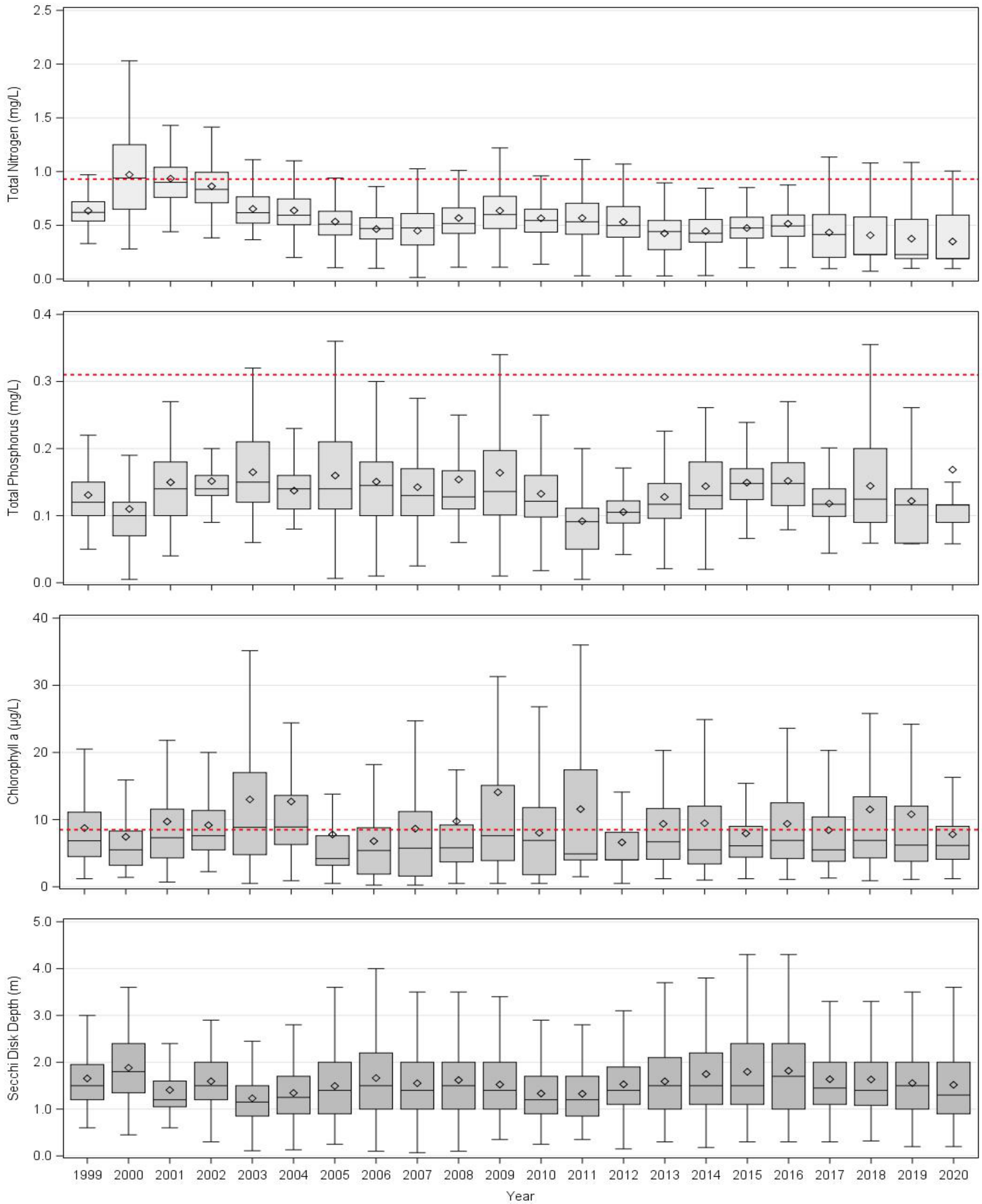

Figure 4
Old Tampa Bay Annual Water Quality 1999–2020

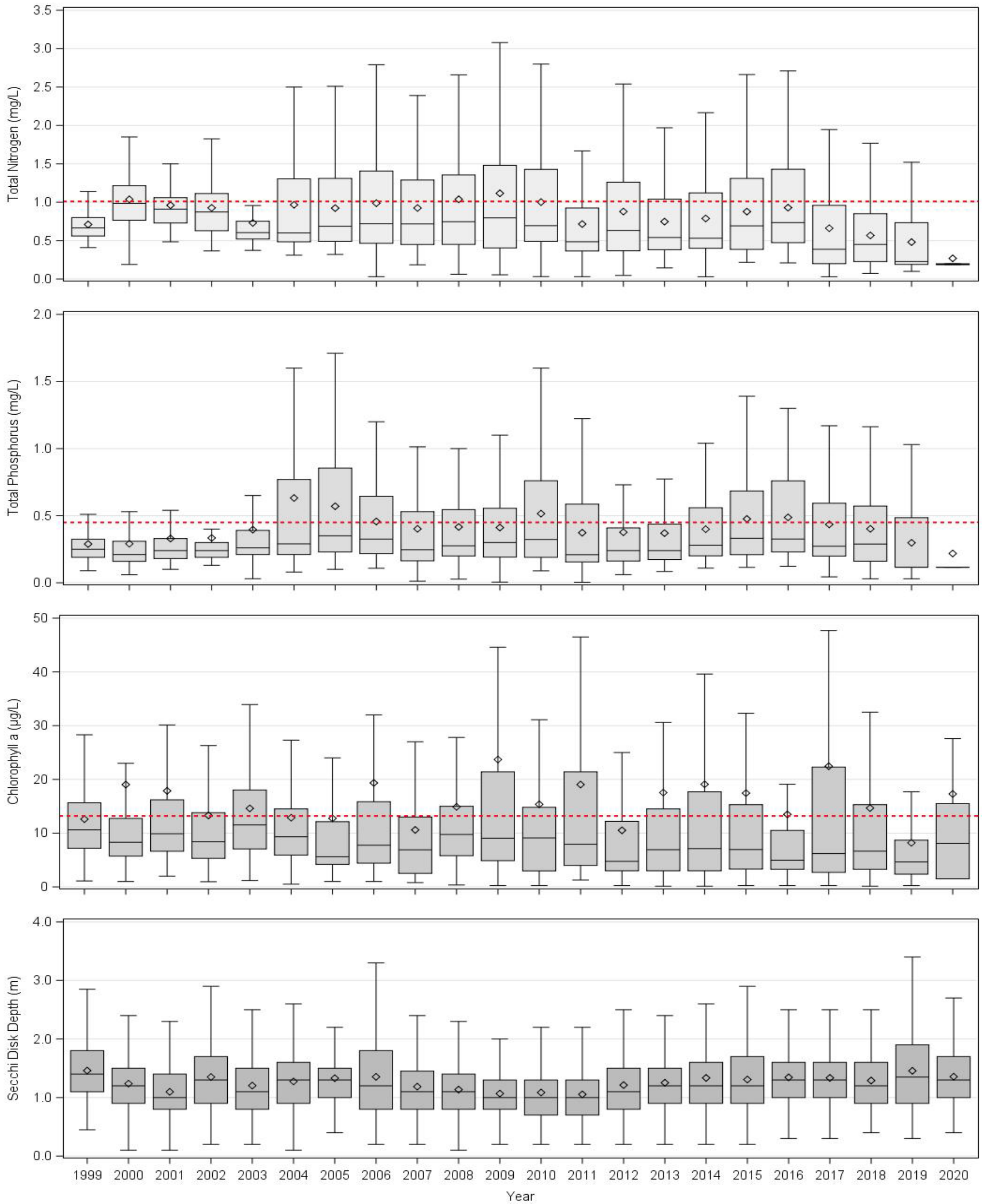

Figure 5
Hillsborough Bay Annual Water Quality, 1999–2020

Middle Tampa Bay

Figure 6 provides a panel of box and whisker plots for the parameters of interest in Middle Tampa Bay for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in Middle Tampa Bay have remained well below the target value of 0.87 mg/l since 2003, and values have declined since 2015. Median TP concentrations in Middle Tampa Bay have also remained well below the target value of 0.29 mg/l throughout the entire study period, and values have also declined since 2015.

Median Chl-a concentrations in Middle Tampa Bay have remained below the target value of 7.4 ug/l throughout the study period; however, the target value was exceeded by the 75th percentile in 10 of the 22 years. Median SD depths in Middle Tampa Bay did not meet the translated SD target of 1.79 meters from 2008 to 2012, but values before and after that period have been generally consistent with the target, indicating consistently favorable light conditions for seagrasses. There are no obvious trends in Chl-a concentrations or SD depths.

Middle Tampa Bay is one of two bay segments that occur within the main reach of Tampa Bay. Unencumbered by land barriers and causeways/bridges, tidal circulation and flushing in Middle Tampa Bay is efficient resulting in low water mass residence times and increased mixing with Gulf waters. As a result, excessive phytoplankton growth and nuisance algal blooms in Middle Tampa Bay are significantly less than in Old Tampa Bay and Hillsborough Bay. However, late rainy-season transport of the dinoflagellate *Pyrodinium bahamense* out of Old Tampa Bay sometimes affects chlorophyll-a conditions in Middle Tampa Bay. In addition, periodic *Lyngbya majusculata* and other filamentous algae blooms periodically occur especially along the eastern shore of Middle Tampa Bay.

Lower Tampa Bay

Figure 7 provides a panel of box and whisker plots for the parameters of interest Lower Tampa Bay for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in Lower Tampa Bay have remained well below the target value of 0.74 mg/l since 2003, and values have been declining since 2016. Median TP concentrations in Lower Tampa Bay have remained below the target value of 0.10 mg/l since 2004, but there has been no obvious trend since then.

Median Chl-a concentrations in Lower Tampa Bay have remained below the target value of 4.6 ug/l throughout the study period; however, the target value was exceeded by the 75th percentile in 9 of the 22-years. In addition, values have been increasing since 2016. Median SD depths in Lower Tampa Bay were generally below the translated SD target of 2.92 meters, and there is no obvious trend in SD depths.

Lower Tampa Bay is the other bay segment that occurs within the main reach of Tampa Bay. Like Middle Tampa Bay, it is unencumbered by land barriers and causeways/bridges, and tidal circulation and flushing is highly efficient resulting in low water mass residence times and even greater mixing with Gulf waters. Accordingly, excessive phytoplankton growth and nuisance algal blooms in Lower Tampa Bay are rare. However, the increasing trend in Chl-a concentrations since 2016 is notable. In addition, as with Middle Tampa Bay, periodic blooms of *Lyngbya majusculata* and other filamentous algae blooms occur especially along the eastern shore of Lower Tampa Bay; and drift macroalgae (*Ancanthophera, Gracillaria*, etc.) can be quite extensive and persistent in this bay segment.

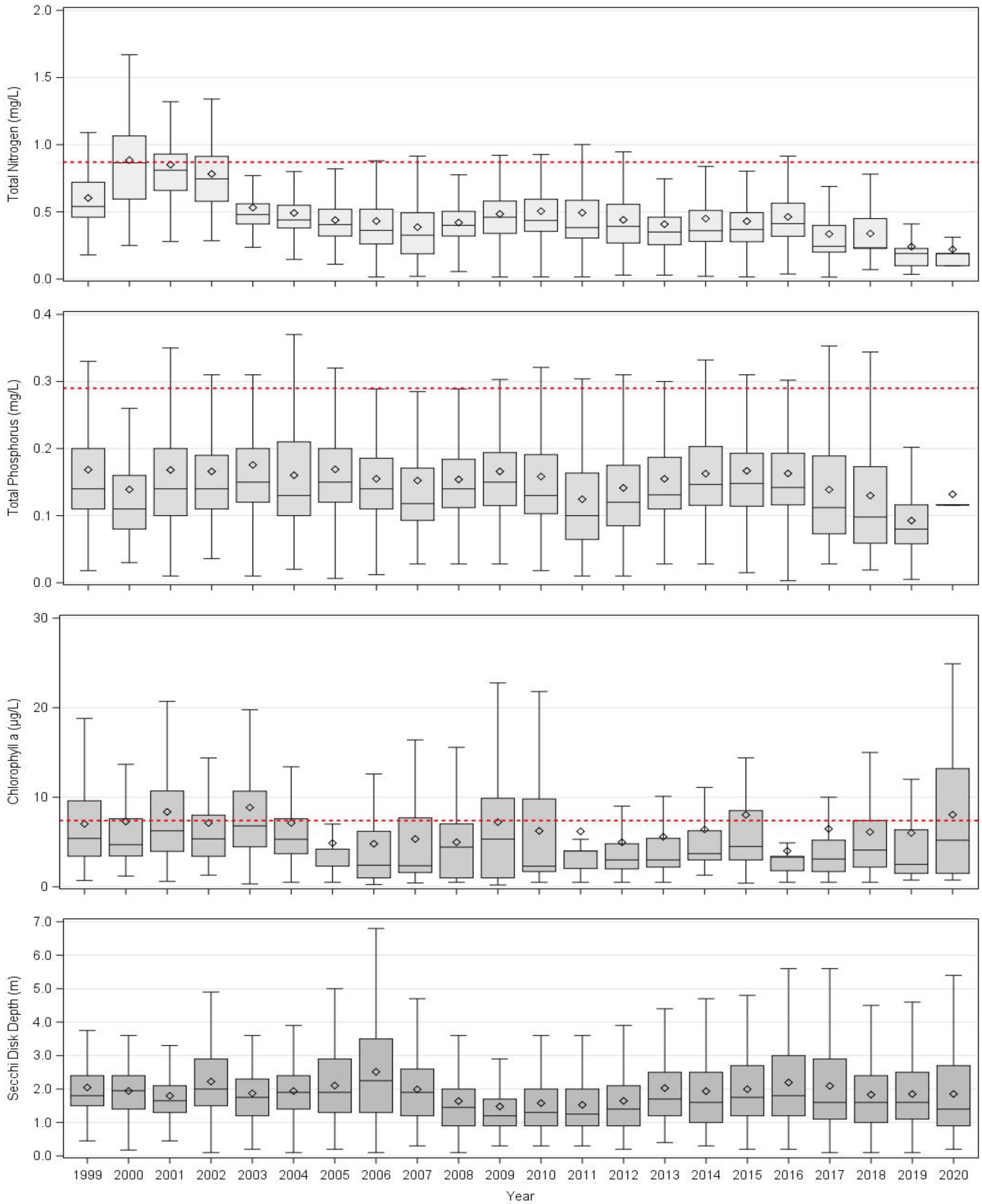

Figure 6
Middle Tampa Bay Annual Water Quality, 1999–2020

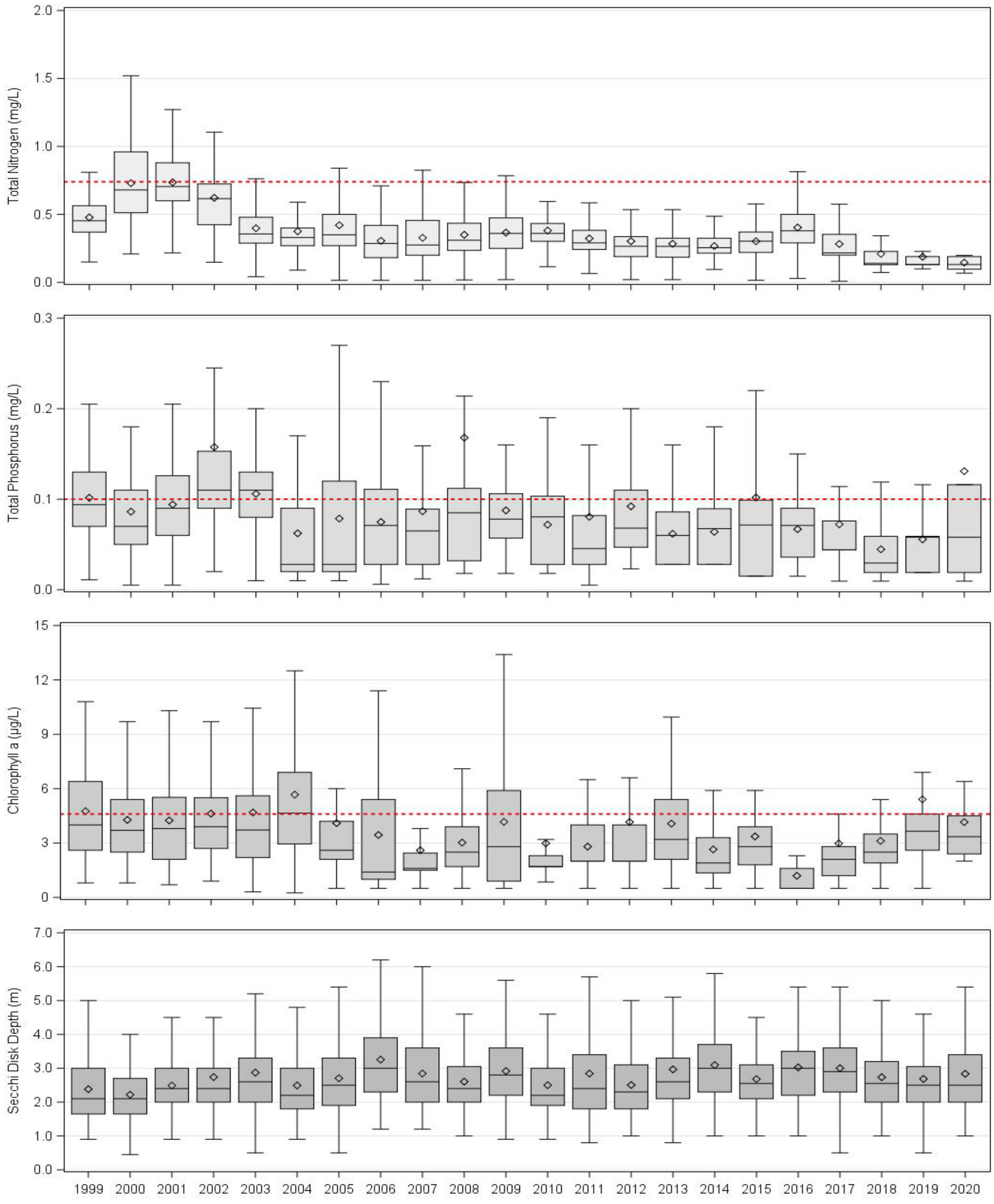

Figure 7
Lower Tampa Bay Annual Water Quality, 1999–2020

Boca Ciega Bay North

As noted above, the TBEP developed separate water quality criteria for the north and south lobes of Boca Ciega Bay, divided by the Treasure Island Causeway. **Figure 8** provides a panel of box and whisker plots for the parameters of interest in Boca Ciega Bay North for the 1999–2020 study period.

Median TN concentrations in Boca Ciega Bay North have exceeded the target value of 0.57 mg/l in 8 years of the 22-year study period, including every year since 2015. In addition, there is a clear increasing trend in TN concentrations since 2014. Median TP concentrations were well below the target value of 0.11 mg/l in all years of the period of record, and there are no obvious trends in TP concentrations over the study period.

Median Chl-a concentrations in Boca Ciega Bay North have remained close to the target value of 7.7 ug/l throughout the study period; and there is a slight decreasing trend since 2017. Median SD depths in Boca Ciega Bay North were below 1.0 meter in 20 years of the 22-years in the study period, indicating generally poor water clarity. There are no obvious trends in SD depths.

Boca Ciega Bay South

Figure 9 provides a panel of box and whisker plots for the parameters of interest in Boca Ciega Bay South for the 1999–2020 study period.

Median TN concentrations in Boca Ciega Bay South remained below the target values of 0.54 mg/l until 2017, and values have exceeded the target since then. In addition, there is a clear increasing trend in TN concentrations since 2014. Median TP concentrations were well below the target value of 0.12 mg/l in all years of the period of record, and there are no obvious trends in TP concentrations over the study period.

Median Chl-a concentrations in Boca Ciega Bay South remained well below the target value of 6.2 ug/l throughout the study period, except for 2017–2018 when values were elevated; and there is no obvious trend in Chl-a concentrations. Median SD depths in Boca Ciega Bay South ranged between 1.0 meter and 1.5 meters throughout the study period of record, indicating consistently favorable light conditions for seagrasses. There are no obvious trends in SD depths.

More characteristic of a coastal lagoon, the physiography of Boca Ciega Bay is substantially different than the other bay segments. Freshwater inflows are limited to small creeks and urban drainage ditches/canals. Tidal circulation and flushing occur via water exchange with the Gulf of Mexico through coastal passes, and water quality in areas closest to the passes is generally better than in the more isolated reaches. The clear increasing trend in TN concentrations in both Boca Ciega North and South since 2015 is notable; however, no corresponding trends in Chl-a or SD are evident.

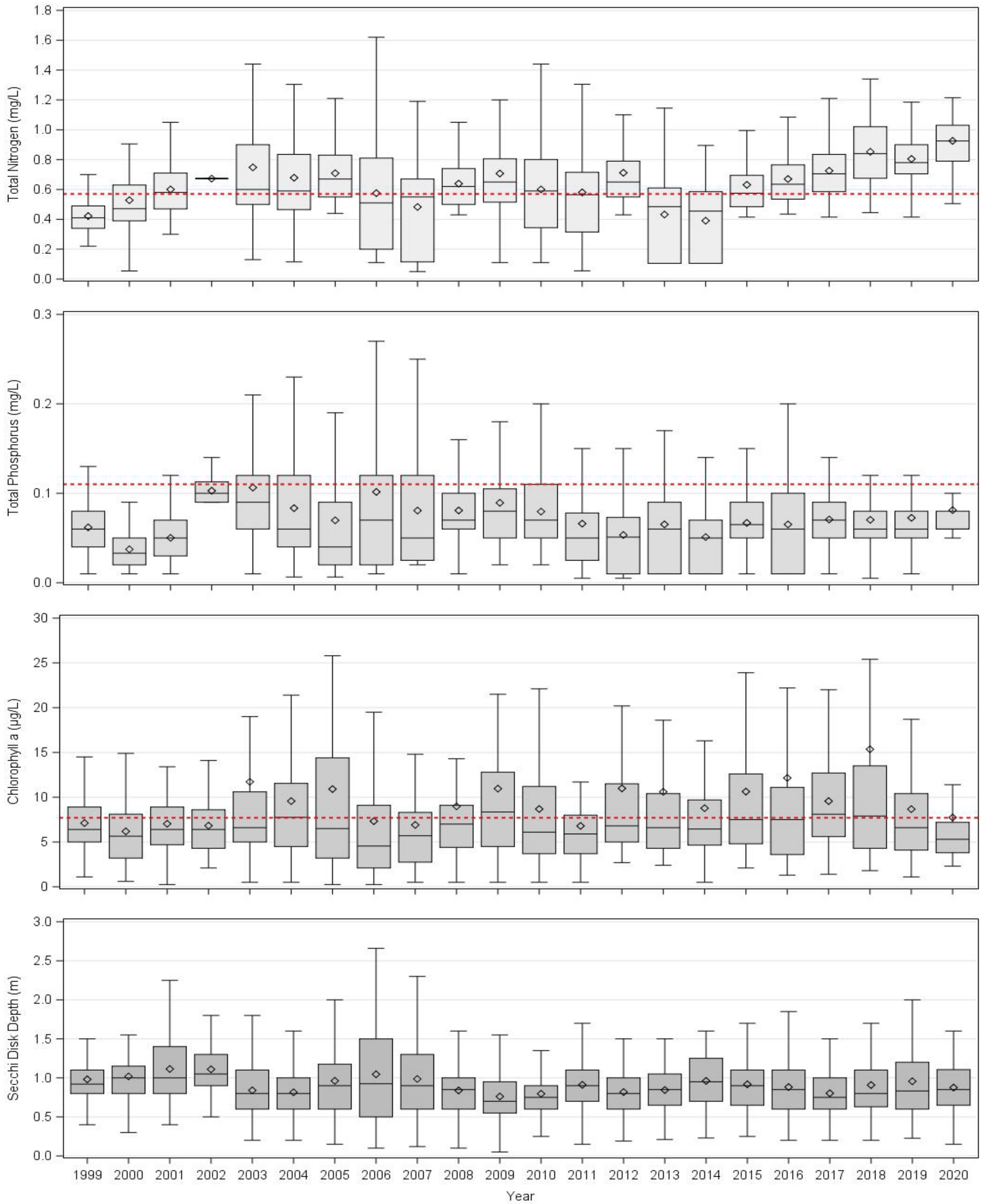

Figure 8
Boca Ciega Bay North Annual Water Quality, 1999–2020

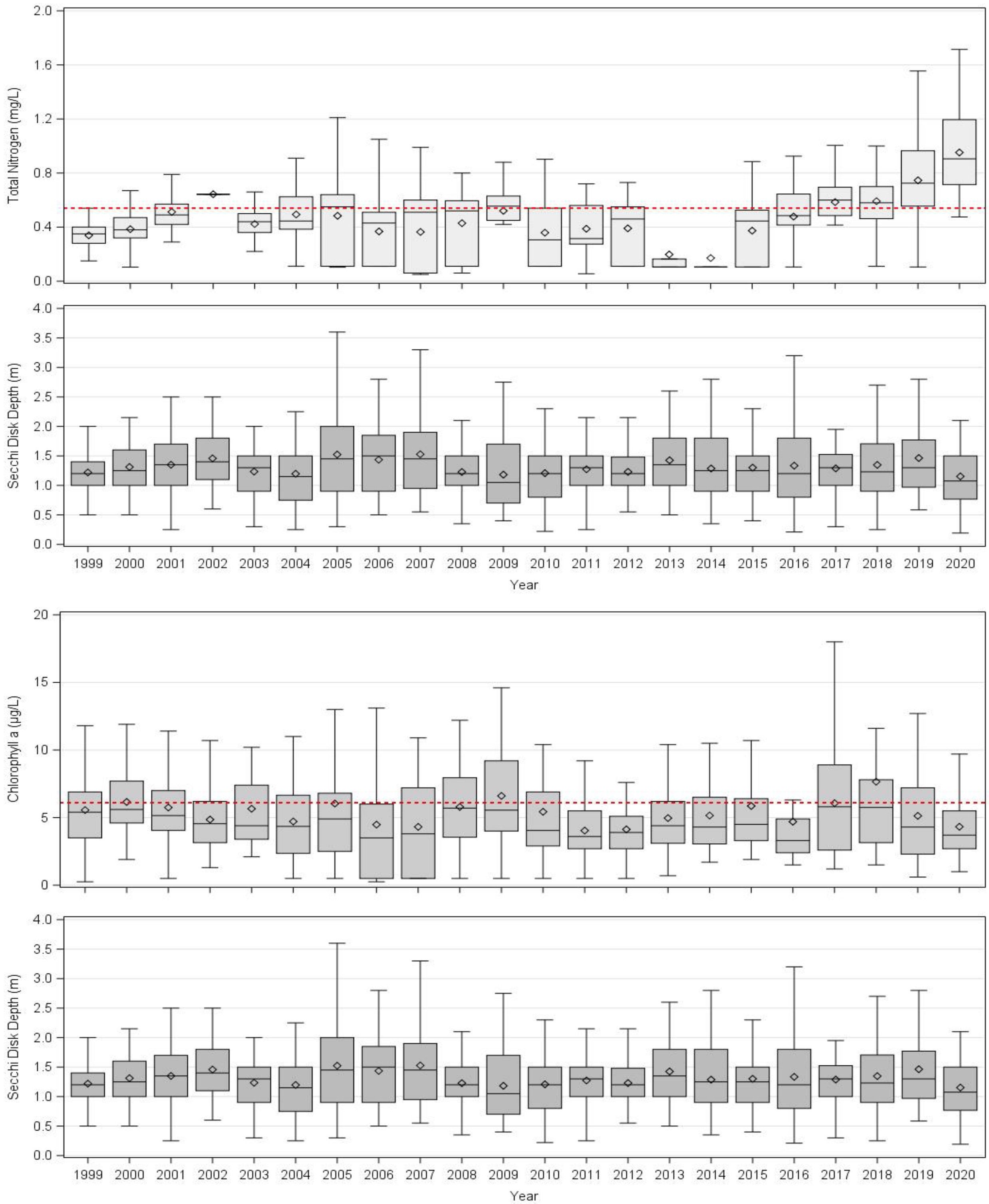

Figure 9
Boca Ciega Bay South Annual Water Quality, 1999–2020

Terra Ceia Bay

Figure 10 provides a panel of box and whisker plots for the parameters of interest in Terra Ceia Bay for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in Terra Ceia Bay have remained below the target value of 0.69 mg/l since 2004; declining from 2012 to 2014, and then remaining steady since then. Median TP concentrations were below the target value of 0.20 mg/l in all years of the period of record, and there are no obvious trends in TP concentrations over the study period.

Median Chl-a concentrations in Terra Ceia Bay have remained below the target value of 8.7 ug/l since 2004; and there has been no obvious trend since then. Median SD depths in Terra Ceia Bay were well above 1.0 meter throughout the 1999–2020 study period, indicating consistently favorable light conditions for seagrasses. There are no obvious trends in SD depths.

Terra Ceia Bay is a small embayment where tidal circulation and flushing occurs through direct exchange with Lower Tampa Bay. The upper portion of Terra Ceia Bay is partially constricted by the US-19 causeway/bridge. Localized freshwater and nutrient inputs are derived from small tidal creeks as well as urban and agricultural drainage ditches.

Manatee River

Figure 11 provides a panel of box and whisker plots for the four parameters of concern in Manatee River for the 1999–2020 study period. The dotted red line shows the target value applicable to each parameter.

Median TN concentrations in the Manatee River exceeded the target value of 0.65 mg/l in 16 years of the 22-year study period. Median TN concentrations declined in 2017 and have remained below the target value since then, with a slight decreasing trend. Median TP concentrations in the Manatee River exceeded the target value of 0.20 mg/l in 17 years of the 22-year study period, but there is slight decreasing trend since 2017.

Median Chl-a concentrations in the Manatee River have remained below the target value of 8.8 ug/l, and there has been no obvious trend, throughout the 22-year study period. Median SD depths in the Manatee River were well above 1.0 meter until 2014. Since then, median SD values have remained at or below 1.0 meter since, indicating unfavorable conditions for seagrass growth. There are no obvious trends in SD depths.

The physiography of the Manatee River is different from the other bay segments in that it is a tidal river estuary. Freshwater inflows and nutrient inputs come primarily from discharges out of the impounded Manatee River and Braden River reservoirs, as well as urban drainage ditches. Tidal circulation and flushing occur through direct exchange with Lower Tampa Bay.

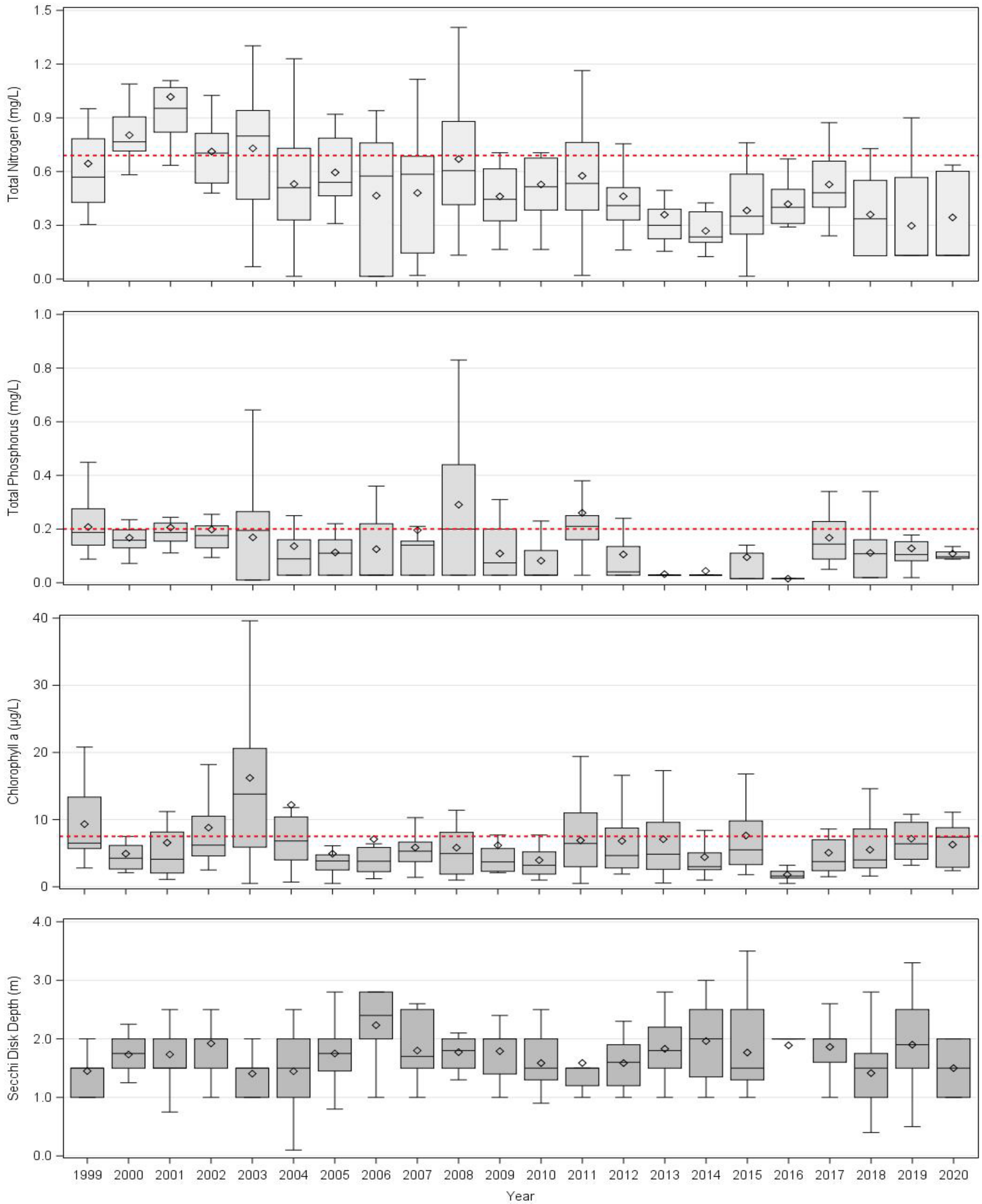

Figure 10
Terra Ceia Bay Annual Water Quality, 1999–2020

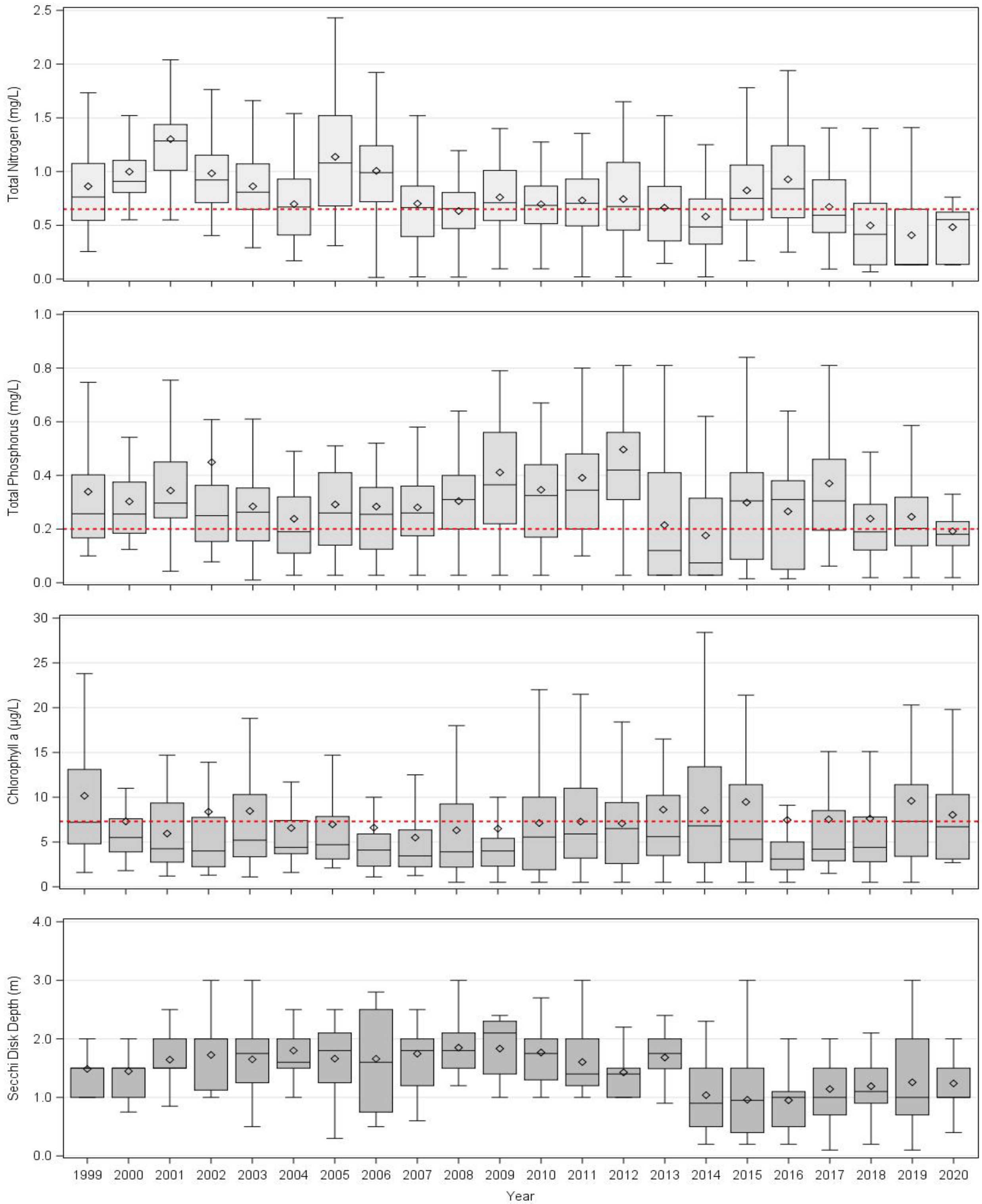

Figure 11
Manatee River Water Quality Conditions

Bay Segment Comparisons by Parameter

To facilitate a visual comparison of water quality conditions by bay segment, **Appendix 1** to this Technical Memorandum presents box and whisker plots for the parameters of interest for each of the bay segments on a single panel.

Water Quality Trends

Obvious trends in the various parameters, as visually observed in times series plots, were discussed in the bay segment summaries presented above. To assess any statistically significant trends in the data, seasonal Kendall trend tests were run for two time periods: the full 1999–2020 study period; and the most recent 6-year block of 2015–2020. **Table 2** presents the results of this analysis.

Statistically significant trends were identified if the p-value was less than or equal to 0.05 and are indicated by an up (↑) or down (↓) arrow. Up arrows indicate a statistically significant inclining trend, while down arrows indicate a statistically significant declining trend, in the measured parameter values. For TN, TP, and Chl-a, a declining trend indicates improving water quality conditions; whereas for SD a declining trend indicates worsening water quality conditions. Adverse trends are denoted by red arrows. Cells with shading indicate occurrences where the 1999–2020 trend was different than the 2015–2020 trend.

Table 2
Water Quality Trend Analysis for 1999–2020 and 2015–2020 Periods

Bay Segment	TN		TP		Chl-a		SD	
	1999–2020	2015–2020	1999–2020	2015–2020	1999–2020	2015–2020	1999–2020	2015–2020
Old Tampa Bay	↓	↓	↓	↓	↓	—	—	↓
Hillsborough Bay	↓	↓	↓	↓	↓	—	—	—
Middle Tampa Bay	↓	↓	↓	↓	↓	↓	↓	↓
Lower Tampa Bay	↓	↓	↓	—	↓	↓	↑	—
Boca Ciega Bay North	—	↑	—	—	—	—	↓	—
Boca Ciega Bay South	↓	↑	↓	—	↓	↓	↓	↓
Terra Ceia Bay	↓	↓	↓	—	↓	—	↓	↓
Manatee River	↓	↓	↓	↓	↓	↑	↓	↑

The results of the trend analysis indicate that Boca Ciega Bay (North and South) had a significant inclining trend in TN concentration during the period 2015–2020, as well as a significant declining trend in water clarity (SD) over the 1999–2020 period. In addition, both Middle Tampa Bay and Terra Ceia Bay had significant declining trends in SD during both the 1999–2020 and 2015–2020 periods; and Old Tampa Bay showed a significant declining trend in SD during the 2015–2020 period.

Nitrogen Loadings

As part of the Tampa Bay Reasonable Assurance Plan development, the TBNMC investigated the relationships between TN loads and chlorophyll-a to better understand how the bay responds to varying nitrogen loads. Non-anthropogenic factors can significantly influence the relationship between chlorophyll-a and TN loadings. The most significant factor is rainfall and its role in determining estuarine residence time, which in turn has been shown to influence this relationship in many lakes and other estuaries.

As residence time shortens, and loadings move more quickly out of the estuary, biological processes have less time to convert nutrients to phytoplankton production (chlorophyll). As residence time lengthens, loadings remain within the system longer, and thus more nutrients can be converted to chlorophyll. Given the same nutrient loads, different residence times within the system can result in very different expressions in water quality constituents. Given this paradigm, that both TN loads and hydrologic loads affect the chlorophyll a within the systems, the annual hydrologic loads to each of the segments must be considered along with the annual TN loads to establish loading thresholds for each segment.

Using this paradigm TN numeric nutrient criteria were developed for each of the four main bay segments, but not for the three minor segments. These criteria were expressed as annual TN loads normalized to hydrologic loads (e.g., tons TN/million cubic meters of inflows), referred to as "nitrogen delivery ratios" (Janicki Environmental Inc. 2011b). **Table 3** shows the adopted annual TN loading criteria for each of the four main bay segments.

Table 3
Adopted Tampa Bay Annual TN Loading Targets

Bay Segment	Nitrogen Delivery Ratio (tons TN/million m^3 inflow)
Old Tampa Bay	1.08
Hillsborough Bay	1.62
Middle Tampa Bay	1.24
Lower Tampa Bay	0.97

Figure 12 shows estimated TN loadings for each of the four main bay segments, plus all segments combined (minus Boca Ciega Bay North), expressed as nitrogen delivery ratios for the period 1985–2020 (TBEP 2021). On each plot the respective annual TN loading target for each segment is shown as a threshold. It should be noted that Boca Ciega Bay South, Terra Ceia Bay and the Manatee River segments are included in the Lower Tampa Bay remainder category.

From these plots it is clear that TN loads in all four main bay segments have remained below their respective target loads, and that there has been a slight decreasing trend in loads (except for the remainder of Lower Tampa Bay), since the mid-2000s. These load reductions are commensurate with the observed decreasing trends in TN concentrations in the four main bay segments during the past decade.

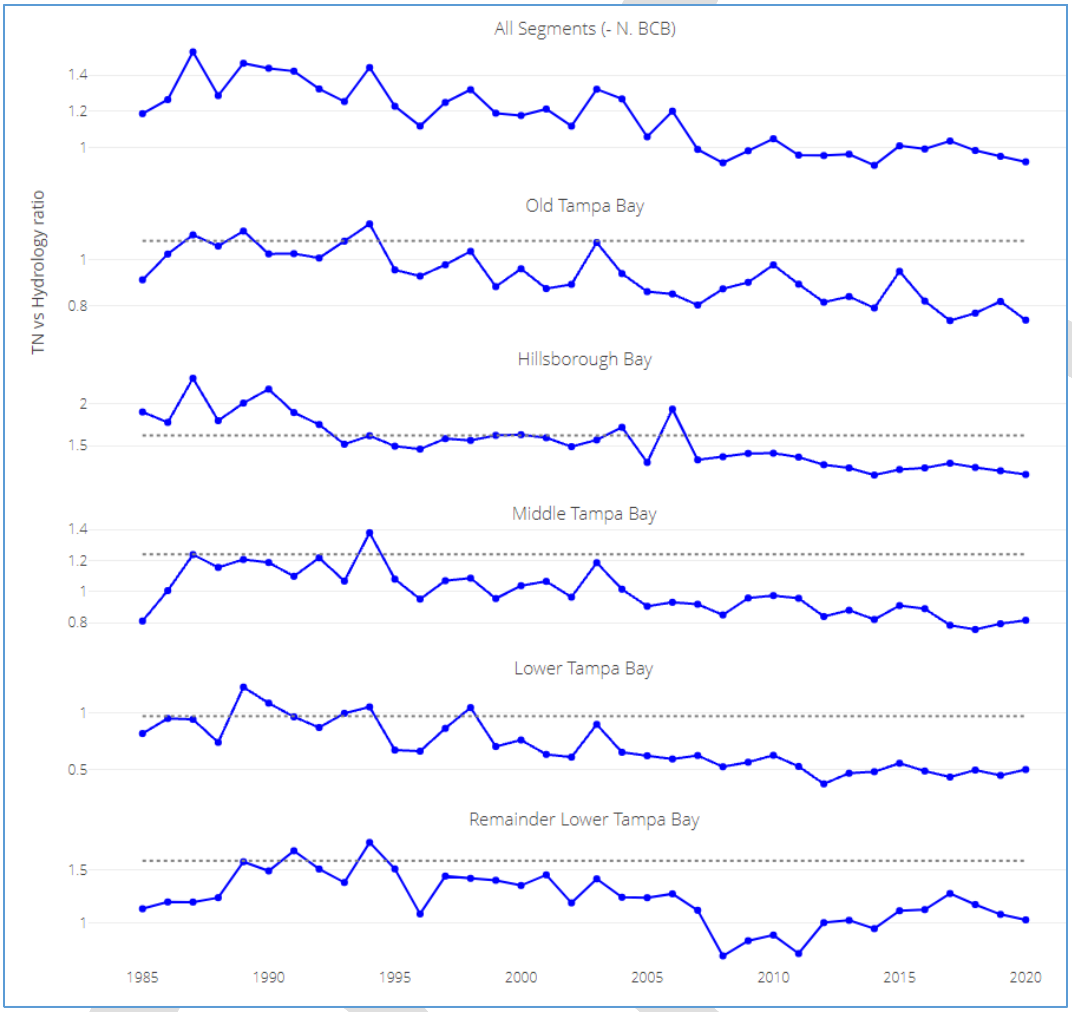

Figure 12
Estimated Nitrogen Delivery Ratios by Bay Segment for the Period 1985–2020

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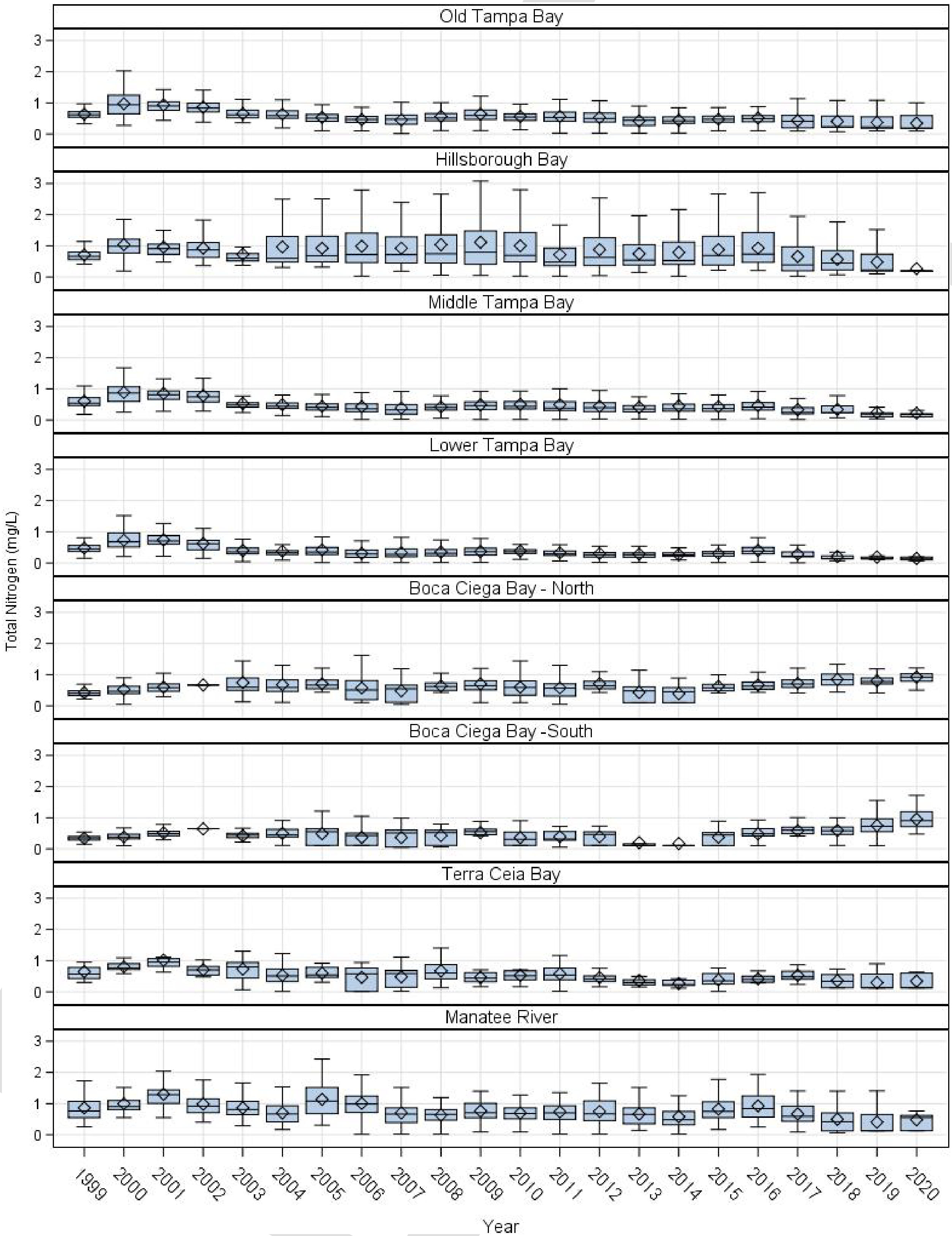
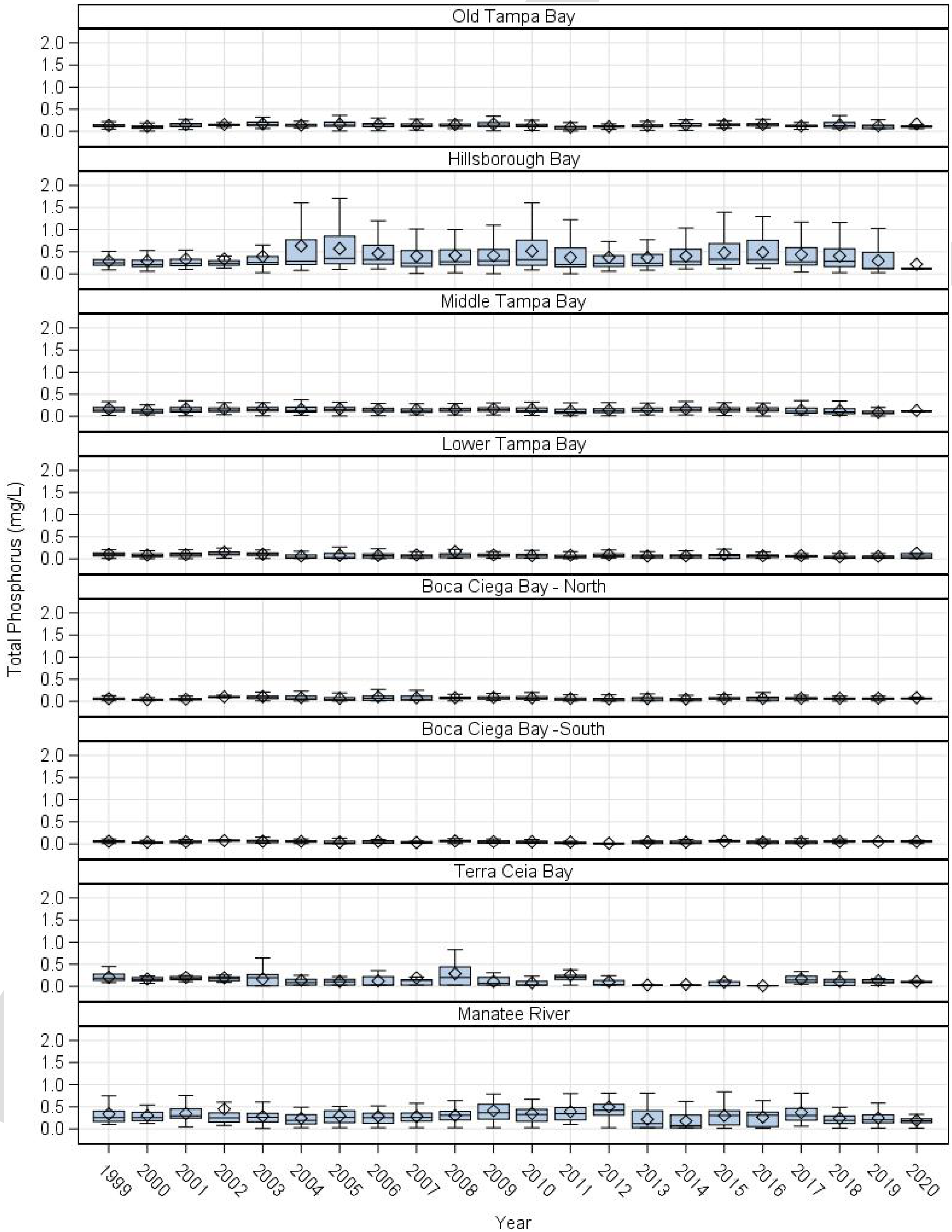
Appendix 1

Bay Segment Comparison of Parameters of Interest

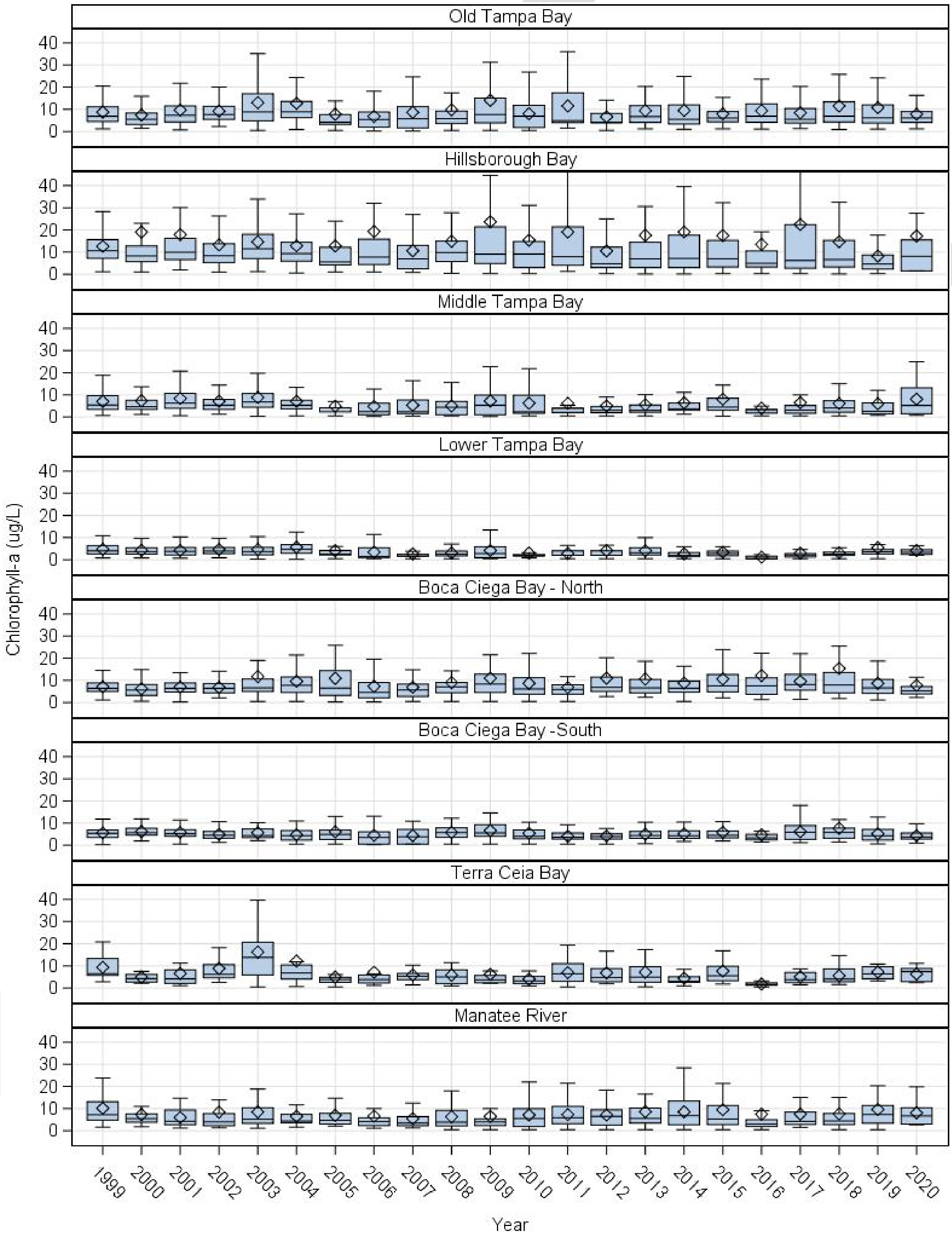
Total Nitrogen



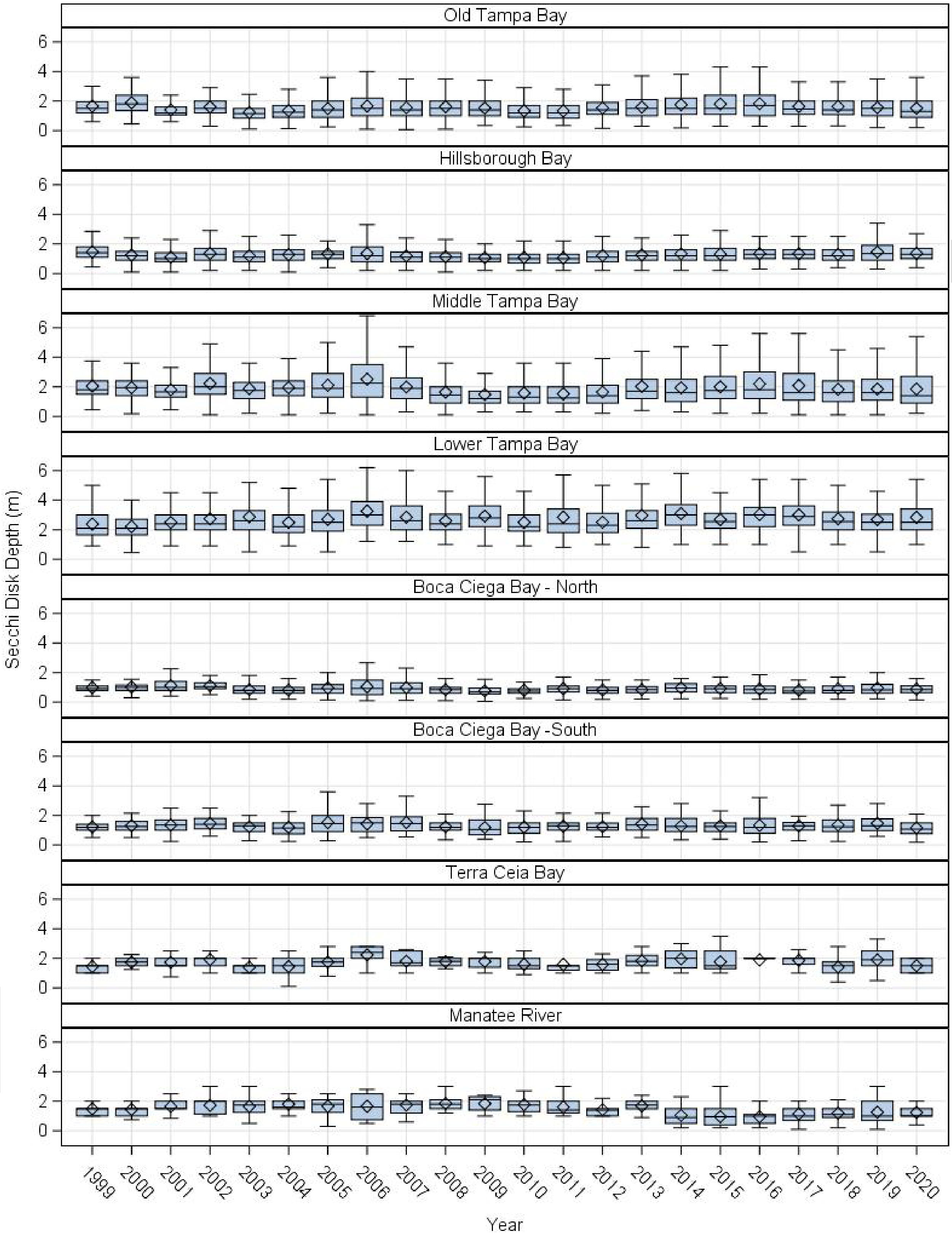
Total Phosphorus



Chlorophyll-a



Secchi Disk Depth



Technical Memorandum

date	December 16, 2021
to	Lizanne Garcia, SWIM Section, Southwest Florida Water Management District
cc	Chris Anastasiou, Ph.D., SWIM Section, Southwest Florida Water Management District
from	Doug Robison, ESA Emily Keenan, ESA
subject	Tampa Bay SWIM Plan Update – Task 4.5 Technical Memorandum: Summary of Habitat Status and Trends

Introduction

This Technical Memorandum provides a summary of the status and trends of habitats in Tampa Bay and its watershed, as specified in Task 4.5 of Task Work Assignment No. 19TW0002731 between the District and ESA. It is anticipated that the material presented below will be included in a chapter in Tampa Bay SWIM Plan Update. This Technical Memorandum is being provided herein as a draft for review and comment by the Tampa Bay SWIM Plan technical stakeholders.

Summary of Habitat Status and Trends

Habitats of Interest

The Southwest Florida Water Management District (District) promotes the "watershed approach" to address a wide range of water and environmental resource issues. The basic tenet of the watershed approach is that all water that falls within the boundaries of the watershed is interconnected and expressed through the continuum of natural plant communities that extend from the headwaters to the estuary. Native upland habitats in the Tampa Bay watershed constitute important aquifer recharge areas converting rainfall to groundwater, or to surface water runoff that flows into and through freshwater wetlands and streams. These freshwater habitats transition into tidal rivers and tributaries, which in turn flow through emergent tidal wetlands to the bay and its subtidal habitats. This SWIM Plan update acknowledges this interconnectedness and addresses the full mosaic of all natural habitats in the Tampa Bay watershed.

The major types of habitats in the Tampa Bay watershed can be described and organized pursuant to their relationship to tidal influence. Subtidal habitats include those that are submerged all or most of the time. Intertidal habitats include those that are submerged during high tides but exposed during low tides, and supratidal habitats include those that occur above the high tide line. In addition to natural habitats, constructed habitats—including living shorelines and artificial reefs—now constitute important components of the mosaic of Tampa Bay habitats. Moving from the open bay to the headwaters and uplands of the Tampa Bay watershed, the habitats of interest are classified as follows:

- **Subtidal Habitats**
  - Hard bottom
  - Seagrasses

- Tidal flats
- Oyster bars
- Artificial reefs

- **Intertidal Habitats**
  - Mangrove forests
  - Salt marshes
  - Salt barrens
  - Tidal tributaries
  - Living shorelines
- **Supratidal Habitats**
  - Freshwater wetlands (including spring runs)
  - Native forested uplands
  - Coastal uplands.

Data Sources

The status and historical trends of Tampa Bay habitats of interest were updated as part of the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020) published by Tampa Bay Estuary Program (TBEP) and co-funded by the District. For the majority of subtidal, intertidal and supratidal habitats addressed in that document, primary data derived from two routine spatial assessment programs conducted by the District were utilized.

The data source used to estimate the most recent areal coverage of the three subtidal habitats in Tampa Bay—seagrasses, tidal flats, and oysters—was the "Seagrass in 2020" geodatabase published by the District (SWFWMD 2020). These data are available through the District's Open Data Portal (https://data-swfwmd.opendata.arcgis.com). Since the completion of the *Tampa Bay 2020 Habitat Master Plan Update* the District released the results of the 2020 seagrass and subtidal habitat mapping effort, and those results are included herein. This database classifies subtidal habitat types, photo-interpreted from aerial photography, collected between November 1, 2019, and February 28, 2020.

The District maps subtidal habitats in Tampa Bay on a two-year cycle using aerial imagery specifically collected for the purpose of mapping seagrasses. Imagery is acquired via fixed-wing aircraft from November 1 through February 28 when atmospheric and water clarity conditions are optimal for aerial photography. The District began mapping seagrass habitat in 1988 and continues to do so on a two-year cycle. GIS maps are produced from the photointerpretation of aerial imagery collected specifically for the purpose of mapping seagrass. Both imagery and map products undergo rigorous quality control and field verification before being published. These maps and accompanying analyses are used by the District and it's many partners as a way to track overall estuarine health. These maps are also a valuable tool used to evaluate the effectiveness of ongoing water quality improvement projects and initiatives. It is important to note when using acreage estimates for habitats other than seagrasses, that the mapped extent only includes those areas shallow enough to support seagrasses. Therefore, when using these maps for other subtidal habitats like hard bottom and oyster bars, acreage estimates may be less than what was present at the time of acquisition.

The source data used to estimate and map the most current areal coverage of various land use and habitat cover types in the Tampa Bay watershed were the *District Land Use Land Cover 2017* (SWFWMD 2019) geodatabase, also published on the District website. This database classifies the land use and cover types, photo-interpreted from 2017 aerial photography pursuant to the Florida Land Use Cover and Forms Classification System, commonly known as FLUCCS (SWFWMD 2014). The land use/cover mapping program began in 1990 and is updated every 2 to 3 years. The results were used to track trends in intertidal and supratidal habitats including emergent tidal wetlands, freshwater wetlands, and native upland habitats.

Habitat Status

Table 1 summarizes the most recent estimates of the extent (e.g., acres or linear feet) of Tampa Bay habitats of interest. The data year is the year(s) from which the data were derived.

Table 1
Summary of Current Extent of Tampa Bay Habitats

Habitat Type	Current Extent	Data Year	Data Source(s)
Subtidal Habitats			
Hard Bottom	423 acres	2017–2019	Kaufman 2017; CSA Ocean Sciences 2019
Seagrasses	35,297 acres	2020	SWFWMD 2020
Tidal Flats	2,379 acres	2020	SWFWMD 2020
Oyster Bars	195 acres	2020	SWFWMD 2020
Artificial Reefs	166 acres	2019	EPCHC 2020; ESA 2020
Intertidal Habitats			
Mangrove Forests	15,300 acres	2017	SWFWMD 2017
Salt Marshes	4,557 acres	2017	SWFWMD 2017
Salt Barrens	496 acres	2017	SWFWMD 2017
Tidal Tributaries	387 miles	2019	Janicki Environmental/Mote Marine Lab 2016
Living Shorelines	11.3 miles	2020	ESA 2020; Tampa Baywatch 2020
Supratidal Habitats			
Forested Freshwater Wetlands	152,132 acres	2017	SWFWMD land use/cover mapping
Non-Forested Freshwater Wetlands	67,587 acres	2017	SWFWMD land use/cover mapping
Native Uplands (Non-Coastal)	140,600 acres	2017	SWFWMD land use/cover mapping
Coastal Uplands	3,619 acres	2017	ES, 2020

Habitat Trends

The term "trend" is used herein to qualitatively characterize changes in habitat extent and percentage over time and is not used in the context of statistical trend analysis and significance testing. Temporal trends in the Tampa Bay habitats of interest are discussed below.

Subtidal Habitats

Table 2 shows changes in the subtidal habitat acreage over time, as compiled from the District seagrass mapping program over the period 1988 to 2020. Key observations from this table include the following.

Table 2
Trends in Tampa Bay Subtidal Habitats

Habitat Descriptor	FLUCCS Codes	1988	1990	1992	1994	1996	1999	2001	2004	2006	2008	2010	2012	2014	2016	2018	2020	1988–2020 Change	
																		Acres	%
Seagrass Patchy	9113	8,726	9,203	9,664	11,810	13,473	11,208	8,190	10,975	10,021	9,200	11,434	12,629	16,367	17,152	17,349	13,005	4,279	49%
Seagrass Continuous	9116	14,562	16,027	16,094	14,719	13,465	14,639	17,891	16,053	18,279	20,446	21,464	22,014	23,928	24,504	23,304	21,292	6,730	46%
Seagrass Total		***23,288***	***25,230***	***25,758***	***26,529***	***26,938***	***25,847***	***26,081***	***27,028***	***28,300***	***29,646***	***32,898***	***34,643***	***40,295***	***41,656***	***40,653***	***34,297***	***11,009***	***47%***
Tidal Flats	6510	27,388	25,617	26,098	25,465	25,927	32,695	31,238	36,153	36,285	33,292	28,786	25,601	17,560	2,346	2,146	2,379	-25,009	-91%
Submerged Other than Seagrass	7210	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11,767	14,131	16,157	4,390	37%
Non-vegetated Total		***27,388***	***25,617***	***26,098***	***25,465***	***25,927***	***32,695***	***31,238***	***36,153***	***36,285***	***33,292***	***28,786***	***25,601***	***17,560***	***14,113***	***16,277***	***18,536***	***-8,852***	***-32%***
Oyster Bars	6540	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	131	167	171	195	64	49%
Oysters Total		***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***ND***	***131***	***167***	***171***	***195***	***64***	***49%***

- **Seagrasses** – Baywide seagrass acres from 1982 through 2020 are shown in **Figure 1**. With the exception of 1982, acreages are estimated based on aerial imagery collected over the winter months from November 1 of the preceding year through February 28 of the year shown on the x-axis. Total baywide seagrass coverage increased by 11,009 acres (47%) during the 32-year period of record. This increase has been more or less linear through 2018 other than the period 1996–1999 where there was a 1,091 acre (4%) loss. In 2016, the total seagrass coverage reached 41,656 acres, the largest extent since the District monitoring program began. However, significant seagrass losses were documented in 2018, and again in 2020. Between 2016 and 2020, total seagrass coverage declined by 7,359 acres (18%). The 1996–1999 and 2016–2018 declines followed an El Niño event and a hurricane, respectively; and District rainfall data indicates that the average annual rainfall in the Tampa Bay region during the period 2015–2019 was several inches greater than the long-term annual average. These observations indicate that seagrasses are sensitive to excessive rainfall and acute storm events, and associated changes in salinity, nutrient loads, and turbidity. Seagrass declines since 2016 have been disproportionate across the bay segments, with Old Tampa Bay showing the greatest loss (>30%). Of note, much of the loss in Old Tampa Bay was replaced with attached algae (*Caulerpa proliferens*). Minor seagrass loss (<5%) in Boca Ciega Bay and Terra Ceia Bay were reported, while Hillsborough Bay, Middle Tampa Bay, Lower Tampa Bay, and the Manatee River remain essentially unchanged.

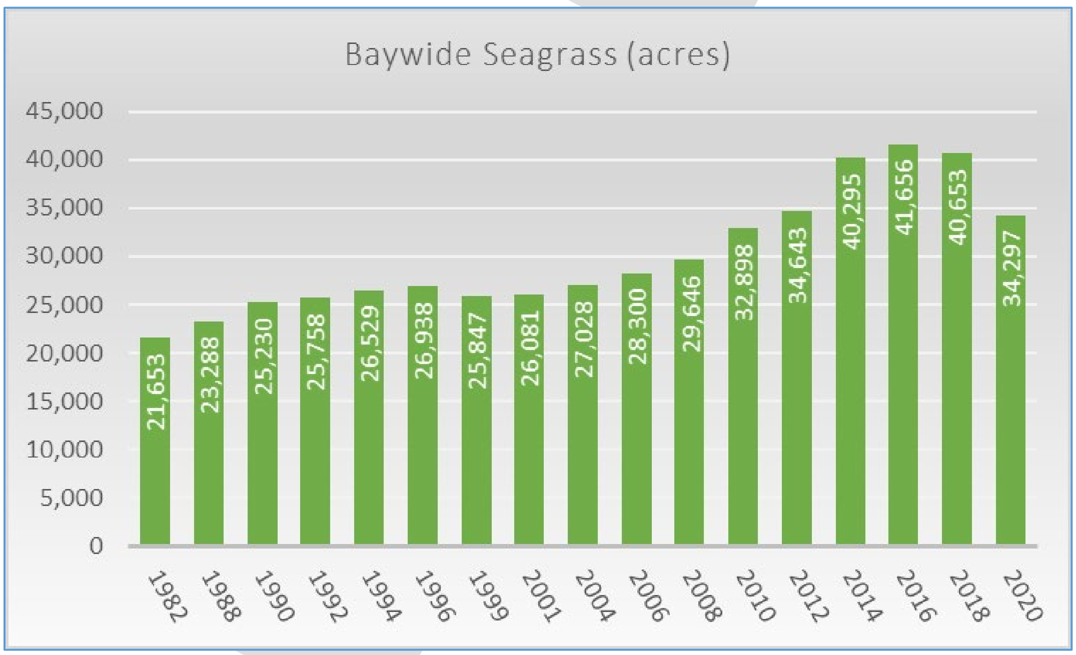


Figure 1
Tampa Bay Seagrass Trends, 1982–2020

- **Tidal Flats** – Assessing trends in the coverage of tidal flats is difficult because of changes in mapping methods used by the District over time. From 1988 through 2014, all non-vegetated subtidal areas were mapped as Tidal Flats (FLUCCS 6510). However, in 2016 the District began distinguishing Tidal Flats from Sand Other Than Beaches (FLUCCS 7210) and mapped them as separate habitat types. In 2020, another refinement was made to FLUCCS 7210 modifying the definition to Submerged Other Than Seagrass to account for large increases of drift macroalgae between 2018 and 2020 that are not by convention mapped as part of this effort. The Tidal Flats category (FLUCCS 6510) in its current definition includes flats that are periodically exposed during low tides and provide foraging habitat for wading birds. When data for both classifications are combined, the non-vegetated total has decreased by 8,852 acres (32%) during the 32-year period of record. It is surmised that much of this decline is associated with the expansion of seagrass on to previously non-vegetated bottom areas, thus representing a positive ecological trend.

- **Oyster Bars** – Oysters have been mapped by the District since 2014. Over the 2014–2020 period of record, the mapped coverage of Oyster Bars has increased by 40 acres (30%). This increase is likely not a significant trend, and probably represents improved image quality and photointerpretation of oyster bar signatures. The District seagrass maps provide a conservative estimate of oyster coverage and underestimates oyster clusters and shallow reefs along mangrove fringes.

Regarding hard bottom habitat there are no well-documented quantitative historical estimates to meaningfully compare with the current estimate of 423 acres, as derived from recent surveys (Kaufman 2017; CSA 2019). The extent of hard bottom is largely determined by underlying geology (e.g., rock outcrops). Port-related dredging and the installation of subaqueous pipelines have resulted in historic losses of hard bottom habitat (Savercool and Lewis 1994); however, these losses have not been quantified. In addition, hard bottom habitat may be temporarily impacted by storm events that can cover and uncover limestone outcrops with sediment. In the absence of new major dredging or pipeline projects, significant changes in the extent of hard bottom in Tampa Bay are not likely in the future.

The extent of artificial reefs is generally well-documented, as permits are required for the creation or expansion of these reefs. The current estimate of 166 acres is expected to increase somewhat over time as the horizontal boundaries and vertical profiles of existing reefs are expanded with the addition of new material placed in response to demands by recreational users.

Intertidal Habitats

Table 3 shows changes in intertidal habitat acreage over the period 1990–2017, as compiled and reported in the *2020 Tampa Bay Habitat Master Plan Update* (ESA 2020). Key observations from this table include the following.

- **Mangrove Forests** – Mangrove forest coverage has increased by 1,689 acres (12%) during the 27-year period of record. The largest increase occurred between the 1999 and 2004 mapping periods, and since then, mangrove coverage has been more or less stable.
- **Salt Marshes** – Salt marsh coverage has increased by 74 acres (2%) during the 27-year period of record. While this is a modest increase, it is probably overshadowed by the invasion of salt marshes by mangrove forests – a phenomenon that has not been captured and quantified in the District land use/cover mapping program. As noted above, it is estimated that 540 acres of salt marshes have been invaded by, and at least partially converted, to mangrove habitat (TBEP, unpublished data). This phenomenon has been observed throughout the Gulf of Mexico and has been attributed to both climate change (e.g., fewer freeze events) and sea level rise (Comeaux et al. 2012). Field data collected as part of the TBEP Critical Coastal Habitat Assessment (Price et al. 2017) indicated that mangrove invasion of salt marshes tends to first occur along tidal creek margins, followed by encroachment into larger contiguous *Juncus* marshes.
- **Salt Barrens** – Salt barren coverage has increased by 34 acres (7%) during the 27-year period of record. This modest increase can be explained by the landward expansion of salt barrens in response to sea level rise. An examination of historical aerial imagery conducted as part of this 2020 Habitat Master Plan update indicated that the extent of salt barrens has clearly expanded landward into undeveloped coastal uplands in areas where the land surface slope is very flat and there are no physical or hydrologic impediments to more frequent tidal inundation.
- **Emergent Tidal Wetlands** – As discussed above, the suite of emergent tidal wetlands includes mangrove forests, salt marshes, and salt barrens, which exist in a dynamic equilibrium controlled by factors such as storm surge and flood damage, periodic freezes, and sea level rise (Robison 2010). Over the 27-year period of record, the suite of emergent tidal wetlands experienced a net gain of 1,791 acres (10%). This overall gain is likely a reflection of (1) the effectiveness of state and federal wetland regulatory programs; (2) the cumulative gains resulting from publicly funded habitat restoration projects and regulatory mitigation; and (3) the aggregate effects of climate change and sea level rise.

Table 3
Trends in Tampa Bay Intertidal and Supratidal Habitats

Habitat Descriptor	FLUCCS Codes	1990	1995	1999	2004	2007	2011	2014	2017	1990–2017 Change	
										Acreage	Percent
Mangrove Swamps	6120	13,611	14,446	14,409	15,739	15,690	15,688	15,611	15,300	1,689	12%
Salt Marshes	6420	4,483	4,437	4,443	4,641	4,634	4,607	4,798	4,557	74	2%
Salt Barrens	6600	468	479	492	488	456	502	529	496	28	6%
Tidal Wetlands Total		***18,562***	***19,362***	***19,344***	***20,868***	***20,780***	***20,797***	***20,938***	***20,353***	***1,791***	***10%***
Stream & Waterways	5100	3,728	2,482	2,509	2,824	2,763	2,758	2,794	2,641	-1,086	-29%
Lakes	5200	13,242	13,491	13,986	13,502	13,296	12,631	13,011	13,212	-30	0%
Wetland Hardwood Forests	6100	101,548	101,486	99,666	104,972	103,788	103,688	105,585	103,147	1,599	2%
Wetland Coniferous Forests	6200	29,930	29,752	29,512	29,829	29,639	29,421	29,922	29,487	-443	-1%
Wetland Forested Mixed	6300	27,798	26,035	25,522	20,795	20,072	19,952	21,734	19,498	-8,300	-30%
Vegetated Non-Forested Wetlands	6400	54,404	51,413	51,102	58,395	65,043	68,837	68,906	67,587	13,183	24%
Freshwater Wetlands Total		***230,649***	***224,659***	***222,297***	***230,318***	***234,600***	***237,289***	***241,952***	***235,572***	***4,923***	***2%***
Dry Prairie	3100	2,393	807	699	463	627	688	7,729	628	-1,765	-74%
Shrub and Brushland	3200	85,993	83,645	71,460	56,031	54,839	53,153	45,998	48,340	-37,653	-44%
Mixed Rangeland	3300	3,304	2,872	2,588	7,077	7,318	7,219	9,191	6,758	3,454	105%
Upland Coniferous Forests	4100	70,664	50,904	46,230	37,466	33,293	33,105	36,773	31,776	-38,888	-55%
Upland Hardwood Forests	4200/4300	72,920	74,578	70,166	62,438	59,068	58,523	65,875	56,717	-16,203	-22%
Native Uplands Total		***235,274***	***212,806***	***191,144***	***163,476***	***155,145***	***152,689***	***165,565***	***144,219***	***-91,055***	***-39%***

For tidal tributaries, there are no quantitative historical estimates to meaningfully compare with the current estimate of 387 linear miles. Tidal tributaries are protected under state and federal wetland regulations, and the major alterations to tidal tributaries in the Tampa Bay watershed (e.g., impoundment, channelizing, hardening) mostly took place prior to these regulations being in place. Accordingly, the extent of tidal tributaries is not expected to change much over time. However, protecting the full suite of emergent tidal wetlands that occur within tidal tributaries is largely dependent on the continued delivery of adequate freshwater inflows to maintain salinity gradients along the tidally influenced reaches.

Similarly, there are no quantitative historical estimates of the extent of living shorelines to compare with the current estimate of 11.3 linear miles. In recent years, living shorelines have become a more common component of coastal resilience and habitat restoration projects, as they have been shown to be effective in stabilizing and building coastal shorelines, and in providing both subtidal and intertidal habitat for fish and wildlife (NOAA 2015). For these reasons the extent of living shorelines is expected to increase in the future.

Supratidal Habitats

Table 3 also shows changes in supratidal habitat acreage over time, as compiled from the District land use/cover mapping program over the period 1990 to 2017. Key observations from this table include the following.

- **Freshwater Wetlands** – The suite of freshwater wetlands includes natural streams, waterways and lakes; wetland hardwood forests (e.g., bay swamps); wetland coniferous forests (e.g., cypress swamps); wetland forested mixed; and vegetated non-forested wetlands (e.g., freshwater marshes). As noted previously, the District land use/cover mapping program is not considered to be highly reliable for determining the extent of natural freshwater open water habitats (5000 FLUCCS series). However, for the forested and non-forested wetland classifications listed above (6000 FLUCCS series), the District land use/cover program generally provides consistent and reliable information for the assessment of status and trends. Over the 27-year period of record, the suite of freshwater wetlands (exclusive of the 5000 FLUCCS series) has experienced a net gain of 6,040 acres (3%). This overall gain is likely a reflection of (1) the effectiveness of state and federal wetland regulatory programs and (2) the cumulative gains resulting from publicly funded habitat restoration projects and regulatory mitigation. The results of the present work indicate that there has been a substantial increasing trend in vegetated non-forested freshwater wetlands since 1990, with a gain of 13,183 acres (24%), while forested freshwater wetlands have decreased by 7,144 acres (4%). The vast majority of forested wetland losses have been Wetland Forested Mixed.

It should be noted that these contemporary trends differ from those presented in the *Master Plan for the Protection and Restoration of Freshwater Wetlands in the Tampa Bay Watershed, Florida* (Rains et al. 2012; Ries and Scheda 2014). Those studies conducted change analyses of freshwater wetland coverage in the Tampa Bay watershed over the period circa 1950 to 2007 and determined that while there had been substantial decreases in both forested and vegetated non-forested freshwater wetlands (55,426 and 47,395 acres, respectively), vegetated non-forested freshwater wetlands had been disproportionately lost on a percentage basis (-43% versus -27%). The authors speculated that the disproportionate loss of vegetated non-forested wetlands may have been due to several factors which, combined, may have resulted in a regulatory system that favored the development of non-forested wetlands.

Prior to the mid-1990s, regulations made it less costly to impact non-forested wetlands, as mitigation ratios for impacts to non-forested wetlands were lower than those for forested wetlands. Mitigation areas for non-forested wetlands were also easier to design, construct, and maintain, and success criteria (e.g., percent cover) were relatively easy to achieve. In addition, construction costs associated with clearing and filling non-forested wetlands were lower than for forested wetlands. Therefore, there were economic incentives, in the form of lower mitigation and construction costs, to develop site plans that impacted less forested wetlands and more non-forested wetlands. In addition, the disproportionate loss in non-forested wetlands may have been partially attributable to the suppression of natural forest fires in association with increasing development in the watershed, resulting in the conversion of non-forested wetlands to forested wetlands over time (Ries and Scheda 2014).

The data presented above indicate that the trend in freshwater wetland losses and gains has reversed since 1990, with a substantial gain in vegetated non-forested wetlands, and a corresponding loss in forested wetlands. This trend can be at least partially explained by the increased development of native upland and forested wetland habitats followed by the creation of herbaceous mitigation areas and surface water management system features (e.g., ponds and swales).

- **Native Uplands** – The suite of native upland habitats includes dry prairies; shrub and brushland (native grasslands); mixed rangeland; upland coniferous forests (e.g., pine flatwoods) and upland hardwood forests (e.g., oak hammocks). Over the 27-year period of record, the suite of native upland habitats has experienced a net loss of 91,055 acres (39%). Particularly hard hit were the Upland Coniferous Forest (e.g., pine flatwoods – 55% loss), Upland Hardwood Forests (e.g., oak hammocks – 22% loss), and Shrub and Brushland (e.g., native grasslands – 44% loss) classifications.

This substantial loss in native upland habitats was largely due to residential land development activities in the watershed, with virtually all areas of native upland habitat loss being converted to urban land uses. In addition, phosphate mining in the Alafia River watershed also contributed to native upland habitat losses.

Status and Trends Summary

When viewed as a whole, the most significant and meaningful trends in the Tampa Bay habitats of interest over the periods of record examined include (1) the 47 percent gain in seagrasses between 1988 and 2020; (2) the recent 18% decline in seagrasses between 2016 and 2020; (3) the slight gains in both emergent tidal wetlands (10% gain) and freshwater wetlands (2% gain) since 1990; and (4) the 39 percent loss in native upland habitats since 1990. The increasing long-term trend in seagrass coverage is a testament to improved bay water quality resulting from focused reductions in both point and non-point sources of pollution. Improved domestic wastewater treatment by local government utilities – as required by the Grizzle-Figg legislation (Section 403.086, Florida Statutes) – was responsible for the most significant improvements in Tampa Bay water quality. Pollutant load reduction commitments made by industrial point source permittees in association with the TBEP Nitrogen Management Consortium have also led to additional improvements in bay water quality (Greening et al. 2016). The causes of the recent seagrass declines are not yet fully understood; however, recent increases in precipitation, algal blooms, and red tide events have likely been contributing factors.

As discussed above, the observed gains in both emergent tidal wetlands and freshwater wetlands are likely a reflection of (1) the effectiveness of state and federal wetland regulatory programs and (2) the cumulative gains resulting from publicly funded habitat restoration projects and, to a lesser extent, regulatory mitigation. Gains in emergent tidal wetlands are also likely due to the landward expansion of the complex suite of these habitats associated with climate change and sea level rise. Also, since 1990, there has been a significant and disproportionate gain in vegetated non-forested freshwater wetlands, reversing disproportionate losses in this habitat type between circa 1950 and 2007. It is surmised that this shift is related to the clearing of forested wetlands associated with development, mining, and silviculture followed by the creation of herbaceous mitigation areas and surface water management system features (e.g., ponds and swales).

The decreasing trend in native upland habitats is clearly the result of continued urban development in the Tampa Bay watershed, combined with the lack of state and federal regulatory protection of native upland habitats. The responsibility for protecting native upland habitats resides mostly with local governments through the implementation of their planning, zoning, and land development regulations. Federal and state regulations related to listed species management impart some protection to certain rare upland habitats (e.g., scrub jay habitat); however, common and historically abundant native upland habitats, such as pine flatwoods, are left largely unprotected. Local governments in the Tampa Bay watershed must improve local protections for native upland habitats, or this trend will continue.

Previous Habitat Restoration Activities

The Tampa Bay watershed has been the focus area of substantial publicly funded habitat restoration and enhancement projects over the past 40 years. However, accurately documenting these projects and activities has been difficult. As part of the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020), various sources of information regarding past and current habitat restoration and enhancement activities in the Tampa Bay area were compiled, reviewed, and consolidated into a single geospatial database. This database only includes publicly funded restoration/enhancement projects, and specifically excluded mitigation and mitigation banks. The results of this effort are summarized in **Table 4**.

Table 4
Summary of Completed Habitat Restoration/Enhancement Projects in Tampa Bay

Habitat Type	No. of Projects	Enhancement		Restoration
		Acres	Linear Feet	Acres
Estuarine	228	3,147.6	99,501	2,074.0
Freshwater	53	449.1	23,156.8	1,191.1
Mixed	60	5,924.5	0	1,195.4
Upland	119	22,428.6	17,710	426.9
Totals	***460***	***31,949.8***	***140,367.8***	***4,887.3***

Based on this analysis a total of 460 completed or ongoing projects, resulting in 4,887 acres of restoration and enhancement, have been documented over the period 1990 through 2020. Of these totals, the District (primarily SWIM) has been the lead partner responsible for 79 projects resulting in 2,541 acres of restoration and enhancement; by far the greatest single contributor to these accomplishments.

The habitat change analysis summarized in Table 3 indicates that emergent tidal wetlands have increased by a total of 2,152 acres since 1990. This total is remarkably similar to the estimated 2,074 acres of estuarine habitats restored through publicly funded habitat restoration activities (Table 4), which constitutes 96% of the total gain in emergent tidal wetlands since 1990. While no geospatial analysis was conducted as part of this project to determine if the gains in emergent tidal wetlands directly correspond to documented restoration projects, it is reasonable to conclude that publicly funded restoration activities account for a significant percent of these gains.

This synthesis of habitat restoration and enhancement activities provides a useful tool for assessing the feasibility of future habitat restoration/enhancement targets. As noted above, a total of 4,887 acres of habitat restoration and enhancement was completed over an approximate 30-year period of record, which equates to an average annual total of about 163 acres/year for all habitat types combined. Over the past decade (2010–2020) this rate of restoration project completion has increased to over

200 acres/year. Assuming that funding levels remain in the same range as the past decade, and lands are available for restoration/enhancement activities, this annual average can be used to set reasonable limits on restoration potential and quantitative targets.

While this data synthesis and analysis represents the best estimate of habitat restoration and enhancement efforts compiled to date for the Tampa Bay watershed, there are gaps and inconsistencies in the way this information is documented and reported. For example, restoration/enhancement acreages for multi-phased projects were double counted in some cases; and the actual spatial boundaries of the vast majority of projects are poorly documented. To address these issues for projects where the District and/or its cooperator was the lead, the District is currently working on a geodatabase project to better account for habitat restoration projects and acreages, including the development project area polygons. This information will be updated in the SWIM Plan. In addition, the TBEP is developing an improved reporting platform and web-based dashboard to monitor habitat restoration progress throughout the watershed.

Habitat Assessment Data Gaps

Monitoring is differentiated from assessment in that monitoring is an ongoing, routine process; whereas assessment activities are performed initially, and then repeated only periodically, as needed to fill data gaps. The assessment needs and recommended programs discussed below address data gaps that currently limit the determination of Tampa Bay habitat status and trends, and the refinement of related management actions. The following summarizes assessment data gaps and actions proposed in the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020) to address these gaps.

- **Hard Bottom** – Hard bottom has been assessed in Tampa in recent years using a side-scan sonar methodology (Kaufman 2017; CSA 2019). The method has proven to be cost-effective; however, to date only Lower Tampa Bay, the western portions of Middle Tampa Bay, and the southern portions of Old Tampa Bay have been mapped. The assessment need for hard bottom is the completion of the hard bottom mapping g for all of Tampa Bay, including the remaining portions of Middle Tampa Bay and Old Tampa Bay, Hillsborough Bay, Terra Ceia Bay, and Boca Ciega Bay. This effort should utilize the same side-scan sonar methods used in the previous studies and would be used to identify critical hard bottom protection areas throughout Tampa Bay.
- **Oyster Bars** – Oysters provide both benthic habitat as well as water clarity benefits resulting from their filter feeding capacity. While there is anecdotal information that oysters were once abundant in Tampa Bay, there are no reliable estimates of how much of their historical extent was lost to dredge and fill and hydrologic alterations (Lewis and Estevez 1988). In addition, the ongoing assessment and mapping of existing oyster bars is problematic. As noted above, the assessment of oysters in Tampa Bay was incorporated into the District seagrass mapping program beginning in 2014; and this program utilizes traditional manual photointerpretation methods that likely underestimates the actual extent of oysters, as the prevalence of oysters clustered under mangrove canopies makes a bay wide quantitative assessment difficult (O'Keife et al. 2006). The assessment needs for oyster bars include (1) improved mapping of the extent of existing live oysters and (2) the mapping of relic oyster bars in both the open bay as well as within tidal tributaries. These assessments would be conducted in both intertidal and subtidal habitats that currently and/or historically supported oysters, utilizing a side-scan sonar methodology similar to that used for hard bottom mapping. Both types of information would be used to assess the restoration potential for oyster bars, as well as to locate sites best suited for restoration.
- **Tidal Tributaries** – The Tampa Bay Tidal Tributary Research Team (TBEP 2008) and the Sarasota Bay Estuary Program (Janicki Environmental Inc. and Mote Marine Laboratory 2016) have conducted ecological assessment activities in several representative tidal creek systems. However, many of the mapped tidal tributary segments have not been characterized. The assessment needs for tidal tributaries include an inventory and field investigations of water quality and habitat conditions in a more complete suite of representative tidal tributaries, with the goal of

developing a comprehensive ecological assessment of all mapped tidal tributaries in the watershed. The comprehensive ecological assessment would be used to develop a ranking system of tidal tributary segments for potential restoration and/or enhancement projects and activities.

- **Coastal Uplands** – The term "coastal uplands" is used herein as a generic catch-all for the variety of native terrestrial plant communities that occur immediately landward of the emergent tidal wetlands complex, typically on sandy soils. As part of the habitat change analysis conducted as part of the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020) it was possible to derive an estimate of the current extent of coastal uplands by combining all native upland FLUCCS codes and clipping them to the land area encompassed by the 5-foot contour extending around the Tampa Bay shoreline. The assessment needs for coastal uplands include (1) developing a consensus definition of what constitutes the natural coastal upland communities in the Tampa Bay watershed and (2) mapping all remaining natural coastal uplands in the watershed. Better defining and mapping coastal uplands would help identify future land acquisition and habitat protection priorities.
- **Reclaimed Mined Lands** – The hydrologic and water quality characteristics of historically mined lands remain poorly understood. In particular, pollutant loads associated with surface water runoff and/or shallow groundwater seepage from these areas have not been adequately assessed, and the potential contributions of pollutant loads discharged from reclaimed lands to water quality impairments in affected basins. There are extensive opportunities for the restoration and/or enhancement of reclaimed mined lands in the Alafia River watershed, and the Little Manatee River watershed to a lesser extent. Reclaimed lands on publicly owned conservation lands offer the greatest restoration potential due to long-term control of the affected parcels. The assessment needs for reclaimed mined lands include (1) the development of a comprehensive ecological inventory of reclaimed mined lands that exist on publicly owned conservation lands in the Tampa Bay watershed and (2) an assessment of the hydrologic and water quality characteristics of reclaimed lands, including pollutant loadings to surface and ground waters. The ecological assessment would evaluate the restoration potential of these areas with respect to various natural community types, including headwater streams, forested floodplain wetlands, isolated forested and non-forested wetlands, and native upland plant communities. Existing digital topographic and aerial photographic information, combined with field reconnaissance, would be used to develop restoration and enhancement priorities on reclaimed mined lands.

Habitat Protection and Restoration Opportunities

As part of the *Tampa Bay 2020 Habitat Master Plan Update* (ESA 2020), various habitat restoration "paradigms" and guiding principles for habitat restoration target setting were reviewed and evaluated. Several problems with the "Restoring the Balance" (RTB) paradigm were identified, and a more holistic approach was recommended that integrates multiple and disparate types of information into a comprehensive and repeatable method for developing and updating habitat protection and restoration targets. This recommended approach has been termed as "Maximizing the Potential" (MTP). The MTP approach differs from the RTB approach in that it considers the entire watershed and is both retrospective and prospective. Accordingly, the MTP approach:

- Integrates all native habitats in the watershed including coastal, freshwater, and upland habitats;
- Is informed by contemporary trends in both habitat changes and restoration performance;
- Considers both current and future stressors – especially land development, sea level rise and climate change; and
- Focuses on existing opportunities, and what is realistically possible in the future, rather than replicating past ecological conditions.

Pursuant to the MTP approach, the term "opportunity areas" refers to geographic areas where habitat protection and restoration activities are possible, and where they should best be focused to attain defined targets. Defining and mapping opportunity areas involved a stepwise geospatial analytical process and was the first step in quantifying the "restoration potential" for a particular habitat type, which is a measure of what is actually possible under current and future projected conditions. Restoration potentials were then used to develop quantitative habitat protection and restoration targets.

Figure 2 shows the combination of existing conservation lands, proposed conservation lands, and proposed reservation lands, on a single map.

The total area of existing conservation lands (green polygons) in the Tampa Bay watershed is 201,516 acres, exclusive of the subtidal portions of the Aquatic Preserves. The majority of restoration opportunities on existing conservation lands is for native uplands and freshwater wetlands. However, there are approximately 1,550 acres of emergent tidal wetland restoration opportunities on existing conservation lands; with about 241 acres applicable to higher salinity mangrove forests and salt barrens, and about 1,309 acres applicable to lower salinity salt marsh (e.g., *Juncus roemerianus*) restoration and creation.

The proposed conservation lands (blue polygons) were derived from the most current Florida Natural Areas Inventory (FNAI 2020) GIS data layers, as well as supplemental information provided by local county agencies. These polygons represent the best professional judgement of state and local natural resource management agencies, and associated academic experts, with regard to priority environmental lands parcels to be targeted for public conservation acquisition.

The term "reservation" refers to the protection of native coastal habitats and "soft development" (e.g., restorable habitats) within the coastal stratum (Mean Lower Low Water to elevation +5 feet, NAVD88) to allow for the natural adaptation and landward migration of coastal habitats in response to sea level rise. The reservation concept is based on the understanding that sea levels will continue to rise and cause substantial ecological changes in existing native coastal habitats, as well as repetitive coastal flood loss damages in low-lying developed areas.

Reservation lands (magenta polygons) represent priority areas within the coastal stratum for conservation through public acquisition, or for the implementation of other protective land use mechanisms such as rolling easements (Titus 2011). Based on 2017 land use/cover data, there are currently 16,158 acres of reservation lands in the Tampa Bay watershed, which includes 12,898 acres of native habitats and 3,260 acres of restorable habitats.

While existing development areas are not considered feasible for major habitat restoration activities at this time, there are many opportunities to enhance and restore habitat functions and improve coastal resilience in such areas. Examples include the construction of living shorelines, and/or the placement submerged habitat modules, along developed urban shorelines and seawalls. In addition to urban development, four major types of disturbed sites around the Tampa Bay coastline have been identified as priority estuarine habitat restoration sites, including (1) dredged holes, (2) filled and spoil disposal areas, (3) abandoned aquaculture ponds, and (4) coastal borrow pits and stormwater ponds.

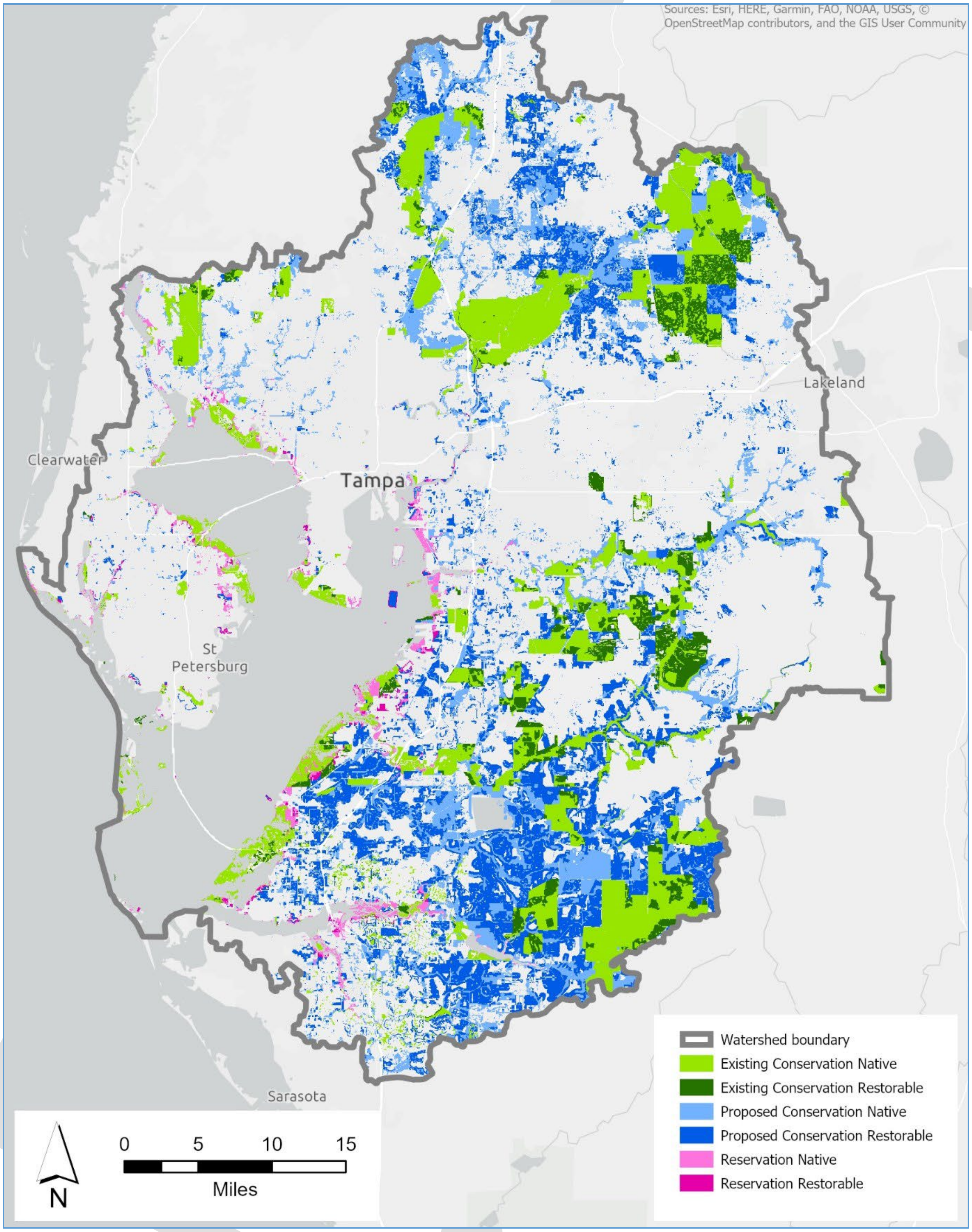


Figure 2
Existing Conservation Lands, Proposed Conservation Lands, and Proposed Reservation Lands in the Tampa Bay Watershed (Source: ESA 2020)

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Appendix B: Tampa Bay SWIM Plan Technical Working Group

SWIM Plan Update Technical Working Group

The Tampa Bay SWIM Plan Technical Working group includes members from the District and TBEP, as well as the TBEP TAC. The TBEP's TAC consists of representatives from academia, the private sector, and local, regional, state, and federal agency scientific and technical staff with regulatory or management mandates that affect Tampa Bay.

This Technical Working Group was convened to assist the District in review of data and identification of issues, and management actions for consideration in the Tampa Bay SWIM Plan update. Participants in the District's Tampa Bay Technical Working group are identified below.

Tampa Bay SWIM Plan Update Technical Work Group Members	
Member	**Organization**
Alana Todd	Agency on Bay Management
Alex Awad	Tampa
Allison Conner	FDOT
Amber Smith	SWFWMD GARM
Anthony Andrade	SWFWMD Water Resources Bureau
Ashlee Painter	Oldsmar
Benjamin Ralys	DEP
Bob Woithe	ESA
Brejesh Prayman	St. Petersburg
Brent White	SWFWMD Water Resources Bureau
Candice Wheelahan	USACE
Carla Burrmann	FDEP
Carole Estes	SWFWMD FARMS Program
Caroline Gorga	FWC
Chris Anastasiou	**SWFWMD SWIM**
Chris Pratt	Hillsborough County
Christopher Benigni	City of Largo
Dan Saunders	St. Petersburg
David Glicskberg	Hillsborough County
Doug Robison	**ESA**
Ed Sherwood	TBEP
Emily Keenan	ESA
Fatima Sohrabi	St Pete
Greg Blanchard	Manatee County
Jaime Swindasz	SWFWMD SWIM
Jesse Wood	St Pete
Jessica Stempien	FDACS
Kelly A. Thomas	City of St. Petersburg
Ken Weaver	FDEP

Tampa Bay SWIM Plan Update Technical Work Group Members	
Member	**Organization**
Kevin Coyne	FDEP
Kevin O'Donnell	DEP
Kris Kaufman	NOAA/NMFS
Lizanne Garcia	**SWFWMD SWIM**
Maya Burke	TBEP
Michael Miller	DEP
Michael Perry	St Pete
Nicole Mytyk	SWFWMD Engineering & Watershed Management
Patrick Casey	SWFWMD Structure Operations
Rene Brown	Pasco County
Renee Cooper	Safety Harbor
Robert Burnes	Pinellas County
Robin Speidel	SWFWMD Data Collection Bureau
Roger Johansson	Janicki Environmental Inc.
Ron Basso	SWFWMD Environmental Flows and Levels
Ross Dickersn	Hillsborough County – ELAPP
Sarah Johnson	City of St. Petersburg
Sarah Kessler	Clearwater
Seyedeh F. Sohrabi	City of St. Petersburg
Shelby Beauchemin	City of Largo
Stacey Day	Pinellas County
Tara Schiro	SWFWMD SWIM
Tim Bassett	City of Largo
Tom Ash	EPC of Hillsborough County
Tom Ries	ESA
Tracy Hurst	USACE
Trevor Fagan	SWFWMD Data Collection Bureau
Vivianna Bendixson	SWFWMD SWIM
Will Van Gelder	SWFWMD SWIM
Yuan Li	SWFWMD Water Resource Bureau

Note: Co-chairs of this committee are represented in **bold text**.

Appendix C: Permitted Point Sources within the Tampa Bay Watershed

This appendix describes point sources of nutrients within the Tampa Bay Watershed. The data described below were downloaded from FDEP's Geospatial Open Data website on August 30, 2022. For the most up to date point source data visit: http://geodata.dep.state.fl.us/.

There are more than 300 wastewater permits within the Tampa Bay Watershed including 154 domestic wastewater programs for mobile home or RV parks, apartment complexes, and schools; 163 industrial wastewater programs; 25 phosphate wastewater management programs; and six power plant wastewater management programs.

There are six power plants within the Tampa Bay watershed which include three in Hillsborough County: Big Bend Power Station, Culbreath Bayside Power Plant, and Hillsborough County Resource Recovery Facility, the Manatee Power Plant located in Manatee County, and two in Pinellas the Duke Energy Power Plant at Weedon Island and Pinellas County Resource Recovery Facility.

A Municipal Separate Storm Sewer System or MS4 is defined in Rule 62-624.200(8), F.A.C., as follows: Municipal separate storm sewer or MS4 means a conveyance or system of conveyances like roads with stormwater systems, municipal streets, catch basins, curbs, gutters, ditches, constructed channels, or storm drains: Owned or operated by a State, city, town, county, special district, association, or other public body (created by or pursuant to state law) having jurisdiction over management and discharge of stormwater, or an Indian tribe or an authorized Indian tribal organization, that discharges to waters of the state; Designed or used for collecting or conveying stormwater; Which is not a combined sewer; and Which is not part of a Publicly Owned Treatment Works (POTW). POTW means any device or system used in the treatment of municipal sewage or industrial wastes of a liquid nature which is owned by a "State" or "municipality." This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment. As of August 2022, within the Tampa Bay Watershed there are 42 MS4 permits.

Based on an email from FDEP Southwest District Office staff on September 26, 2022, the facilities listed in Table C-1 below are currently out of compliance with their permits. For additional information please see the FDEP website for the permits and Consent Orders.

Table C-1 – List of wastewater facilities operating under a Consent Order.

Facility Name	Facility ID	Consent Order No.
Mockingbird MHP	FLA012782	21-0532
City of Clearwater	FL0021857, FL0128937, FL0021865, FL0186261	21-0522
City of St. Petersburg	FLA128821, FLA128848, FLA128856, FLA012881	16-1280
City of Bradenton	FL0021369	18-1466
City of Largo	FL0026603	03-0666
Tampa Bay Downs	FLA314137	19-0075
TECO Bayside	FL0000809	21-1222
Kinder Morgan Port Sutton Terminal	FL0122904	21-0475

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Appendix D: Jurisdictional Authority within the Tampa Bay Watershed

Various levels of government are involved in resource management and regulatory activities within the Tampa Bay watershed. These include single purpose local governments (i.e., independent taxing districts), general purpose local governments (i.e., cities and counties), regional agencies (i.e., Southwest Florida Water Management District (SWFWMD) and the Tampa Bay and Central Florida regional planning councils (TBRPC & CFRPC), as well as state and federal agencies.

Federal Agencies

Federal jurisdiction in Tampa Bay watershed involves the regulatory responsibilities of the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Coast Guard, the U.S. Fish and Wildlife Service, and the U.S. Department of Interior (which coordinates its many agriculture-related activities with those of the Florida Department of Agriculture and Consumer Services). Their main regulatory functions include overseeing dredge and fill activities, maintaining navigability of the waters of the United States, overseeing cleanups following pollution spills, protecting endangered species, protecting overall environmental quality, and managing offshore activities. These agencies, in conjunction with the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, also contribute to the collection of technical data concerning Tampa Bay and its watershed. Land based conservation measures within the watershed may be addressed by the U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS) which provides farmers and ranchers with financial and technical assistance to voluntarily apply conservation measures which benefit the environment and agricultural operations.

U.S. Army Corps of Engineers (USACE)

The U.S. Army Corps of Engineers Regulatory Program began in 1890 with the responsibility of protecting and maintaining the nation's navigable waterways. As a result of changing public needs and evolving policy via new laws and court decisions, protection has been extended to all waters of the United States, including many wetlands. The Jacksonville Regulatory Division of USACE (https://www.saj.usace.army.mil/Missions/Regulatory/Office-Locations/) has jurisdiction over the geographic region of Florida, Puerto Rico, and the U.S. Virgin Islands. The Division is geographically aligned in three Permitting Branches, which are further divided into eleven Sections, and Mitigation Bank Team and Enforcement Section. The Jacksonville District administers the largest regulatory permitting program in the Corps, which provides protection for waters of the United States, including federally delineated wetlands and navigable waters.

U.S. Environmental Protection Agency (EPA)

The Environmental Protection Agency (Southeast Regional Office, Region IV, Atlanta, Georgia) through its Water Division, implements the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA) as well as portions of the Marine Protection Research and Sanctuaries Act (MPRSA) and the Coastal Zone Act Reauthorization Amendments (CZARA). The Division works with states and tribes to develop and approve programs to protect public health and natural resources through source water protection, improving aging infrastructure, water reuse and nutrient reduction.

U.S. Coast Guard (USCG)

The U.S Coast Guard is a branch of the U.S. Armed Forces. It encompasses a law enforcement organization, a regulatory agency and many other responsibilities and partnerships. The USCG is the principal Federal agency responsible for maritime safety, security, and environmental stewardship in U.S. ports and inland waterways, In inland waters the Coast Guard Auxiliary, a volunteer group, performs boating safety inspections and search and rescue missions.

U.S. Department of Interior (USDOI)

The primary water-related functions performed by this agency involve the review of proposed activities which may impact threatened or endangered species, review of USACE permits for potential effects on fish and wildlife, and management of all federally owned public lands. Within the department, the U.S. Geological Survey conducts investigations concerning hydrology, hydrogeology, water use, and ground and surface water quality. The U.S. Fish and Wildlife Service manages and restores fish and wildlife populations and conducts research on the effects of pollution on those resources. The National Park Service maintains federal parks and sanctuaries, regulating multiple uses on these lands to achieve a balance of benefits for both man and wildlife. The department also oversees those requests and offshore activities associated with exploration and development on the outer continental shelf.

U.S. Fish and Wildlife Service (USFWS)

The U.S. Fish and Wildlife Service, working with others, is responsible for conserving protecting and enhancing fish and wildlife and their habitats for the continuing benefit of the American people through Federal programs relating to migratory birds, endangered species, interjurisdictional fish and marine mammals, and inland sport fisheries.

U.S. Geological Survey (USGS)

The USGS is the nation's largest water, earth, and biological science and civilian mapping agency. The U.S. Geological Survey (USGS) collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. Of particular relevance are the surface and ground water quality monitoring, stream flow measurements, and ground water recharge and contamination research.

U.S. Department of Agriculture (USDA)

The primary environmental related functions of the USDA are to preserve and conserve natural resources through restored forests, improved watersheds, and healthy private working lands. These broad objectives are facilitated by three USDA agencies: Farm Service Agency, the U.S. Forest Service, and the Natural Resources Conservation Service.

Natural Resources Conservation Service (NRCS)

The Natural Resources Conservation Service (NRCS) is an agency of the U.S. Department of Agriculture (USDA) which provides financial and technical assistance to farmers, ranchers, and forest landowners. The NRCS administers multiple programs: Farm Bill conservation programs, Landscape Conservation Initiatives, small-scale farm fact sheets, and resources. All NRCS programs are voluntary science-based solutions. The NRCS was established by Congress under Public Law 74-46 in 1935.

State Agencies

Many state agencies are involved in environmental regulation and resource management in the Tampa Bay watershed and estuary. The Florida Department of Environmental Protection is the lead state agency in the protection and management of Tampa Bay. Other relevant entities include the Florida Fish & Wildlife Conservation Commission, the Marine Fisheries Commission, Florida Department of Agriculture and Consumer Services, Florida Department of Health and Rehabilitative Services, Florida Sea Grant Program, and the Florida Department of Transportation.

Florida Department of Agriculture and Consumer Services (FDACS)

The FDACS Division of Agricultural Environmental Services (AES) administers various state and federal regulatory programs concerning environmental consumer protection issues. These include state mosquito control program coordination; agricultural pesticide registration, testing and regulation; pest control regulation; and feed, seed and fertilizer production inspection and testing. The division ensures that pesticides are properly registered and used in accordance with federal and state requirements; mosquito control programs are effectively conducted; and feed, seed and fertilizer products are safe and effective.

The FDACS Office of Agricultural Water Policy (OAWP) facilitates communications among federal, state, and local agencies and the agricultural industry on water quantity and water quality issues. collaborates with Florida's agricultural landowners and producers to implement best management practices (BMPs) for nutrient reduction, irrigation management, and the protection of water resources. Agricultural BMPs are an integral part of water resource protection required under the regulatory BMP Program implemented by FDACS OAWP. The office is directly involved with statewide programs to implement the Federal Clean Water Act's Total Maximum Daily Load (TMDL) requirements for agriculture. Once a TMDL is adopted, FDEP may develop a basin management action plan (BMAP) that identifies enforceable strategies for restoring the impaired waterbody. The agricultural industry is one of many stakeholders identified in most BMAPs. Florida law requires agricultural landowners located within BMAPs to either enroll in the FDACS BMP Program and properly implement the BMPs applicable to their property and operation or conduct water quality monitoring activities. Enrollment in the BMP Program and the proper implementation of applicable BMPs provides a presumption of compliance with state water quality standards that is not provided otherwise. Producers or agricultural landowners within a BMAP who are enrolled in the FDACS BMP Program and are properly implementing the applicable BMPs identified on the Checklist are entitled to a presumption of compliance with state water quality standards. FDACS is required to perform BMP Implementation Verification (IV) site visits to enrolled operations every two years to ensure that BMPs are being properly implemented. Producers and agricultural landowners outside BMAP areas are strongly encouraged to enroll in the BMP Program for the benefits that enrollment provides.

Through the Florida Forest Service (FFS), the FDACS is responsible for developing, implementing, and monitoring BMPs through the Silviculture BMP Program to control forestry-related water quality non-point source pollution. The FFS manages Florida's 34 State Forests and several other parcels of public land. The FFS meets its responsibility for Silviculture BMP implementation by means of a two-prong approach via a formal BMP training program and by providing on-on-one technical advice. The goal of both approaches is to educate forestry practitioners and landowners about the importance of implementing Silviculture BMPs to prevent nonpoint sources pollution. To ensure Florida's Silvicultural BMPs achieve the objectives of the Federal Clean Water Act and prevent nonpoint source pollution from forestry operations entering surface and ground water, effectiveness studies have been conducted since 1996 and are currently ongoing.

As a regulatory branch of the FDACS, the Division of Plant Industry works to detect, intercept and control plant and honeybee pests that threaten Florida's native and commercially grown plants and agricultural resources.

Florida Department of Environmental Protection (FDEP)

The Florida Department of Environmental Protection (FDEP) is the lead state agency involved in water quality, pollution control, and resource recovery programs. The FDEP sets state water quality standards and has permit jurisdiction over point and non-point source discharges, certain dredge and fills activities, drinking water systems, power plant siting, and many construction activities conducted within waters of the state. The FDEP also interacts closely with other federal and state agencies on water-related matters, and the FDEP and the District share responsibilities in non-point source management and wetland permitting. The Southwest District Office in Tampa has responsibility for proprietary and regulatory permitting issues in the Tampa Bay watershed area.

The Division of State lands oversees the management of state lands, including state parks. The Division of Recreation and Parks and the Office of Resilience and Coastal Protection are directly responsible for day-to-day land management, and beaches in this watershed. The Florida Geological Survey Division provides geoscience products to support initiatives related to water-resource conservation and management, and improvement of the quality of natural resource. The FDEP is the primary reviewer of SWIM plans and is responsible for the disbursement of legislatively appropriated funds to the water management districts. The FDEP is also highly involved in the management of estuarine resources.

Division of Water Resource Management

The Southwest District Office in Tampa has responsibility for proprietary and regulatory permitting issues in the Tampa Bay watershed area.

Florida Department of Health (FDOH)

The primary statutes providing FDOH authority are in Chapter 154, 381 and 386 of the Florida Statutes and the 64E Series of the Florida Administrative Code, known as the "Sanitary Code". Each county has a FDOH Office responsible for jurisdiction within the county. The environmental focus of the FDOH is to prevent disease of environmental origin. Environmental health activities include prevention, preparedness, and education and are implemented through routine monitoring, education, surveillance and sampling of facilities and conditions that may contribute to the occurrence or transmission of disease. Responsibilities of the FDOH include the public health functions of water supplies (primarily small to medium supplies), onsite sewage treatment and disposal systems permitting and inspection, septic tank cleaning and waste disposal (in conjunction with FDEP), and solid waste control (secondary role).

Florida Fish & Wildlife Conservation Commission (FFWCC)

The Florida Fish and Wildlife Conservation Commission (FWC) manages fish and wildlife resources for their long-term well-being and the benefit of people. Agency personnel work together to protect and manage more than 575 species of wildlife, 200 species of freshwater fish and 500 species of saltwater fish. The FWC works to balance the needs of these fish and wildlife species and the habitats that support them with the needs of Florida's population of 21.7 million people and approximately 100 million visitors each year. The FWC is comprised of six divisions including the Fish and Wildlife Research Institute, Freshwater Fisheries Management, Habitat and Species Conservation, Hunting and Game Management, Law Enforcement and Marine Fisheries Management.

The FWC accomplishes its mission by pursuing strategic goals such as those highlighted in Florida's State Wildlife Action Plan, a comprehensive, statewide plan for conserving Florida's wildlife and natural areas for future generations (https://myfwc.com/conservation/special-initiatives/swap/). Through collaborative efforts FWC researchers and resource managers have informed and assisted multiple hydrologic and aquatic habitat restoration efforts supporting District SWIM Program objectives.

The FWC's efforts within the SWIM plan area primarily involve freshwater sport and commercial fishing, fisheries and habitat management, fish stocking, fisheries research, wildlife monitoring, enforcement of fisheries/wildlife regulations, listed species protection, wildlife research, development review, and regional planning. The FWC is directed by 62-43 F.A.C. to review SWIM plans to determine if the plan has adverse effects on wild animal life and freshwater aquatic life and their habitats.

Florida Department of Transportation (FDOT)

The Department of Transportation's Project Development and Environmental Offices assist in the design, review, and permitting of road and right-of-way projects in the Tampa Bay watershed region.

Florida Sea Grant Program

The Florida Sea Grant Program is supported by awards from the Office of Sea Grant (National Oceanic and Atmospheric Administration) under provisions of the National Sea Grant College and Programs Act of 1966. The Florida Sea Grant Program has three major components: applied marine research, education, and advisory services (through local marine extension agents). Florida Sea Grant provides scientific research and habitat-related information that are useful in the management of Tampa Bay's natural resources.

Regional Agencies

Several regional agencies exist within the SWFWMD boundaries of the Tampa Bay watershed. These are the Tampa Bay and Central Florida regional planning councils, the Southwest Florida Water Management District, Tampa Bay Water, the Peace River Water Manasota Regional Supply Authority, and the Polk Regional Water Cooperative.

Tampa Bay Regional Planning Council (TBRPC)

The TBRPC was established in 1962 and includes the counties of Hillsborough, Manatee, Pasco Pinellas, with Hernando and Citrus added in 2015. The mission of the TBRPC is to serve its citizens and member governments by providing a forum to foster communication, coordination, and collaboration to identify and address needs/issues regionally. The TBRPC is a multi-purpose agency responsible for providing a variety of services including natural resource protection and management, emergency preparedness planning, economic development and analysis, transportation and mobility planning, growth management and land use coordination, and technical assistance to local governments.

The Agency on Bay Management (ABM), which is administered and staffed by TBRPC, is a community organization focusing on the protection and management of the Tampa Bay estuary. The ABM, established in 1985, is an association of representatives from the recreational commercial fisheries, industrial, regulatory, academic, and scientific sectors, local, regional, state, and federal governments and legislators. ABM was integral in the establishment of the Surface Water and Improvement and Management (SWIM) program state-wide, and designation of Tampa Bay as a National Estuary Program.

Central Florida Regional Planning Council (CFRPC)

The CFRPC was officially created in July 1974, when the five counties of DeSoto, Hardee, Highlands, Okeechobee, and Polk entered into Interlocal Agreements with the State of Florida. The mission of the CFRPC is to provide support, planning, and programs to serve the citizens, cities, and counties of our region. Since its inception, the CFRPC has provided planning advisory services and programs to all five counties and 25 cities within the region. Diverse services include economic development. strategic planning, emergency preparedness planning, transportation planning, intergovernmental coordination, coordinating regulations for large scale developments, community visioning, and a wide variety of grant writing and grant management activities.

Southwest Florida Water Management District (SWFWMD)

The mission of the SWFWMD is to manage water and related natural resources to ensure their continued availability while maximizing the benefits to the public. Central to the mission is maintaining the balance between the water needs of current and future users while protecting and maintaining water and related natural resources, which provide the SWFWMD with its existing and future water supply. The SWFWMD is responsible for performing duties assigned under Ch. 373, F.S., as well as duties delegated through FDEP for Ch. 253 and 403, F.S., and for local plan review (Ch. 163, F.S.). It performs those duties for the entire Tampa Bay watershed within its boundaries.

Tampa Bay Water (TBW)

Tampa Bay Water (TBW), a special district of the state of Florida, was created to plan, develop, and deliver a high-quality drinking water supply and to protect the water supply sources of its members. Members of TBW include the counties of Hillsborough, Pasco, and Pinellas, as well as the cities of New Port Richey, Tampa, and St. Petersburg. TBW manages several diverse water facilities including 14 wellfields, surface water withdrawals from the Tampa Bypass Canal and Alafia River, and a seawater desalination facility. It is an independent special district authorized by Section 373.1962, F.S., as subsequently reenacted in Section 373.713, F.S., and created by an interlocal agreement executed pursuant to Section 163.01, F.S., in 1998. The three counties and the cities of Tampa and St. Petersburg are within the boundaries of the Tampa Bay watershed.

Peace River Manasota Regional Water Supply Authority (PRMRWSA)

The Peace River Manasota Regional Water Supply Authority (PRMRWSA) provides wholesale drinking water to three of its four members and the City of North Port. Members of the PRMRWSA include the counties of Charlotte, DeSoto, Manatee and Sarasota. The mission of the PRMRWSA is to provide the region with a sufficient, high-quality, and safe drinking water supply that is reliable, sustainable, and protective of our natural resources now and into the future. The PRMRWSA acquired the Peace River Water Treatment Facility in 1991 and has expanded the facility to meet regional demands. It is an independent special district authorized by Section 373.1962, F.S., as subsequently reenacted in Section 373.713, F.S., and created by an interlocal agreement executed pursuant to Section 163.01, F.S., in 1982. A portion of Manatee County is within the Tampa Bay watershed.

Polk Regional Water Cooperative (PRWC)

In 2017, Polk County and fifteen municipal governments agreed to form the Polk Regional Water Cooperative (PRWC) to lead planning activities for their collective future water supply needs. The PRWC's role is to proactively identify sustainable regional alternative water supply sources, develop strategies to meet future water demands, and determine needed infrastructure for treatment and distribution projects required to meet water supply needs across the County. The PRWC is a special purpose local government pursuant to Section 163.0I (7)(g) and 373. 713, Florida Statutes. A portion of Polk County is within the Tampa Bay watershed.

West Coast Inland Navigation District (WCIND)

The WCIND is a multi-county special taxing body, covering Manatee, Sarasota, Charlotte, and Lee counties, encompassing an estimated 1.8 million people. WCIND was established by the Florida Legislature in 1947 to complement the U.S. Army Corps of Engineers (USACE)—sharing the cost of planning, construction, and maintenance of a 152-mile-long, 100-foot-wide, and 9-foot-deep Gulf Intracoastal Waterway (GIWW) between the mouth of the Caloosahatchee River and the Anclote River. In the Tampa Bay region, the GIWW runs from south to north across Lower Tampa Bay and the Gulf between Manatee and Pinellas counties.

The WCIND serves an important role in water way projects that promote safe navigation from the "open water" of the Gulf of Mexico or the GIWW to systems of secondary waterways. In addition to maintaining the GIWW, its responsibilities include improving and maintaining public channels connected to the GIWW—and any waters that make a significant contribution to waterway traffic or commerce. WCIND assists member counties in navigation projects, waterway research, erosion and accretion studies, and environmental restoration projects. Activities carried out by the WCIND also include posting of manatee protection speed zone signs and sponsoring programs to encourage boating safety and environmental stewardship.

Local Governments

There are 37 local governments that have jurisdiction within the Tampa Bay watershed. These include five counties and 32 municipalities. Each of these local governments have a role in protecting Tampa Bay and its watershed. Rather than provide a list of these responsibilities for each local government, the Counties are briefly described and the municipalities within the counties are identified. For more information on their water resource management programs the reader is referred to their respective websites.

Hillsborough County

Hillsborough County has an estimated permanent population of approximately 1.5 million in 2021 and a land area of 1,022 square miles (BEBR 2021). The 2020 Census information listed Hillsborough County as the fourth most populous county in the state. It is served by the Board of County Commissioners. Cities include Tampa, Temple Terrace, and Plant City.

Pinellas County

Pinellas County has an estimated permanent population of 964,500 in 2021 and a surface area of 274 square miles (BEBR 2021). It is served by the Board of County Commissioners. There are many local governments within Pinellas County, including the cities of Clearwater, Gulfport, Largo, Madeira Beach, North Redington Beach, Oldsmar, Pinellas Park, Redington Shores, Safety Harbor, St. Petersburg, St. Pete Beach, Tarpon Springs, and Treasure Island that participate in the Tampa Bay Estuary Program.

Manatee County

Manatee County has an estimated permanent (2021) population of 411,200 and a surface area of 743 square miles (BEBR 2021). It is served by a Board of County Commissioners and contains the cities of Bradenton, Palmetto and several smaller towns and municipalities. The City of Bradenton and Palmetto are located within the Tampa Bay watershed.

Pasco County

Pasco County has an estimated permanent population of 575,900 (2021) and a surface area of 747 square miles (BEBR 2021). It is served by the Board of County Commissioners. The cities of Dade City, San Antonio and Zephyrhills are in the Tampa Bay watershed.

Polk County

Polk County has an estimated 2021 permanent population of 748,400, with about 699,100 in SWFWMD and 49,300 in SFWMD boundaries, and a surface area of 1,798 square miles (BEBR 2021). It is served by the Board of County Commissioners. There are several cities within the County with the cities of Lakeland and Mulberry being within the Tampa Bay watershed.

Appendix E: List of Acronyms

Abbreviation	Description
BEBR	Bureau of Economic and Business Research
BMPs	Best Management Practices
CCMP	Comprehensive Conservation and Management Plan
CDOM	colored dissolved organic matter
CFI	Cooperative Funding Initiative
CFRPC	Central Florida Regional Planning Councils
Chl-a	Chlorophyll-a
CWA	Clean Water Act
District	Southwest Florida Water Management District
DO	Dissolved Oxygen
ELAPP	Environmental Land Acquisition and Protection Program (Hillsborough County)
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
FARMS	Facilitating Agricultural Resource Management Systems
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FFS	Florida Forest Service
FFWCC	Florida Fish and Wildlife Conservation Commission
FLUCCS	Florida Land Use Cover Classification Scheme
FMRI	Florida Marine Research Institute
FNAI	Florida Natural Areas Inventory
GFC	Florida Game and Fresh Water Fish Commission
GICW	Gulf Intracoastal Waterway
HMPU	Habitat Master Plan Update (TBEP 2020)
IWR	Impaired Waters Rule
Kd	light attenuation
LHFDA	Lower Hillsborough Flood Detention Area
m	meter
MFC	Marine Fisheries Commission
MFLs	Minimum Flows and Levels
mg/l	milligrams per liter
mgd	million gallons per day
MTP	Maximizing the Potential
NEP	National Estuary Program
NGOs	Non-government organizations (non-profit)
NMC	Nitrogen Management Consortium
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service

Abbreviation	Description
OAWP	Office of Agricultural Water Policy
OFMAS	Office of Fisheries Management and Assistance Services
OTB	Old Tampa Bay
PAR	Photosynthetically Active Radiation
PLRG	Pollutant Load Reduction Goal
ppm	Parts Per Million
RA	Reasonable Assurance
RTB	Restoring the Balance
SD	Secchi Depth
SOD	sediment oxygen demand
SWFRPC	Southwest Florida Regional Planning Councils
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
SWUCA	Southern Water Use Caution Area
TAC	Technical Advisory Committee
TBC	Tampa Bypass Canal
TBEP	Tampa Bay Estuary Program
TBRPC	Tampa Bay Regional Planning Council
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TP	Total Phosphorus
TSS	Total Suspended Solids
UAV	unmanned aerial vehicles
ug/l	micrograms per liter
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WBIDs	Water Body Identification units
WBIDS	Water Body Identification Numbers
WCIND	West Coast Inland Navigation District
WMA	Wildlife Management Area