Charlotte Harbor

Surface Water Improvement & Management (SWIM) Plan Update

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Surface Water Improvement and Management SWIM

Southwest Florida Water Management District

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Executive Summary

In 1987 the Florida Legislature created the Surface Water Improvement and Management (SWIM) Act to protect, restore, and maintain Florida's highly 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. In 1993, the Governing Board of the Southwest Florida Water Management District (SWFWMD) adopted the first Charlotte Harbor SWIM Plan. The original plan outlined issues and management actions associated with the three focus areas of water quality, hydrology, and natural systems (habitat). In 2000, the SWFWMD completed the first update of the Charlotte Harbor SWIM Plan. This document represents the most recent update of the original 1993 SWIM Plan.

Charlotte Harbor was formally accepted into the National Estuary Program in 1995 when the U.S. Environmental Protection Agency named the Greater Charlotte Harbor Watershed an estuary of national significance. The Charlotte Harbor National Estuary Program, renamed the Coastal and Heartland National Estuary Partnership (CHNEP) in 2019, plays a critical role in developing management strategies for Charlotte Harbor's preservation and restoration, as outlined in the CHNEP Comprehensive Conservation and Management Plan (CCMP). The Charlotte Harbor SWIM Plan complements the CHNEP CCMP by focusing on management actions, projects, initiatives, and quantifiable objectives within the SWFWMD's area of responsibility. The SWIM Plan like the CCMP is a living document meant to be a guide to help navigate 21st century challenges facing the Charlotte Harbor system. SWFWMD's Charlotte Harbor SWIM Plan is specific to the area of the Charlotte Harbor estuaries and watersheds within the SWFWMD boundaries. The Lower Charlotte Harbor estuaries, including the Caloosahatchee River, Pine Island, Matlacha Pass and Estero Bay, are within the boundaries of the South Florida Water Management District (SFWMD) and the SFWMD adopted the Lower Charlotte Harbor SWIM Plan in 2008.

Historically, the Charlotte Harbor system has been characterized as a relatively healthy estuary. Therefore, the 2000 SWIM plan adopted a "hold the line" approach for maintaining the Harbor's environmental quality. Unlike the nearby estuaries of Sarasota Bay and Tampa Bay, Charlotte Harbor did not experience substantial environmental degradation through much of the 20th century, and therefore was not in need of major restoration efforts. Nevertheless, the successful management of Charlotte Harbor is not without its challenges and holding the line does not imply doing nothing. On the contrary, the 2000 SWIM Plan highlighted the need for a pollutant load reduction goal (PLRG) to "hold the line" on nitrogen loads to Charlotte Harbor from the Peace River Watershed. This resulted in the SWFWMD implementing the Lake Hancock Outfall Treatment Marsh Project designed to treat high nitrogen water discharging from Lake Hancock into the Upper Peace River via Lower Saddle Creek. This single project was predicted to "hold the line" on nitrogen loads to Charlotte Harbor from the Peace River watershed over a period of 19 years, which would fulfill the PLRG outlined in the 2000 SWIM Plan. Since the 2000 SWIM Plan update, the average nitrogen loads from the gaged portions of the Peace River have changed by less than 5% over the past two decades, achieving the PLRG goal.

Several localized areas of concern have been identified since the last SWIM Plan update. These concerns include recently documented areas of seagrass loss and macroalgae accumulation that may be correlated with localized increases in nutrient loads. Accumulation of filamentous macroalgae has been noted at the confluence of the Myakka and Peace Rivers, and in Coral Creek upstream of its discharge to Gasparilla Sound. Localized nutrient inputs could be an issue in those two areas, and further research is needed. Complicating matters, periodic and sometimes severe red tide episodes have impacted both Charlotte Harbor and Lemon Bay. The long-term impacts of these red tide events are not well understood. Large areas of filamentous macroalgae have been observed along the east wall of Charlotte Harbor. Scientists hypothesize there may be some connection with the major red tide event that occurred between 2018 and 2019. This SWIM Plan update has identified several management actions to target areas of concern and proposes projects to better understand the relationships between water quality, seagrass loss, and macroalgae accumulation.

The 2000 SWIM Plan documented habitat loss throughout the Charlotte Harbor system. Since the last update, continued and substantial habitat losses were found for pine forests and other upland communities, mostly a result of human activities, including urban development, agriculture and mining. In the lower reaches of the Peace and Myakka Rivers, large expanses of marshland have been converted into open water canals with adjacent uplands being converted into residential housing along finger-fill canal communities.

The SWFWMD has been mapping seagrasses in the Charlotte Harbor system since 1988. Over this 30-year period, mapped seagrass acreage has generally increased in both Charlotte Harbor and Lemon Bay. Between 2001 and 2016, seagrass meadows expanded in Charlotte Harbor and Lemon Bay by 11% (12,026 acres) and 25% (638 acres), respectively. Between 2016 and 2018, however, both Charlotte Harbor and Lemon Bay experienced seagrass losses of 2.8% and 10% respectively. While a loss of 2.8% in Charlotte Harbor is only slightly greater than the mapping error, a loss of 10% in Lemon Bay is significant. This loss was restricted to northern Lemon Bay near the mouths of Alligator Creek and Forked Creek and may be linked to localized water quality degradation. With accumulation of filamentous macroalgae persisting in northern Lemon Bay and the east wall of Charlotte Harbor, there is concern that further seagrass loss may be reported in the 2020 SWFWMD seagrass maps to be released in early 2021.

Careful attention is needed to ensure that the progress made since 2000 is not lost due to land use changes, sea-level rise, climate change, and other impacts to water quality, hydrology, and natural systems. To that end, this SWIM Plan Update includes the following quantifiable objectives for the three major focus areas of Water Quality, Hydrologic Alterations, and Natural Systems.

Water Quality	**Target**
"Hold the line" on multi-year average Total Nitrogen (TN) loads from gaged portions of the Peace River	Five-year average TN load of 1,800 tons per year
For the gaged portions of the Peace and Myakka Rivers, maintain area-normalized sub-basin TN loads at or below 2009-2015 average levels	Peace River – 2.7 pounds TN per acre per year Myakka River – 2.8 pounds TN per acre per year
Hydrologic Restoration	**Target**
Continue implementation of hydrologic restoration in the Myakka River watershed	Reduce inflows to Flatford Swamp between 2 and 10 million gallons per day (mgd)
Participate in ongoing hydrologic restoration of Dona Bay watershed	Reduce inflows to Dona Bay by at least 3 mgd
Participate in Charlotte Harbor Flatwoods Initiative	Support data collection and modeling to evaluate scenarios to restore historic flow-ways and hydroperiods
Participate in ongoing hydrologic restoration on conservation lands	Increase percentage of area with natural hydrologic function over the next 10 years
Natural Systems Protection and Restoration	**Target**
Maintain seagrass coverage in Charlotte Harbor and Lemon Bay at 2016 levels	Charlotte Harbor – 20,280 acres Lemon Bay – 3,223 acres
Continue to implement natural systems projects throughout the watershed within the SWFWMD	Habitat Restoration targets have been established by CHNEP for tidal and freshwater wetlands and uplands throughout the Charlotte Harbor estuarine system

To achieve these quantifiable objectives, this SWIM Plan Update identifies management actions that if implemented, would increase the likelihood of achieving these goals.

For Water Quality, management actions include:

Monitoring and Research
Maintain and evaluate streamflow and water quality monitoring activities throughout the Peace and Myakka River watersheds and publish regular updates on watershed-scale nutrient loads and area-normalized nutrient loads for gaged sub-basins
Support ambient water quality monitoring throughout Charlotte Harbor and Lemon Bay and publish regular updates on water quality status and trends
Identify localized nutrient load sources near areas of significant seagrass loss and areas of filamentous macroalgae accumulation
Continue to study impacts of existing and future land use on the water quality of Lemon Bay and Charlotte Harbor
Assess potential sources of nutrient loads in the Forked Creek watershed
Assess potential sources of nutrient loads in Coral Creek and the confluence of the Peace and Myakka Rivers
Water Quality Protection and Restoration
Continue outreach and implementation of Best Management Practices (BMPs) through SWFWMD's Facilitating Agricultural Resource Management Systems (FARMS) program to assist agricultural stakeholders in conserving water and protecting water quality
Work with local, regional, and state agencies to implement stormwater BMPs in urban areas
Support the development of stormwater master plans
Support stormwater retrofits in target areas

For Hydrologic Restoration, management actions include:

Monitoring and Research
Maintain and evaluate gaged stream flow stations within the Peace and Myakka River watersheds
Work with stakeholders to quantify the effectiveness of forest management BMPs on aquifer recharge and other hydrologic restoration projects involving forest lands
Develop applicable hydrologic modeling to support large hydrologic restoration projects in strategic areas including Charlotte Harbor Flatwoods and the Cecil Webb Wildlife Management Area
Hydrologic Restoration
Support the SWFWMD's Southern Water Use Caution Area (SWUCA) recovery strategy for the Peace and Myakka Rivers
Continue to support water conservation strategies
Explore opportunities for urban stream restoration including the conversion of drainage ditches to multi-stage channels
Education and Outreach
Continue to support water conservation strategies

For Natural Systems, management actions include:

Monitoring and Research
Continue aerial mapping of seagrass and other benthic habitat in Charlotte Harbor and Lemon Bay on a 2-year cycle
Monitor filamentous macroalgae accumulation and distribution in areas of concern within Charlotte Harbor and Lemon Bay
Investigate potential linkages between red tide events and the occurrence of filamentous macroalgae blooms
Work with stakeholders to monitor the impacts of accelerated sea-level rise on coastal ecosystems
Habitat Conservation
Coordinate with the SWFWMD Operations and Land Management Bureau on potential land acquisitions
Habitat Restoration
Where appropriate, support the programs and projects identified in the CHNEP's Habitat Restoration Needs Update Plan
Encourage and support strategic projects that include design elements to restore and improve living shorelines
Coordinate forestry management and hydrologic restoration programs

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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 habitats.

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), 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 adopted by the water management district's governing board and approved by the FDEP. Before the SWIM plan can be adopted, it must undergo a review process involving the required state agencies. The purpose of this Charlotte Harbor 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 Coastal and Heartland National Estuary Partnership Comprehensive Conservation and Management Plan

The Charlotte Harbor Estuary was the sixth SWIM priority water body named since the program's inception in 1987. The first Charlotte Harbor SWIM Plan was approved in 1993. Two years later, the U.S. Environmental Protection Agency established the Charlotte Harbor National Estuary Program (CHNEP). The SWFWMD updated the original 1993 SWIM Plan in 2000. To be consistent with the CHNEP boundary, the 2000 SWIM Plan update expanded the original 1993 SWIM Plan boundary to include Lemon Bay, and Dona and Roberts Bays (Coastal Venice Basin).

In 2019, the Charlotte Harbor National Estuary Program implemented a major revision and update to its Comprehensive Conservation and Management Plan (CCMP). One of the most significant changes was the expansion of the CHNEP's boundary to include all the Caloosahatchee River watershed up to Lake Okeechobee. This additional area is within the South Florida Water Management District and does not affect the SWFWMD's boundary for the Charlotte Harbor SWIM Plan. After the expansion and update of the CCMP, the CHNEP changed its formal name to the Coastal and Heartland National Estuary Partnership, thus retaining its well-known acronym, CHNEP.

The Charlotte Harbor SWIM Plan compliments the CHNEP CCMP Action Plans for Water Quality Improvement, Hydrological Restoration and Fish, Wildlife and Habitat Protection by focusing on specific actions within the SWFWMD's area of responsibility. The SWIM Plan, like the CCMP, is a living document meant to be a guide to help navigate 21st century challenges facing the Charlotte Harbor system, Florida's second largest open water estuary. This SWIM plan update identifies Quantifiable Objectives, Management Actions and projects to address the three major focus areas of Water Quality, Hydrologic Restoration and Natural Systems Protection and Restoration.

SWIM Plan Geographic Setting

This plan encompasses both the estuarine systems and the watersheds that feed into the estuaries. The Charlotte Harbor estuarine system and its associated watersheds include areas outside the jurisdiction of the Southwest Florida Water Management District. This plan focuses only on those watersheds that fall within the SWFWMD's boundaries (Figure 1). These include Greater Charlotte Harbor (includes the Peace River, the Myakka River, and Charlotte Harbor Proper), Lemon Bay, and Dona and Roberts Bays (which together are known as the Coastal Venice Basin, which makes up the Dona & Roberts Bay watershed). In this plan, unless otherwise stated, the Dona & Roberts Bay watershed is considered part of the Lemon Bay system.

Areas that are in the South Florida Water Management District, specifically the Caloosahatchee River, Pine Island Sound and Matlacha Pass, are excluded from this plan.

Charlotte Harbor is the second largest open water estuary in Florida with a surface area of approximately 270 square miles. The combined Peace and Myakka watershed that drains into Charlotte Harbor are approximately 3,360 square miles. Therefore, the watershed to open-water ratio of Charlotte Harbor is approximately 12 to 1 and is twice that of Tampa Bay (6 to 1) (Coastal Environmental 1996) and four times that of Sarasota Bay (3 to 1) (Heyl 1992). Consequently, Charlotte Harbor experiences a greater degree of terrestrial and riverine influence than Tampa Bay or Sarasota Bay.

The climate of the Charlotte Harbor watershed is humid subtropical, with an average annual temperature of 72° F and an average annual rainfall amount of approximately 52 inches (SWFWMD 1993). Rainfall is highly seasonal, with more than half of the amount occurring during the wet season (June to September). Streamflow varies in a similar manner as rainfall, but there can be an approximate 1-month lag period between the beginning of the wet season and the increase in streamflow in the Peace and Myakka Rivers. In addition, streamflow in April and May is typically lower than streamflow in November, although November has the lowest average rainfall of any month (Hammett 1990). The low streamflow values in April and May are thought to be due to a combination of low rainfall, low amounts of antecedent rainfall, and increasing evapotranspiration rates.

Greater Charlotte Harbor

Greater Charlotte Harbor includes Charlotte Harbor Proper, Peace River, and Myakka River. Pine Island Sound and Matlacha Pass are outside of the SWFWMD jurisdiction and therefore are not included in this plan. However, small portions of the Charlotte Harbor Proper and Peace River Watersheds do extend into the SFWMD. In those instances, the SWFWMD and the SFWMD work in collaboration to identify management actions and implement projects that cross District boundaries.

Greater Charlotte Harbor is influenced largely by freshwater inflows from the Peace and Myakka Rivers. The Peace River watershed, which is approximately 2,350 square miles (Hammett 1990), is nearly four times as large as the Myakka River watershed (602 square miles) (Hammett 1990) and 12 times as large as the estuary into which it drains (Tomasko and Hall 1999). Approximately 408 square miles of land drain into Charlotte Harbor directly, including most of the southwestern corner of Charlotte County south of the City of Punta Gorda, and most of the Cape Haze Peninsula.

Charlotte Harbor Basin Boundaries

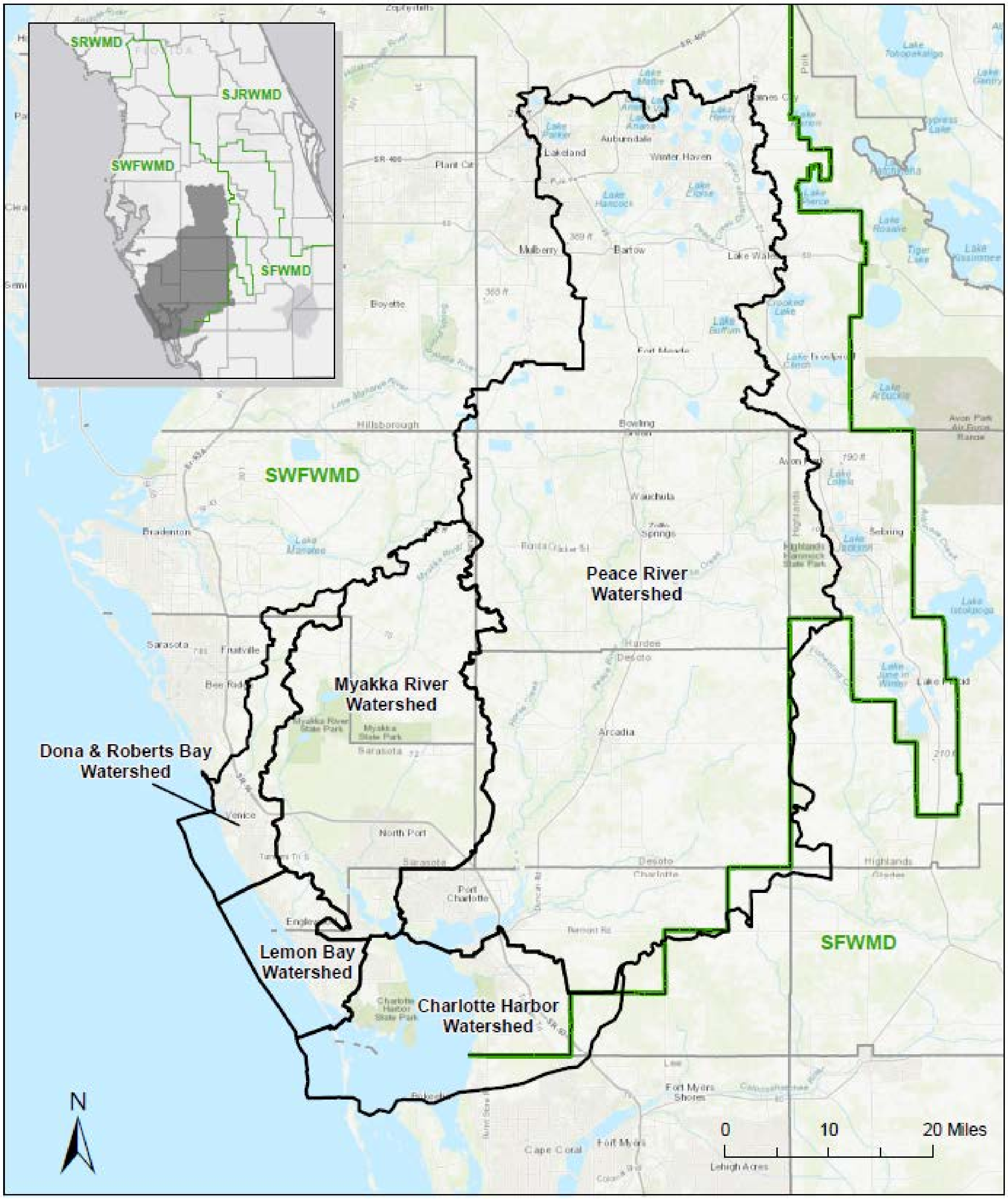


Figure 1 – Basin boundaries for the Charlotte Harbor Estuary including Dona & Roberts Bay and Lemon Bay Watersheds. Source: SWFWMD Mapping and GIS Section.

Charlotte Harbor Proper

Charlotte Harbor Proper includes the immediate watershed including most of the Cape Haze Peninsula, the City of Punta Gorda, and a small portion of northern Lee County (Figure 2). Most of the harbor is surrounded by an extensive conservation buffer system of well over 53,398 acres that both the State of Florida and the SWFWMD began purchasing in the 1970s. Much of the shoreline in this buffer system is unaltered mangrove and salt marsh habitats, thereby providing abundant food and shelter for juveniles of many of the harbor's estuarine species.

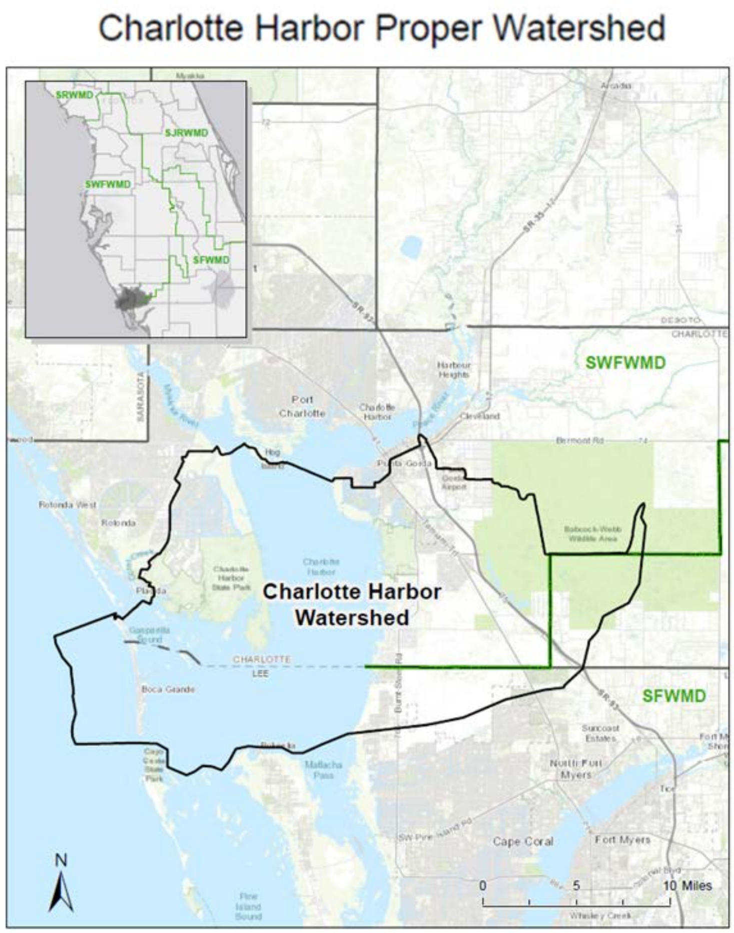


Figure 2 – Basin boundary for the Charlotte Harbor Estuary Watershed. Source: SWFWMD Mapping and GIS Section.

Charlotte Harbor Proper Land Use/Land Cover

The Charlotte Harbor Proper watershed is 128,720 acres and is largely characterized by natural areas and open water. In 2017, the natural areas and open water made up 47.1% (60,588 acres) and 27.9% (35,897 acres) of the watershed, respectively. The relatively large proportion in natural areas is due in large part to the presence of the Gasparilla Sound-Charlotte Harbor Aquatic Preserve, which is part of the 180,000-acre Charlotte Harbor Aquatic Preserves and was established in 1975 (Figure 3).

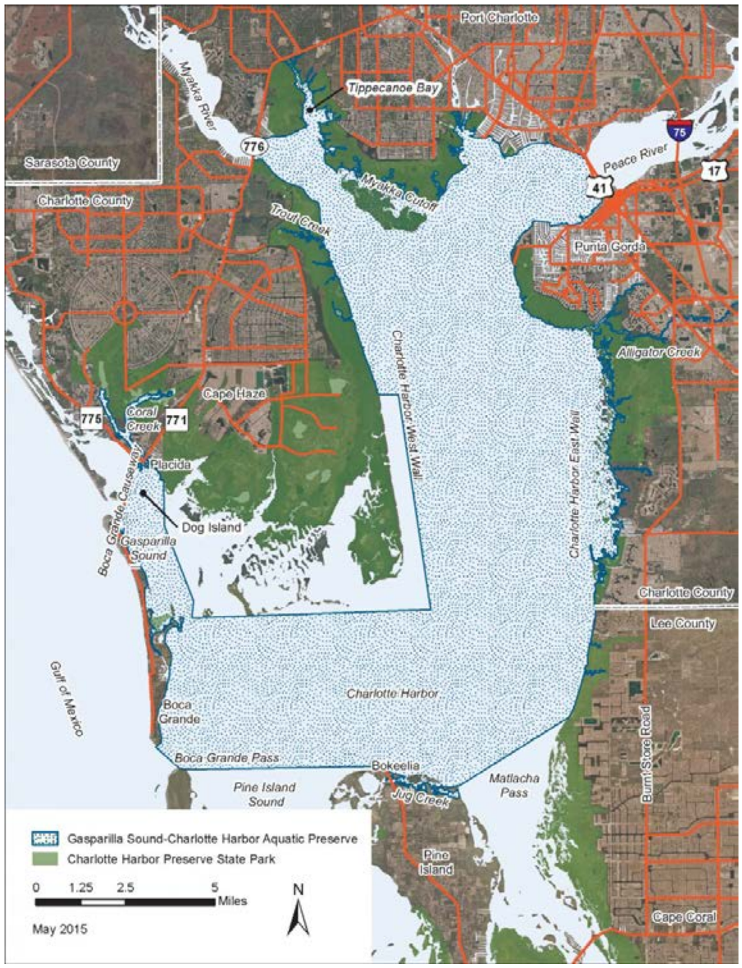


Figure 3 – Gasparilla Sound-Charlotte Harbor Aquatic Preserve and Charlotte Harbor State Park. Source: Florida Department of Environmental Protection.

Since 1995, 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 1). In 1995, 16.6% of the watershed was classified as urban and disturbed, whereas in 2017 that percentage increased to 20.1%. Conversely, the watershed saw a decrease in natural areas from 50.3% of the watershed in 1995 to 47.1% in 2017. Agricultural land use decreased from 5.6% in 1995 to 4.9% in 2014 (Figure 4 and Figure 5).

Charlotte Harbor Proper Watershed						
	1995		2009		2017	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	21,376	16.6%	25,234	19.6%	25,921	20.1%
Agricultural	7,244	5.6%	6,240	4.8%	6,313	4.9%
Natural Areas	64,731	50.3%	61,450	47.7%	60,588	47.1%
Water	35,369	27.5%	35,796	27.8%	35,897	27.9%
Totals	128,720	100.0%	128,720	100.0%	128,720	100.0%

Table 1 – Land use change by acres and percent for the Charlotte Harbor Proper Watershed. Source: SWFWMD Mapping and GIS Section.

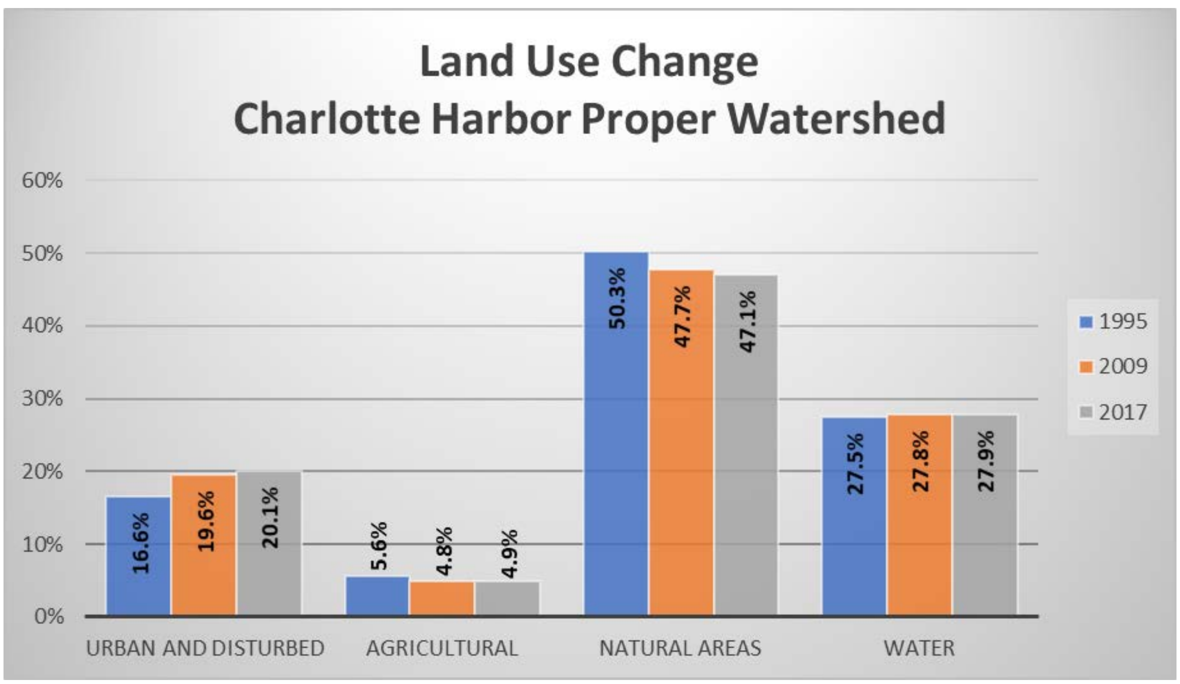


Figure 4 – Land use change for the Charlotte Harbor Proper Watershed for the years 1995, 2009, and 2017. Source: SWFWMD Mapping and GIS Section.

Charlotte Harbor Proper Watershed Land Use
in 1995, 2009, and 2017

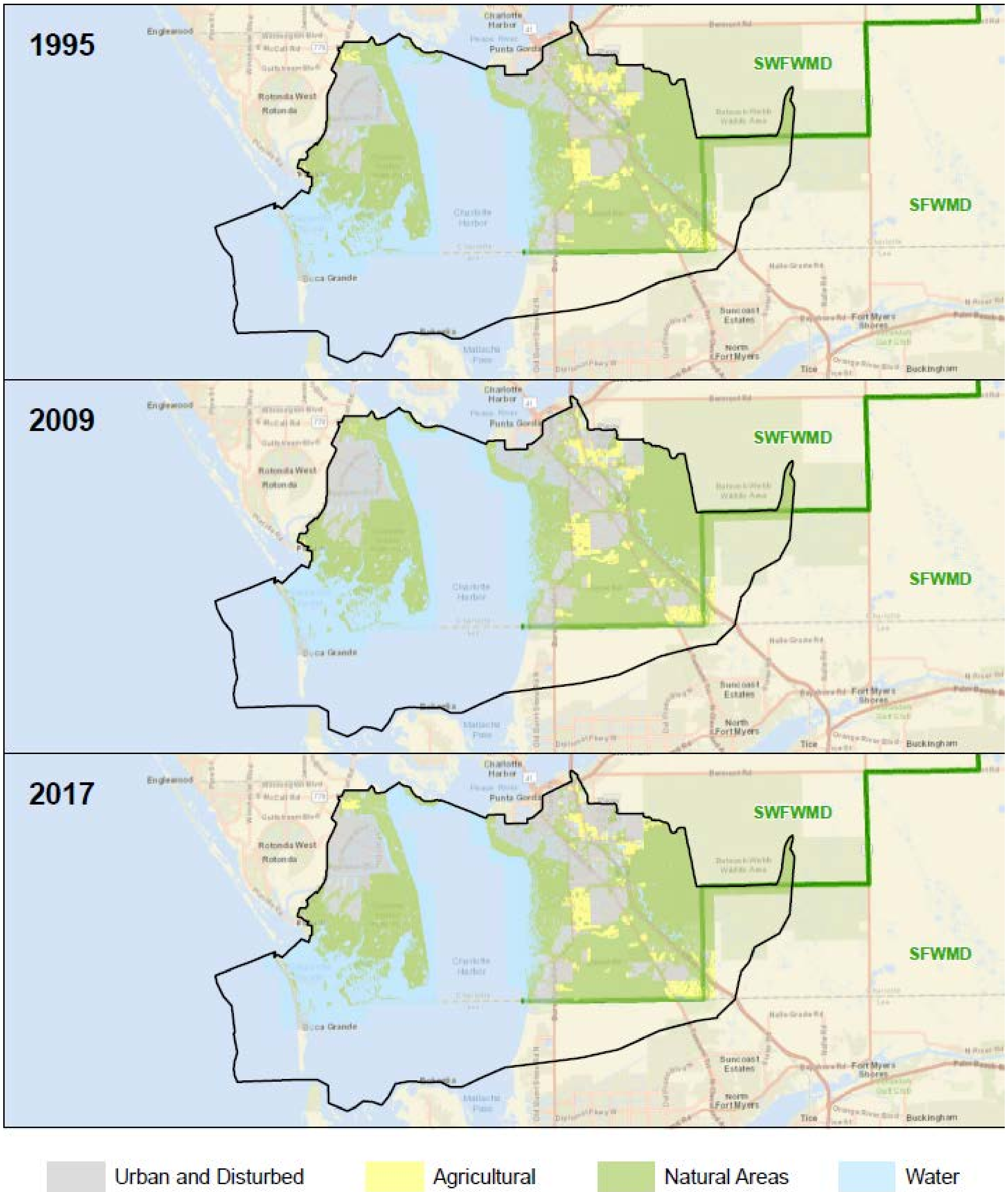


Figure 5 – Land use changes in the Charlotte Harbor Proper Watershed. Source: SWFWMD Mapping and GIS Section.

Peace River

At 2,315 square miles, the Peace River watershed is the largest and most diverse in the CHNEP study area (Figure 6). The river originates at the Green Swamp in central Polk County, draining a series of wetlands and lakes. The rate of river flow is directly proportional to groundwater levels. Underground and overland flows follow natural and altered paths through canals, flood control structures, former and active phosphate mines, wetlands, and Lake Hancock. South of Lake Hancock, canals and tributaries combine to define the main channel of the Peace River that eventually flows more than 100 miles southwest to Charlotte Harbor. Phosphate mining has been a major land use in the Polk County headwaters of the Peace River for more than a century, altering the hydrology, flora, and fauna of the landscape. State law requires all lands mined after July 1, 1975, to be reclaimed. In addition, the adoption of a state trust fund in 1977 allowed a portion of areas mined prior to 1975 to be voluntarily reclaimed. Citrus, cattle ranching, and row crop farming also occur in Polk County, but are more common downstream in Hardee, DeSoto, and Highlands Counties. The Peace River is the largest freshwater contributor to the Charlotte Harbor and is also used for public supply by the Peace River Manasota Regional Water Supply Authority (Authority). The Authority is tasked with providing the region with high-quality, safe drinking water that is reliable, sustainable, and protective of the natural resources. The Authority encompasses all or parts of Charlotte, DeSoto, Manatee, and Sarasota Counties servicing more than 900,000 people. The Peace River basin is of concern to the Florida Legislature, which directed the FDEP to study the cumulative effects of major changes in "landform and hydrology in the Peace River basin." In March 2007, the FDEP transmitted the *Peace River Basin Resource Management Plan* to the Florida Legislature. The plan was based on the *Peace River Cumulative Impact Study,* which is available at www.dep.state.fl.us/water/mines/.

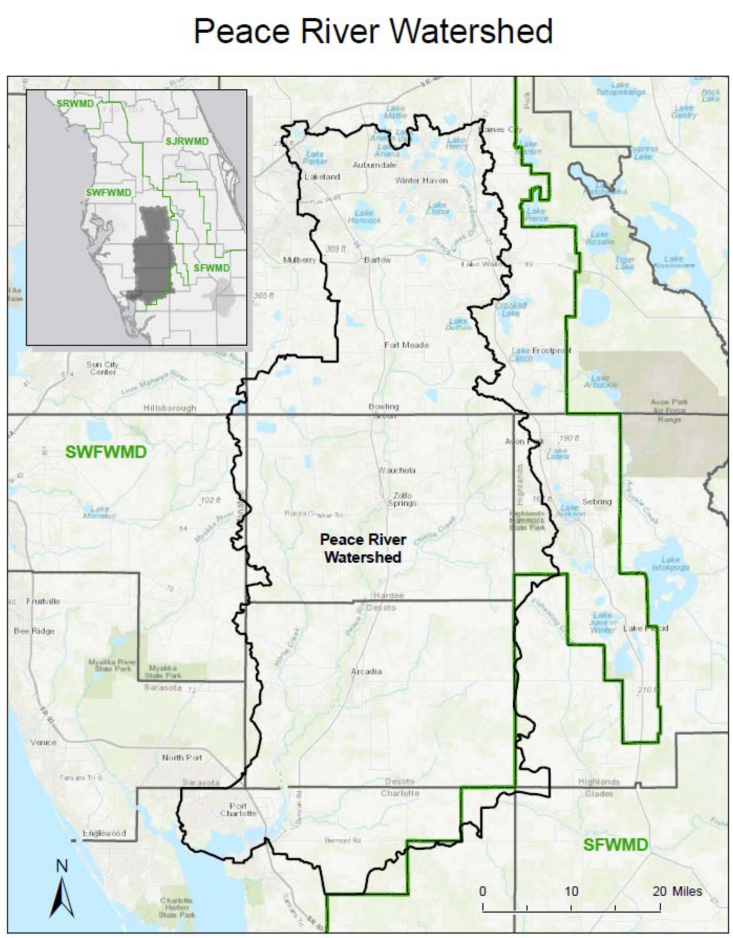


Figure 6 – Basin boundary for the Peace River Watershed. Source: SWFWMD Mapping and GIS Section.

Peace River Land Use/Land Cover

The Peace River watershed is the largest watershed in the Charlotte Harbor system encompassing an area of approximately 1.47 million acres. Land use in the Peace River watershed is largely characterized as mining and agriculture (Table 2). Mining is grouped under the Urban and Disturbed land use class which made up 24.7% of the watershed's land use in 2017. A significant portion of the Peace River watershed is also characterized as natural areas. In 2017, agriculture made up 39.5% (581,495 acres) of the watershed while natural areas made up 31.3% (461,129 acres). The urban and disturbed land use class made up 24.7% (363,343 acres).

Peace River Watershed						
	1995		2009		2017	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	281,235	19.1%	354,159	24.0%	363,343	24.7%
Agricultural	647,526	43.9%	594,429	40.3%	581,495	39.5%
Natural Areas	486,557	33.0%	458,069	31.1%	461,129	31.3%
Water	58,183	3.9%	66,844	4.5%	67,534	4.6%
Totals	1,473,501	100.0%	1,473,501	100.0%	1,473,501	100.0%

Table 2 – Land use change by acres and percent for the Peace River Watershed. Source: SWFWMD Mapping and GIS Section.

Since 1995, the Peace River watershed has experienced a decrease in agriculture and an increase in urban and disturbed areas (Figure 7 and Figure 8). Agricultural land use decreased from 43.9% in 1995 to 39.5% in 2017 while urban and disturbed increased from 19.1% in 1995 to 24.7% in 2017. Natural areas decreased slightly from 33.0% in 1995 to 31.3% in 2017. Between 2009 and 2017 there was a slight increase in natural areas from 31.1% to 31.3%, respectively.

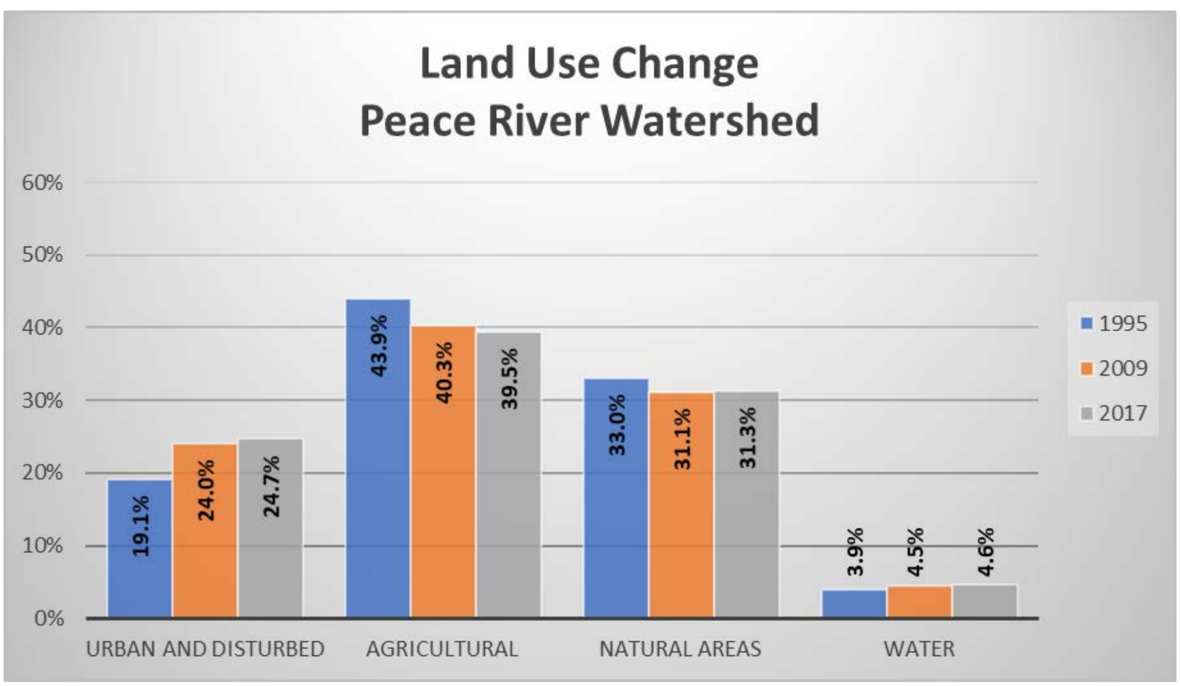


Figure 7 – Land use change for the Peace River Watershed for the years 1995, 2009, and 2017. Source: SWFWMD Mapping and GIS Section.

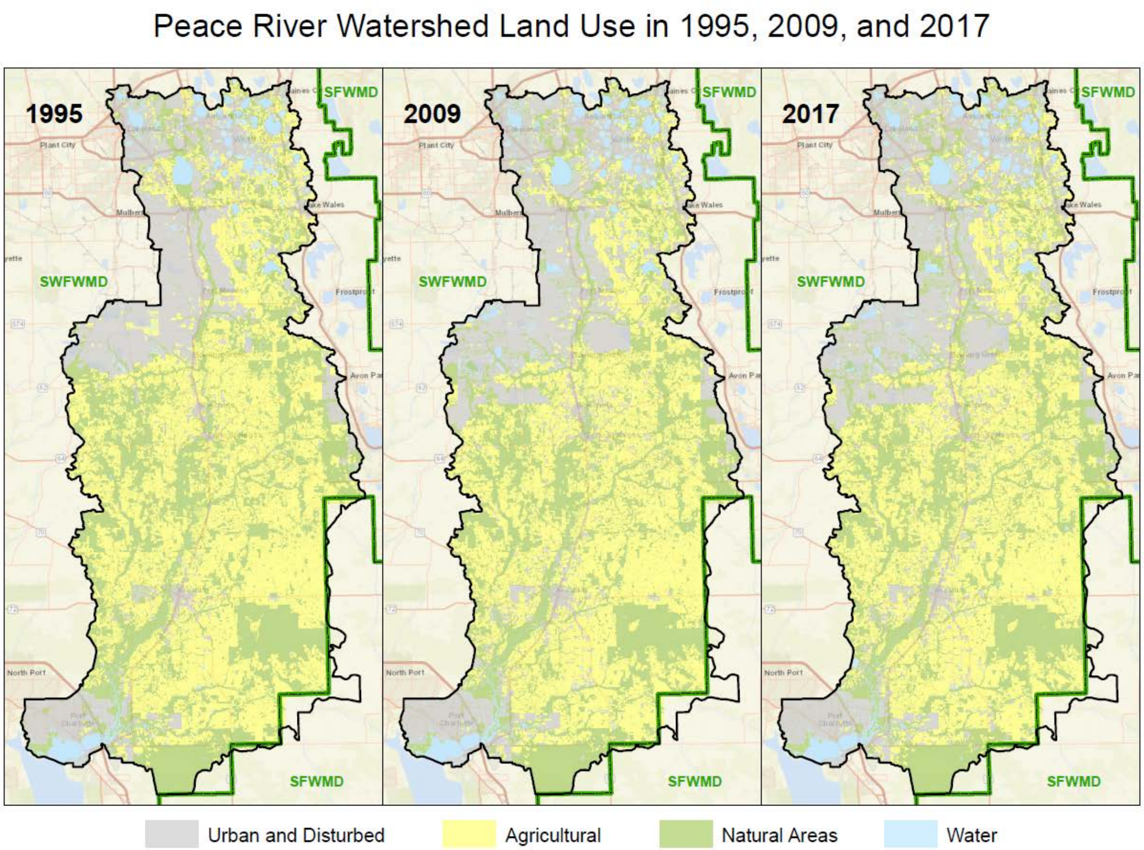


Figure 8– Map view of land use changes in the Peace River Watershed. Source: SWFWMD Mapping and GIS Section.

Myakka River

The Myakka River watershed has the largest contiguous wetland landscape of the three Greater Charlotte Harbor watersheds (Figure 9). The 66-mile river begins its southerly flow from headwaters in Manatee and Hardee Counties. After following a narrow floodplain forest corridor, the river slows and enters a series of lakes in Myakka River State Park, the largest state park in Florida. Deer Prairie Creek and Big Slough feed the river as it widens and enters Charlotte Harbor. The 34-mile portion of Myakka River in Sarasota County is designated a Florida Wild and Scenic River.

Cattle ranching dominates most of the watershed, especially upstream of Myakka River State Park. To satisfy the need for range and pastureland, much of the watershed was drained and diverted. These alterations enabled some of the drained area to be used for row crops and citrus groves. Other parts of the upper and central portions of the Myakka River watershed have been acquired for state management and protection. In the lower portion of the Myakka River watershed, urban development is displacing agriculture. Former grazing lands along the banks of the lower Myakka River are now being converted to urban uses, mostly homes. Construction is occurring on the vast inventory of lands that were platted in the 1960s. At that time, these plats displaced agriculture in western Port Charlotte and in the City of North Port. The Myakka River now becomes even more important to these areas, supplying their drinking water as well as habitat for fish and wildlife.

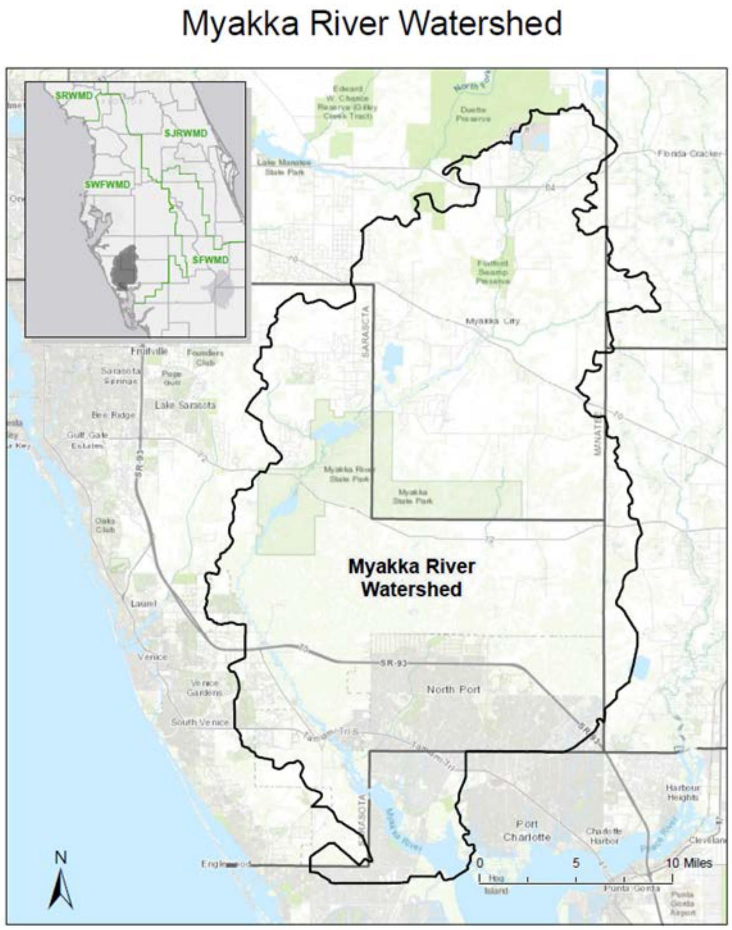


Figure 9 – Basin boundary for the Myakka River Watershed. Source: SWFWMD Mapping and GIS Section.

Myakka River Land Use/Land Cover

Compared to the other Charlotte Harbor watersheds, the Myakka River watershed has the greatest proportion of land classified as natural areas, which includes wetlands, upland forests, and rangelands (Table 3). Within the watershed is the Myakka River State Park and this together with other conservation lands owned by the state, SWFWMD, and local governments, encompasses over 100,000 acres of conservation land within this watershed. Cattle ranching dominates much of the watershed, especially upstream of the Myakka River State Park. In 2017, the natural areas land use class made up 52.2% (199,947 acres) of the watershed. The next dominant land use in this watershed is agriculture, making up 24.6% (94,212 acres), followed by urban and disturbed at 20.2%.

Myakka River Watershed						
	1995		2009		2017	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban & Disturbed	55,590	14.5%	74,472	19.5%	77,156	20.2%
Agricultural	101,158	26.4%	95,938	25.1%	94,212	24.6%
Natural Areas	215,656	56.3%	201,315	52.6%	199,947	52.2%
Water	10,483	2.7%	11,162	2.9%	11,572	3.0%
Totals	382,887	100.0%	382,887	100.0%	382,887	100.0%

Table 3 – Land use change by acres and percent for the Myakka River Watershed. Source: SWFWMD Mapping and GIS Section.

From 1995 to 2017, the urban and disturbed land use class had the greatest percent change, increasing 5.6% from 14.5% in 1995 to 20.1% in 2017 (Figure 10 and Figure 11). Natural areas and agricultural areas decreased over the same period from 56.3% of the watershed in 1995 to 52.2% in 2017, and from 26.4% in 1995 to 24.6% in 2017, respectively.

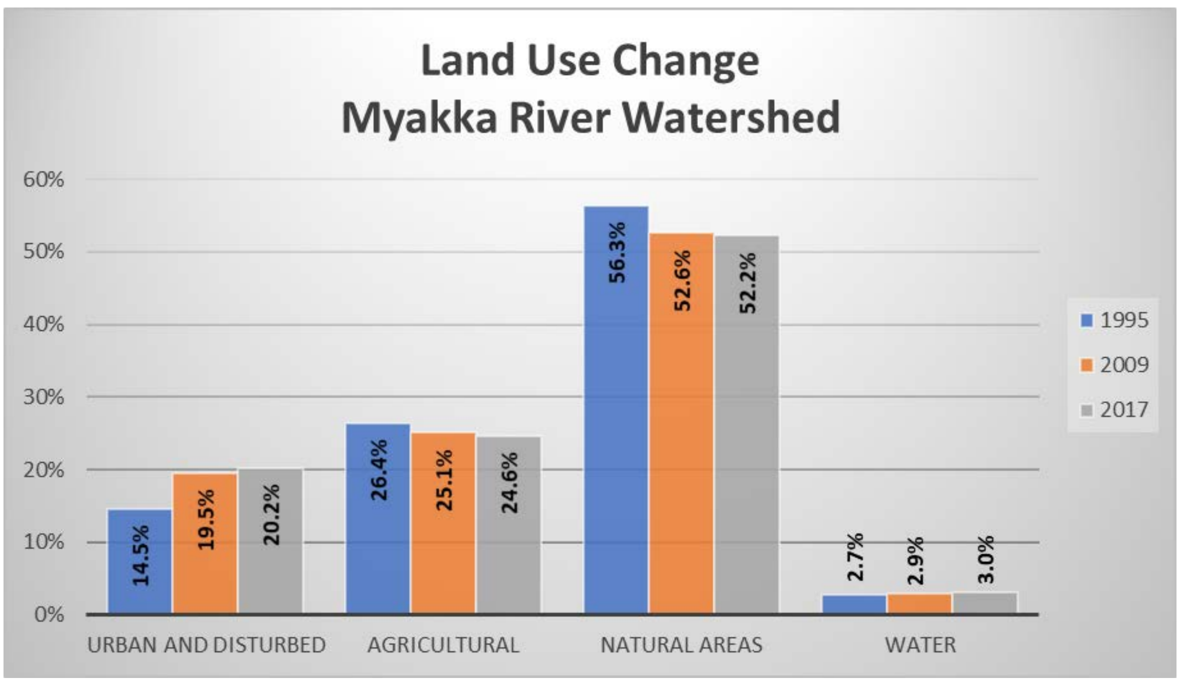


Figure 10 – Land use change for the Myakka River Watershed for the years 1995, 2009, and 2017. Source: SWFWMD Mapping and GIS Section.

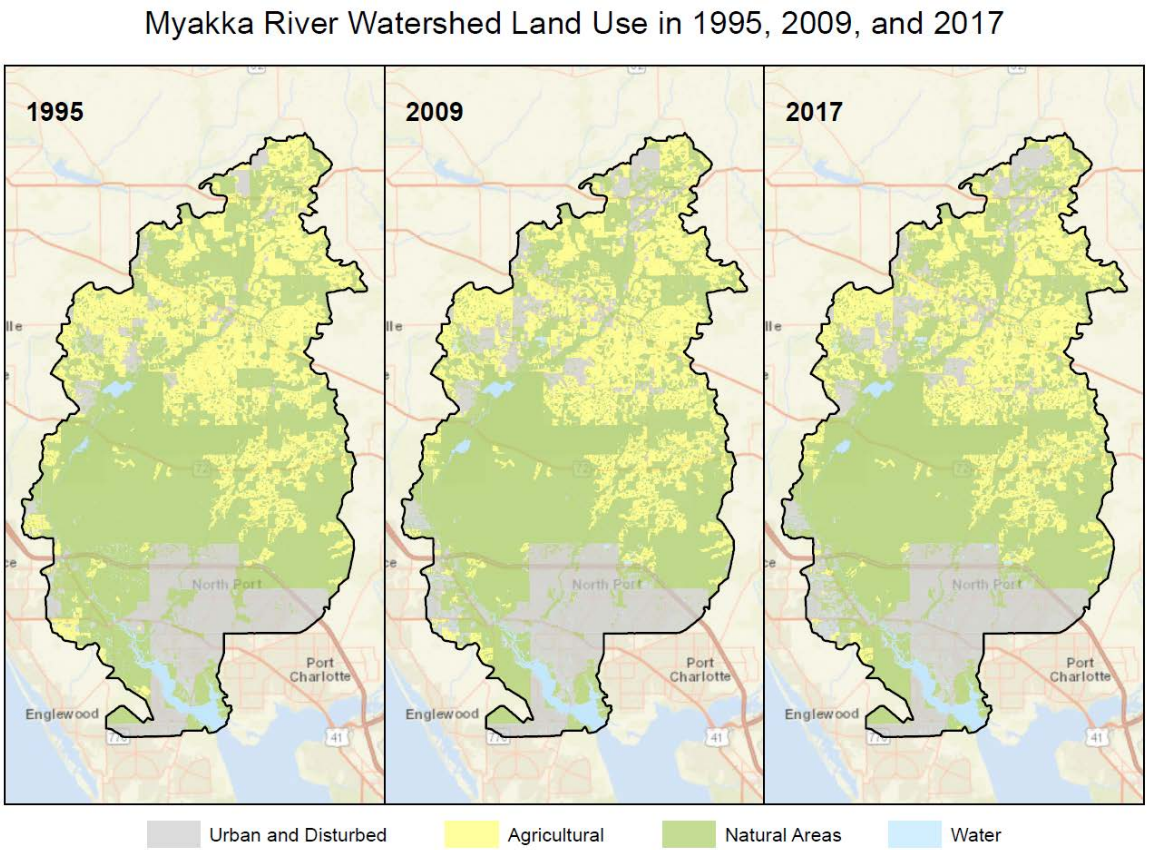


Figure 11– Map view of land use changes in the Myakka River Watershed . Source: SWFWMD Mapping and GIS Section.

Lemon Bay

Lemon Bay is hydrologically linked to Charlotte Harbor via Gasparilla Sound. To the north, Lemon Bay is connected to the Dona & Roberts Bay watershed. Unlike Charlotte Harbor, Lemon Bay's watershed is much smaller at 91.2 square miles (Figure 12). Historically, the tidal creeks that flow into Lemon Bay have been significantly altered by the construction of mosquito ditches and flood control conveyances. Land survey from the mid-1800s confirms that most of Lemon Bay's coastal bayous did not extend very far inland (Janicki and JEA 2010). Land use in the watershed in the 1940s was essentially undeveloped. Today much of the land along the coastal margins has been developed though significant portions of the interior central and southern sections are still largely undeveloped. Lemon Bay is a subtropical estuary dominated by mangroves, seagrass, and oysters. It has a narrow and elongated shape with an average width of only 0.75 miles. The widest sections of the bay are only 1.2 miles wide. The pre-dredged average depth of the bay was approximately 4 feet at mean high water. After the construction of the Intracoastal Waterway, the average depth of the bay increased to 6.5 feet at mean high water.

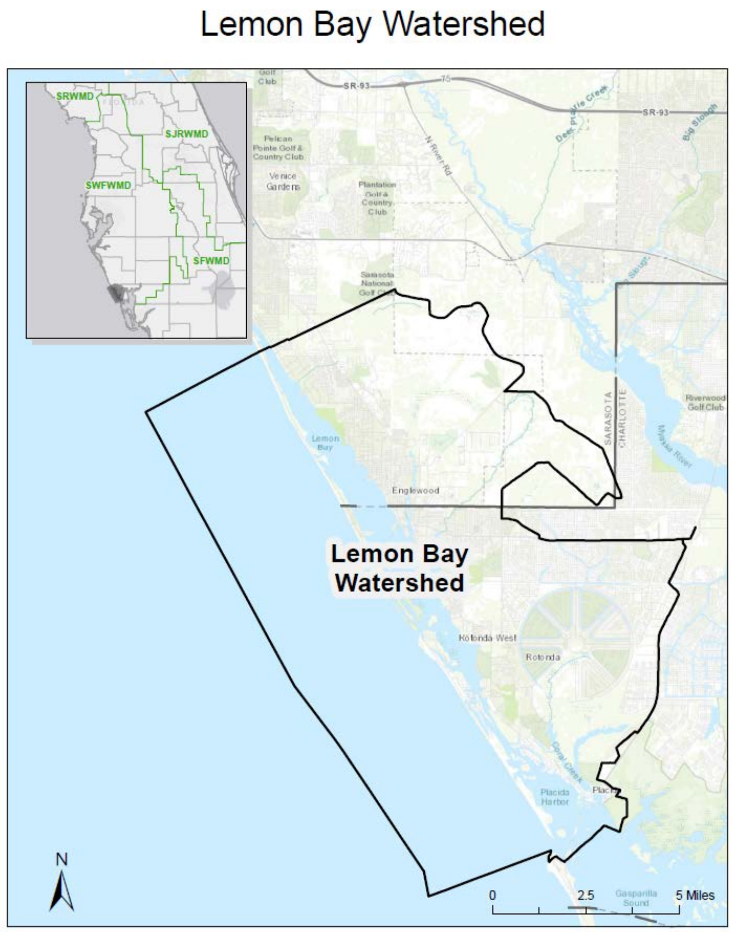


Figure 12 – Basin boundary for the Lemon Bay Watershed. Source: SWFWMD Mapping and GIS Section.

Lemon Bay Land Use/Land Cover

The Lemon Bay watershed is the smallest watershed by area with a total of 58,357 acres. Most of this watershed is heavily developed. Despite its urban character and significant hydrologic alterations via channelization and canals, much of the watershed still retains its historical wetland and mangrove habitats. In 2017, the urban and disturbed land use class made up 40.7% (23,768 acres), natural areas made up 26.8% (15,650 acres), and agriculture made up only 4.7% (2,765 acres) of the watershed (Table 4). The greatest percent change from 1995 to 2017 occurred in natural areas with a 4.5% decrease (Figure 13). Conversely, the urban and disturbed land use class increased from 36.3% in 1995 to 40.7% in 2017.

Lemon Bay Watershed						
	1995		2009		2017	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban and Disturbed	21,203	36.3%	23,300	39.9%	23,768	40.7%
Agricultural	2,719	4.7%	3,998	6.9%	2,765	4.7%
Natural Areas	18,292	31.3%	14,975	25.7%	15,650	26.8%
Water	16,143	27.7%	16,085	27.6%	16,175	27.7%
Totals	58,357	100.0%	58,357	100.0%	58,357	100.0%

Table 4 – Land use change by acres and percent for the Lemon Bay Watershed. Source: SWFWMD Mapping and GIS Section.

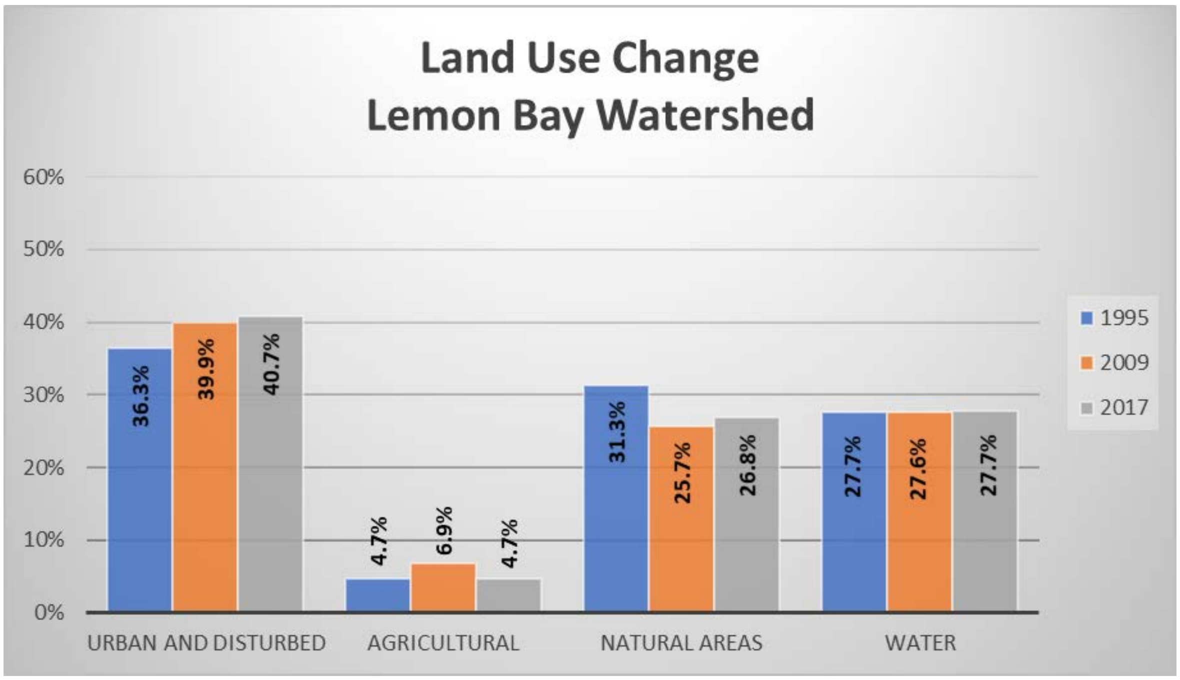


Figure 13 – Land use change for the Lemon Bay Watershed for the years 1995, 2009, and 2017. Source: SWFWMD Mapping and GIS Section.

Much of the agricultural land use is concentrated in the inland areas of the northern portion of the watershed (Figure 14). Most of the urban land use is along the coast and in the Rotonda development. Natural areas are spread throughout the watershed though much is concentrated in the headwaters of Coral Creek with large tracts of conservation land owned by the SWFWMD and Sarasota County.

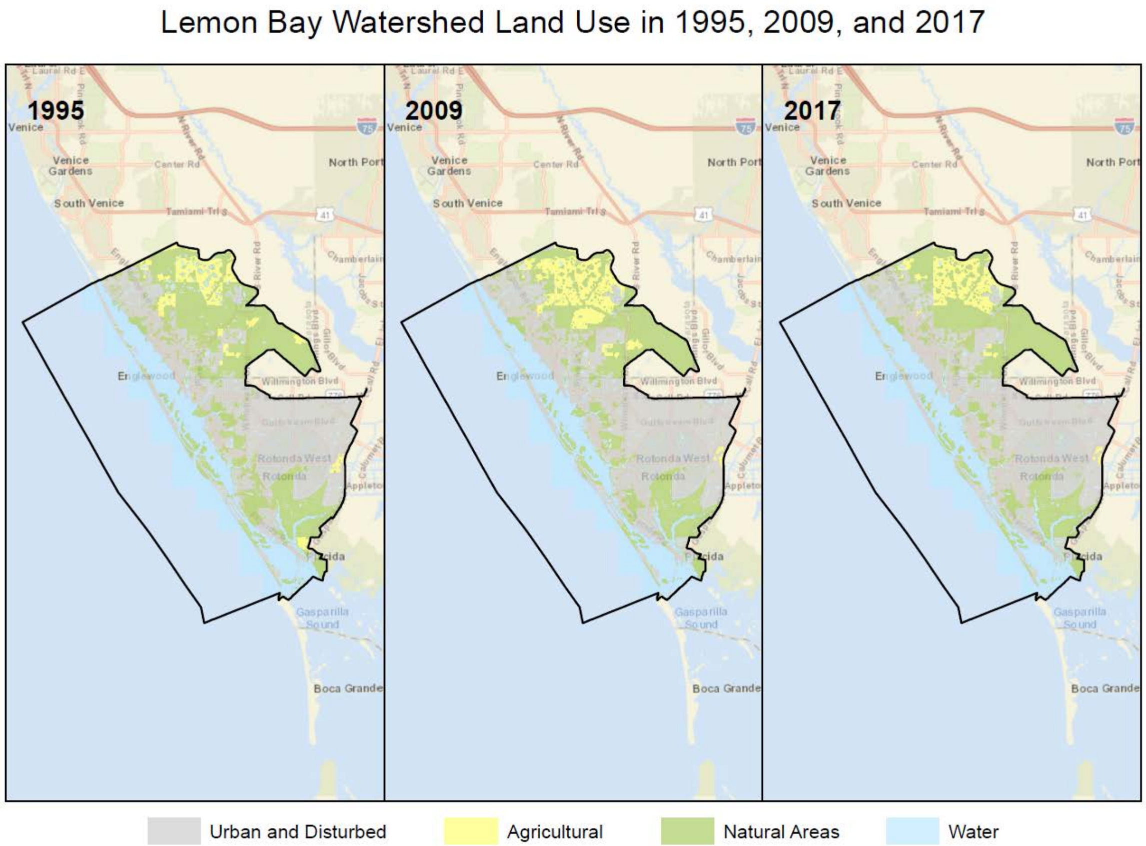


Figure 14 – Map view of land use changes in the Lemon Bay Watershed. Source: SWFWMD Mapping and GIS Section.

Dona & Roberts Bay Watershed (Coastal Venice Basin)

Compared to the Greater Charlotte Harbor watershed, the Dona & Roberts Bay watershed are much smaller, with an area of approximately 97.4 square miles (Figure 15). Like Lemon Bay, the Dona & Roberts Bay watershed is hydrologically linked to Charlotte Harbor. The Dona & Roberts Bay watershed has experienced major hydrologic alterations beginning in the early part of the 20th century with the construction of a ditch to extend Salt Creek to the southern end of the original Cow Pen Slough. The quest to drain Cow Pen Slough lasted for about 50 years, resulting in much greater amounts of freshwater entering Dona Bay and profoundly altering the ecology the system. In Roberts Bay, the completion of Blackburn Canal in the late 1960s was designed to reduce downstream flooding in the lower Myakka River by diverting a portion of high water flows out of the Myakka River and into Roberts Bay via Curry Creek. The long-term result of these hydrologic alterations has been lowered salinities and increased sediment and nutrient loads.

Dona & Roberts Bay Watershed

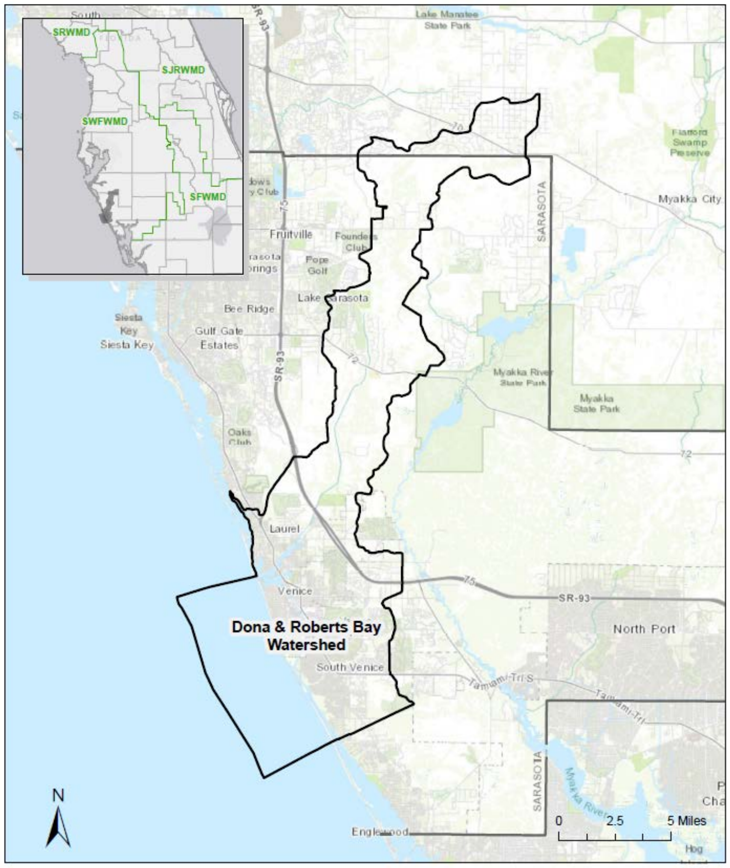


Figure 15 – Basin boundary for the Dona & Roberts Bay Watershed . Source: SWFWMD Mapping and GIS Section.

Dona Bay and Roberts Bay Land Use/Land Cover

The Dona and Roberts Bay watershed is the second smallest watershed by area (78,001 acres), second only to Lemon Bay. The watershed is also the most urbanized of all the Charlotte Harbor watersheds comprising 42% (33,021 acres) of the watershed (Table 5). Urban land use increased sharply from 29% (22,407 acres) in 1995 to 40% (31,506 acres) in 2009, an increase of almost 12% (Figure 16). Over the same period, there was a significant loss of natural areas from just under 42% (32,591 acres) of the watershed in 1995 to 31% (24,501 acres) in 2009, a 10% loss of natural areas. While urbanization occurred across the watershed, much of the change from natural areas to urban occurred in the far northern reaches of the watershed near the Lakewood Ranch developments. From 2009 to 2017, the trend from natural areas to urban continued though at a much slower pace. Urban land-use increased just under 2% between 2009 and 2017 and natural areas decreased by only 1%.

Dona & Roberts Bay Watershed						
	1995		2009		2017	
Use	Acres	Percentage	Acres	Percentage	Acres	Percentage
Urban and Disturbed	22,407	28.7%	31,506	40.4%	33,021	42.3%
Agricultural	15,525	19.9%	14,267	18.3%	13,367	17.1%
Natural Areas	32,591	41.8%	24,501	31.4%	23,575	30.2%
Water	7,478	9.6%	7,727	9.9%	8,038	10.3%
Totals	78,001	100.0%	78,001	100.0%	78,001	100.0%

Table 5 – Land use change by acres and percentages for the Dona & Roberts Bay Watershed. Source: SWFWMD Mapping and GIS Section.

In 1995, agricultural land use made up approximately 20% (15,525 acres) of the watershed. While there has been a decrease in agricultural land use over the period 1995 to 2017, the decline has been gradual, especially when compared to the loss of natural areas. In 2009, agricultural land use decreased by 1.6% and in 2017, decreased another 1.2%.

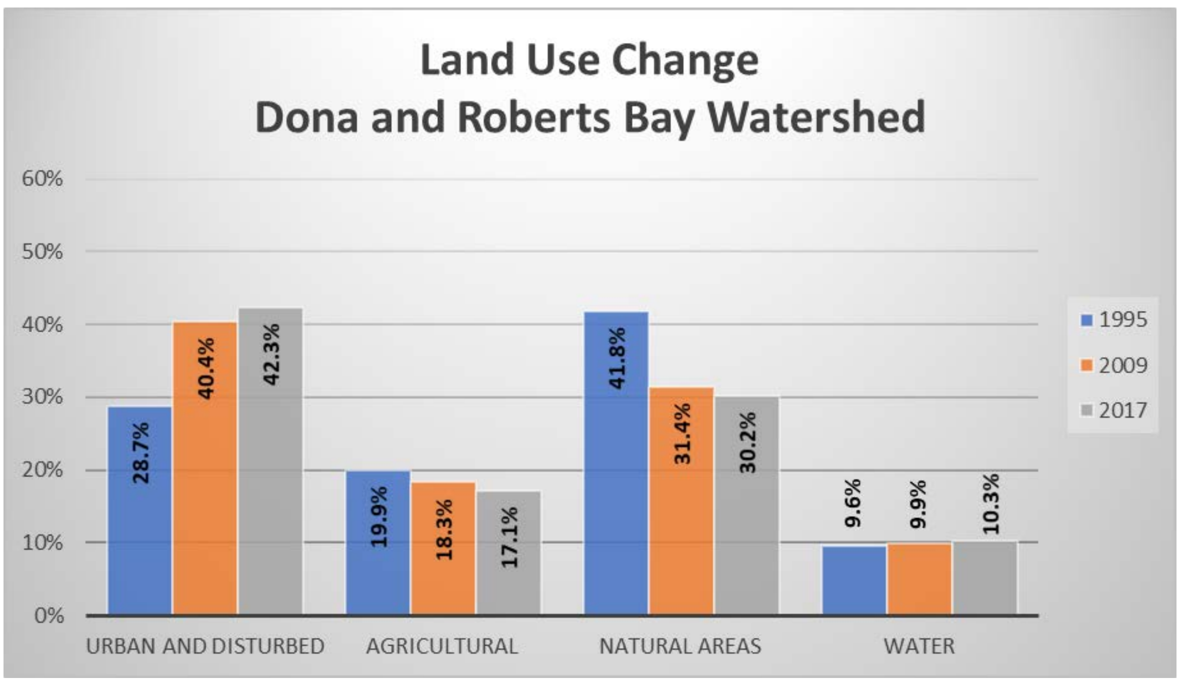


Figure 16 – Land use change for the Dona & Roberts Bay Watershed for the years 1995, 2009, and 2017. Source: SWFWMD Mapping and GIS Section.

Most of the urban development is confined near the coast in the communities of Laurel, Venice, Venice Gardens, and South Venice, though there is a large section of the far northern region of the watershed that has also been urbanized (Figure 17).

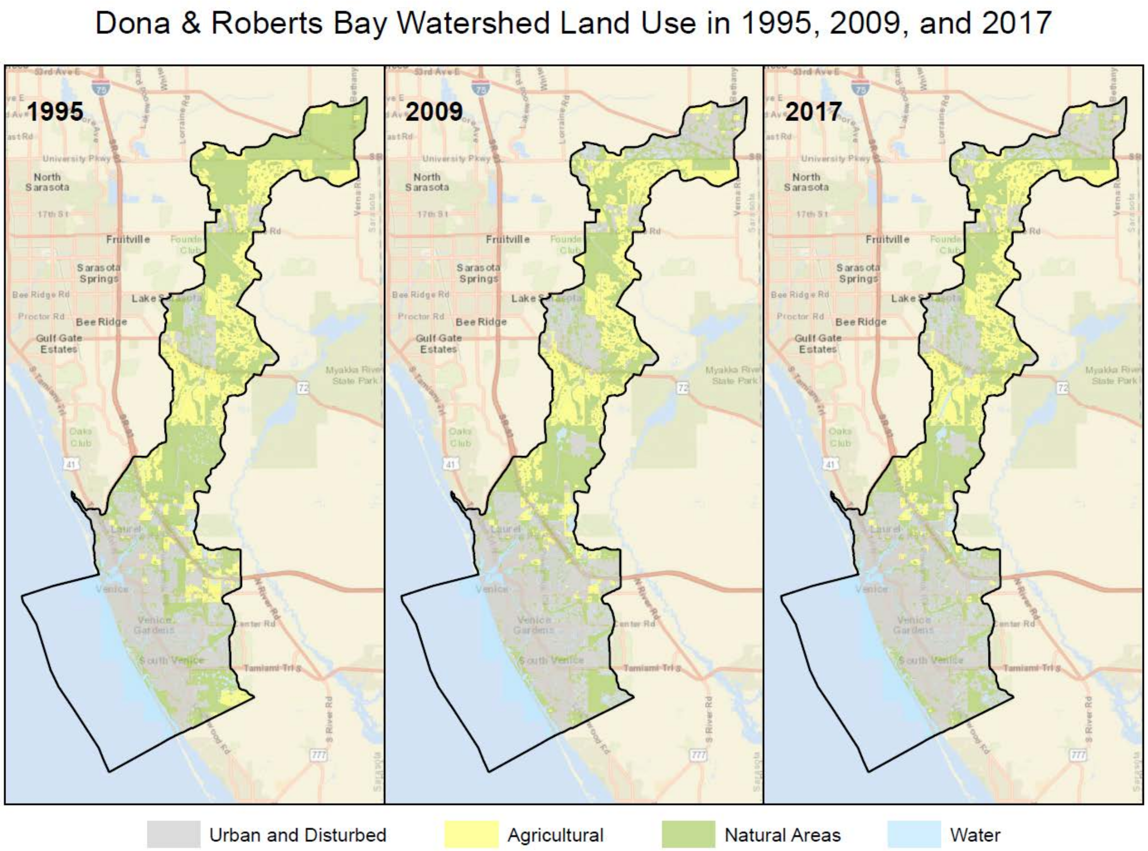


Figure 17 – Map view of land use changes in the Dona & Roberts Bay Watershed . Source: SWFWMD Mapping and GIS Section.

Issues and Drivers

Water Quality

The 2000 SWIM Plan update included an analysis of water quality status and trends over a 20-year period of record from 1976 to 1996, and concluded the following:

- Total Phosphorus (TP) concentrations declined significantly over the period of record
- No trends in Total Kjeldahl Nitrogen (TKN) concentrations were detected
- No trends in Chlorophyll-a concentrations (an indicator of water column algae abundance) were detected
- Salinity decreased concurrent with an increasing trend in streamflow in the Lower Peace River
- Dissolved Oxygen (DO) concentrations declined significantly, and the decline was attributed to an increasing frequency of stratification-driven hypoxia under conditions of increased streamflow
- There was no apparent trend in the number of months with hypoxic conditions during the period 1975 to 1989

Based on these analyses, specifically TP, TKN, and chlorophyll-a, there was no evidence of a nutrient imbalance and therefore the 2000 SWIM Plan concluded that in terms of water quality, Charlotte Harbor was a healthy estuarine ecosystem.

To build upon the trend analysis conducted in the 2000 SWIM Plan Update, trend analyses were completed using all available water quality data for TN, TP and chlorophyll-a at both the regional and WBID levels (Appendix A). To increase the sample size for trend analysis, data were examined for the years 2000 to 2017, using water quality data provided by FDEP for WBID-level analyses. This period of record was chosen, as it corresponds to the period of record just after the last SWIM Plan was produced, and results here can be compared with findings from that plan. Below is a summary of the conclusions from this effort:

- There is no evidence of degrading water clarity over the period of 2000 to 2017 for any of the regions examined.
- There is evidence of improving water clarity over those same years for Charlotte Harbor, the tidal Peace and Myakka Rivers, and Lemon Bay.
- There is no evidence of increasing concentrations of chlorophyll-a over the period of 2000 to 2017 for any of the regions examined.
- There is evidence of declining concentrations of chlorophyll-a over those same years in the tidal reaches of the Peace River.
- There is evidence of declining concentrations of TN over those same years in the tidal reaches of the Peace and Myakka Rivers, Charlotte Harbor, and Gasparilla Sound.
- There is no evidence of increasing concentrations of TP over the period of 2000 to 2017 for any of the regions examined; and
- There is evidence of declining concentrations of TP in the tidal reaches of the Peace and Myakka Rivers, Charlotte Harbor, Gasparilla Sound, and Lemon Bay.
- There is no evidence of increasing concentrations of TN over the period of 2000 to 2017 for any of the regions examined, except for Lemon Bay.

These trend analyses suggest that water quality over the past 17 years is either non-trending or trending towards improvements across the region. The only exception is Lemon Bay where there is evidence of an increasing trend in TN concentration. It is important to note that the trend analyses completed in 2000 and updated here focus on nutrients and the nutrient-chlorophyll-light, paradigm. This paradigm is well established in many estuarine systems including nearby Sarasota Bay and Tampa Bay. Lemon Bay may also fit into this paradigm. Charlotte Harbor, however, is unique in that nutrients are not a major driver of water clarity.

Good water clarity is not only aesthetically pleasing to humans but necessary for seagrass survival. In many estuaries, including nearby Sarasota Bay and Tampa Bay, phytoplankton are the major driver of water clarity, but not so in Charlotte Harbor. A unique characteristic of the Harbor is the relatively high concentrations of colored dissolved organic matter (CDOM). CDOM, also known simply as color, is made up of naturally occurring tannic acids, and other tannin-like substances. These complex organic compounds are associated with wetland vegetation and soils. Tannins naturally leach out of wetland plants, including cypress trees, mangroves, and marsh grasses, and turn the water a brown tea color. The Peace River is a major source of color, especially during the wet season when large quantities of freshwater discharge into the harbor. Tannins strongly absorb light in the blue wavelengths greatly reducing water clarity and blocking light from penetrating to the bottom. The loss of light with depth is called light attenuation (Kd). In Charlotte Harbor, color is the major attenuator of light (McPherson and Miller 1987). Tomasko and Hall (1999) confirmed that seagrass productivity and biomass in Charlotte Harbor were a function of CDOM and not phytoplankton. Because Charlotte Harbor receives a significant amount of freshwater from the Peace and Myakka Rivers, Tomasko and Hall (1999) also found salinity to be a major driver of light attenuation with CDOM and salinity being tightly correlated.

Like seagrass, dissolved oxygen (DO) is also an important indicator of estuarine health. Like the air we breathe on land, dissolved oxygen in water is critical for the health of fish and other animals that live underwater. Because Charlotte Harbor receives large amounts of freshwater, primarily during the wet season, from the Peace and Myakka Rivers, and because of the density differences between fresh and saltwater, the Harbor experiences periods of very low DO concentrations when salinity stratification traps higher density saltwater underneath the less dense freshwater. The lack of adequate DO known as hypoxia, occurs when DO concentrations fall below 2.0 mg/L. CDM (1998) found hypoxia in Charlotte Harbor was mostly a natural event driven by salinity stratification under conditions of high inflows combined with warmer water temperatures (Figure 18).

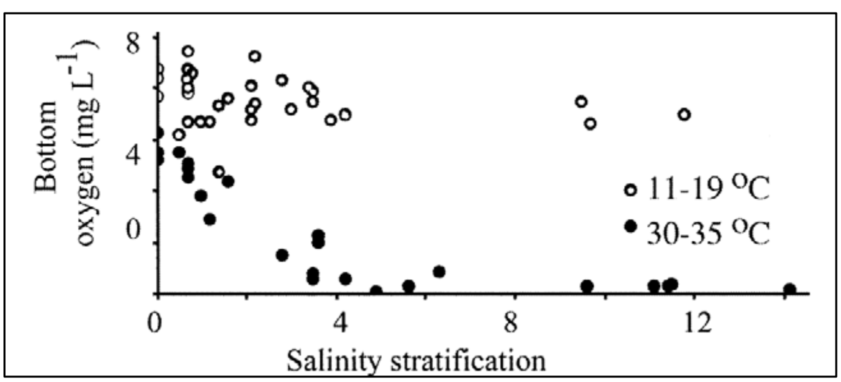


Figure 18 – Relationship between salinity stratification and amount of oxygen in Charlotte Harbor . In warm vs. cool temperature conditions in the bottom waters of Charlotte Harbor, the figure shows the relationship between salinity stratification (difference in salinity in surface vs. bottom waters) and the amount of oxygen (from Figure 5 in Turner et al. 2006).

Although these data suggested that bottom water hypoxia was mostly a natural phenomenon, CDM (1998) concluded that increasing oxygen demand in bottom sediments over time could intensify and increase the duration of the natural hypoxic bottom water condition. To determine if there was any evidence of a potential increase in sediment oxygen demand (SOD) researchers from Louisiana State University (LSU) reconstructed water quality changes for the period 1800 to 2000 by using a suite of biological and geochemical proxies in dated sediments collected in a midsummer hypoxic zone area. The researchers concluded that nitrogen loading toward the end of the period of record was about three times above that prior to the 1800s. The researchers went further to suggest that without management intervention, increasing population may increase nitrogen loading resulting in higher amounts of phytoplankton and worsening hypoxic conditions during salinity stratification events that arise in the wet season (Turner et al. 2006).

That bottom water hypoxia could be influenced by human activity, led to the development of the Pollutant Load Reduction Goal (PLRG) for Charlotte Harbor and included in the 2000 Charlotte Harbor SWIM Plan update. The findings from the LSU study (Turner et al. 2006) were presented to the CHNEP Policy Committee and the SWFWMD Governing Board. Both the CHNEP Policy Committee and the SWFWMD Governing Board supported the formal adoption of a "hold the line" approach to nitrogen loads in Charlotte Harbor from the Peace River watershed. It was this decision that formed the basis for SWFWMD projects designed to reduce impacts of nitrogen loads from Lake Hancock. While the PLRG focused on SOD and bottom water hypoxia, the FDEP Numeric Nutrient Criteria (NNC) uses a nitrogen load-chlorophyll-seagrass paradigm like that used in Tampa Bay. This paradigm assumes that phytoplankton chlorophyll is the dominant attenuator of light. Because, as discussed earlier, Charlotte Harbor is more strongly light-limited by CDOM than chlorophyll, the Tampa Bay paradigm does not work well in this system. For Lemon Bay, however, where CDOM inputs are far less than in Charlotte Harbor, this paradigm works much better for determining impairment.

Charlotte Harbor and Numeric Nutrient Criteria

Given the global extent of water quality degradation associated with nutrient enrichment, eutrophication has and continues to pose a serious threat to potable drinking water sources, fisheries, and recreational water bodies (Chislock et al. 2013). Nutrient enrichment continues to be a major issue in Florida waters, though perhaps less so in Charlotte Harbor. In 2011, the state of Florida adopted quantitative nutrient water quality standards to facilitate the assessment of designated use attainment for its waters and to provide a better means to protect state waters from the adverse effects of nutrient over enrichment (FDEP 2009). To that end, the Florida Department of Environmental Protection (FDEP) developed numeric criteria for causal variables (phosphorus and nitrogen) and/or response variables (chlorophyll), recognizing the hydrologic variability (waterbody type) and spatial variability (location within Florida) of the nutrient levels of the state's waters, and the variability in ecosystem response to nutrient concentrations. However, nutrient effects on aquatic ecosystems are moderated in how they are expressed by many natural factors (e.g., light penetration, hydraulic residence time, presence of herbivore grazers and other food web interactions, and habitat considerations). Therefore, the FDEP recognized that determining the appropriate protective nutrient regime is largely a site-specific undertaking, requiring information about ecologically relevant responses (FDEP 2013). Despite this site-specific approach, it was recognized during NNC development that the nutrient-chlorophyll paradigm did not work in all areas of the Charlotte Harbor system (Janicki, 2011). In fact, there was insufficient evidence to develop defensible numeric nutrient criteria for several estuarine segments, for example, Charlotte Harbor Proper, the Tidal Peace River, and the Tidal Myakka River segments (Janicki, 2011). In those segments, a "reference period" approach was used. For this reason, several segments are listed as impaired based on chlorophyll concentration but do not exceed either TN or TP criteria (Appendix A, Table 2). Although this is a site-specific approach for Charlotte Harbor, the spatial scale at which the criteria were developed NNC is larger than the geographic boundaries at which the

NNC are applied. Figure 19 and Figure 20 illustrate this point for Lemon Bay and Charlotte Harbor, respectively.

Figure 19 – Lemon Bay boundary comparisons for NNC . Comparison of boundaries of regions from which NNC were derived (left) vs. the boundaries of the WBIDs for which the NNC were applied (right) for Lemon Bay.

Figure 20– Charlotte Harbor boundary comparisons for NNC. Comparison of boundaries of regions from which NNC were derived (left) vs. the boundaries of the WBIDs for which the NNC were applied (right) for Charlotte Harbor.

For both Lemon Bay and Charlotte Harbor, the water quality data sets used to develop NNC come from a larger area than the individual Water Body Identification units (WBIDs) to which the criteria are applied. In Charlotte Harbor, the two WBIDs (2065A and 2065B) closest to the inflows of the Peace and Myakka River "fail" NNC for TN, based on data from January 2009 to June 2016. In contrast, the two WBIDs located farther away from the inflows of the Peace and Myakka Rivers (2065C and 2065D) "pass" NNC. When grouped together – at the same spatial scale as the boundaries of data collection for deriving NNC, the combination of all four WBIDs is not impaired for TN. The basis for these findings, and the implications of applying NNC as derived for both Lemon Bay and Charlotte Harbor are explored in greater detail in Appendix A.

Pollutant Loading Model

In the first SWIM Plan Update (SWFWMD 2000), the PLRG that was developed was to "hold the line" on nitrogen loads to Charlotte Harbor from the Peace River watershed. To determine if pollutant loads to Charlotte Harbor had indeed met the PLRG's intention, this SWIM Plan Update includes an empirical pollutant loading model for the gaged Peace and Myakka River watershed for the years of 2009 to 2015. These results were then compared to results from prior loading models conducted for both SWIM and the CHNEP. The mean annual loads for TN, TP, and Total Suspended Solids (TSS) were then compared to prior loading model values, as well as annual average values for chlorophyll-a for the tidal Peace River and Charlotte Harbor nutrient regions.

The pollutant loading model was completed using similar methods as had been previously used by the Charlotte Harbor Environmental Center (2001). The loading model was constructed by compiling flow and water quality data for the gaged locations within the Peace and Myakka River watersheds. For the Myakka River, the farthest downstream gage site (Myakka River at Laurel) only gages 42% of the river's 602-square-mile watershed (Hammett 1990). Therefore, load estimates from the Myakka River do not represent as complete an assessment as is possible with the Peace River, where approximately 89% of the watershed is gaged.

The average nitrogen load from the gaged Peace River, over the 7 years of 2009 to 2015, comes to 1,827 tons of TN per year. In comparison, the average nitrogen load over the 7 years of 1985 to 1992 was 1,820 tons TN per year, a difference of less than 5%. Watershed-wide nitrogen loads were lower than the 7-year average from more than 20 years ago in 5 of the 7 years examined (Figure 21).

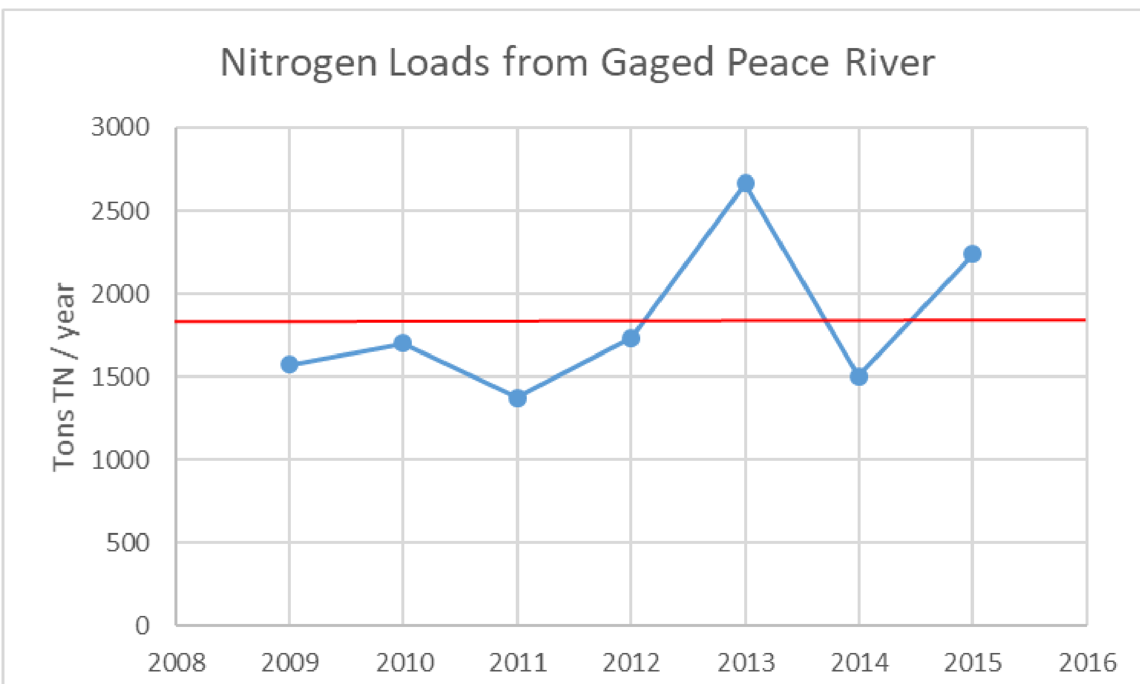


Figure 21– Nitrogen loads from the gaged Peace River watershed, expressed as tons of TN per year, for the years 2009 to 2015. Red line represents average value for the years 1985 to 1992.

The results of the nitrogen loading model update suggest that the "hold the line" strategy outlined in the PLRG has been met for most years. These findings support, in turn, the findings of a lack of degradation in water quality since the last SWIM Plan Update noted previously, as well as the findings of increased seagrass coverage over the past two decades, also discussed above.

However, to continue to "hold the line" on nitrogen loads further action is required, as the population in the Peace and Myakka River watersheds will continue to grow over time. To optimize the efficiency of any such projects, several priority sub-basins were identified, so that stormwater retrofits and/or agricultural BMPs could be focused on areas where benefits would be maximized (see Appendix A).

To further test the hypothesis that unlike Tampa Bay and other phytoplankton-driven systems, Charlotte Harbor does not follow the nitrogen-chlorophyll-water clarity-seagrass paradigm, annual TN loads for the gaged Peace River were compared against the annual average chlorophyll-a values for both the tidal portions of the Peace River, as well as Charlotte Harbor itself (Figure 22 and Figure 23).

The results shown in Figure 22 and Figure 23 are consistent with earlier work in Charlotte Harbor, where it was determined that the nitrogen load – chlorophyll – water clarity – seagrass paradigm developed for Tampa Bay did not work for Charlotte Harbor (McPherson and Miller 1987; Tomasko and Hall 1999).

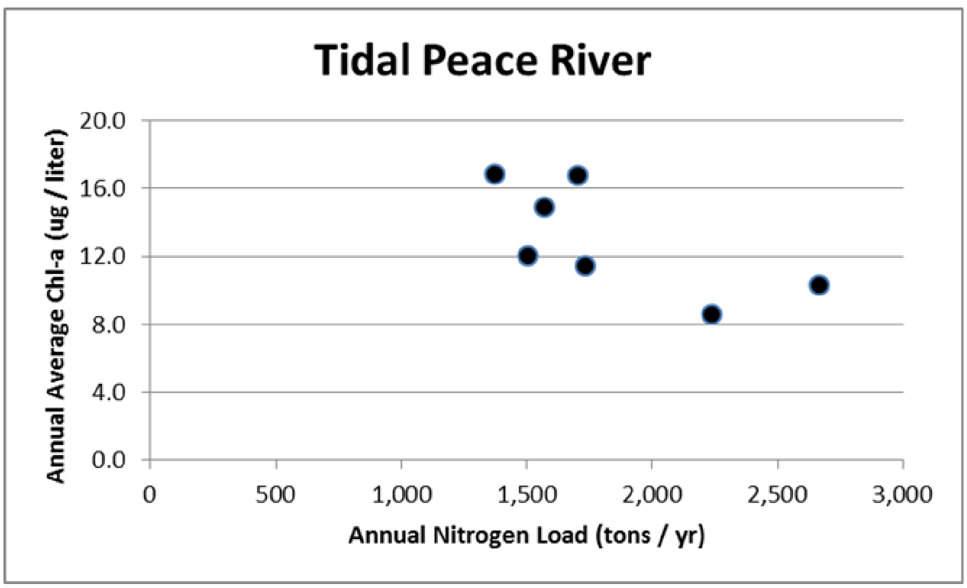


Figure 22–Chlorophyll-a and TN load for Tidal Peace River. Annual TN Loads calculated for the gaged portions of the Peace River are plotted against the average annual chlorophyll-a concentrations for the Tidal Peace River NNC region.

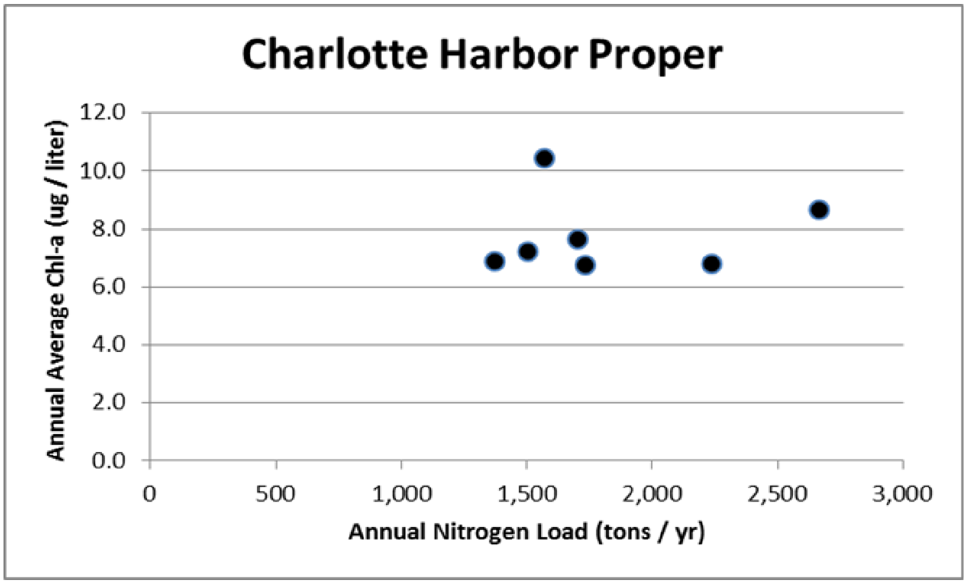


Figure 23– Chlorophyll-a and TN load for Charlotte Harbor Proper. Annual TN Loads calculated for the gaged portions of the Peace River are plotted against the average annual chlorophyll-a concentrations for the Charlotte Harbor Proper NNC region.

Hydrologic Restoration

In the Upper Peace River, historical reductions in stream flow were determined to have been greater than that which could be attributed to changes in rainfall alone (SWFWMD 2002). In the lower reaches of the Peace River, long-term trends in streamflow were more closely aligned with trends in rainfall (Basso and Schultz 2003).

In the Upper Myakka River, an extensive die-off of trees in Flatford Swamp has been linked to increased dry season flows, which have impacted the hydroperiods and water levels in the swamp (PBS&J 1998). Downstream, flows are not as impacted by excess dry season flows, and no similar stresses occur for the lower reaches of the Myakka River.

In the Dona Bay watershed, the construction of the Cow Pen Canal in 1960 expanded the size of Dona Bay's watershed from 15 to 75 square miles. The five-fold increase in the size of the watershed has impacted Dona Bay due to excessive freshwater inflows, particularly during the wet season.

In response to this variety of hydrologic alterations, the 2000 Charlotte Harbor SWIM Plan Update identified several management actions to respond to the diversity of impacts throughout the watershed. The priority actions outlined in the 2000 SWIM Plan Update are summarized below, along with relevant projects and updates on the proposed projects.

Upper, Middle, and Lower Peace River

As was called for in the 2000 SWIM Plan Update, MFLs were established for the Upper, Middle and Lower Peace River. In addition, several tributaries to the river, including Lower Shell Creek, Horse Creek, and Upper Shell Creek have been identified for MFLs establishment on the SWFWMD MFLs priority list and schedule.

The technical basis for the MFLs for the Upper Peace River was completed (SWFWMD 2002), and the MFL was established for three upper river sites (at Bartow, Fort Meade, and Zolfo Springs) in 2007 (Rule 40D-8.041(7), FAC). At the time of their establishment, MFLs established for the Peace River gages at Bartow and Fort Meade were not being met.

A major District Initiative to address recovery of flows and levels in the Upper Peace River and the region is implementation of the Southern Water Use Caution Area (SWUCA) Recovery Strategy (SWFWMD 2006). The primary mechanism for recovering minimum flows in the Upper Peace River is the recently completed Lake Hancock Lake Level Modification Project. This project included modifications to the P-11 structure that controls water levels in Lake Hancock to allow for increased wet weather storage and subsequent delivery of these stored quantities of water during the dry season. Development of a reservation rule for the water stored in Lake Hancock and released to Lower Saddle Creek for recovery of the Upper Peace River (SWFWMD 2020) is expected to be completed in 2020.

The SWFWMD began evaluating the feasibility of raising the lake level in 2003, and in 2004, the SWFWMD Governing Board authorized staff to proceed with the preliminary design and engineering to prepare a conceptual environmental resource permit application for the lake level modification project. The SWFWMD began acquiring property around the lake to support the project, which required obtaining over 8,000 acres of waterside property. In 2007, the Governing Board authorized SWFWMD staff to implement the Lake Hancock Lake Level Modification Project including the final design, permitting, and construction of the necessary improvements.

The modified P-11 structure has been operated since late-2015 to help achieve minimum flows in the Upper Peace River, prevent floods and replenish storage in Lake Hancock. The annual status assessments indicate MFLs for the Upper Peace River have been met in recent years at the Zolfo Springs gage site but not at Bartow and Fort Meade.

The technical basis for the MFLs for the Middle Peace River was completed (SWFWMD 2005a) and minimum flows were established in 2006 (Rule 40D-8.041(5), FAC). Since their establishment, minimum flows for the Middle Peace River have been and continue to be met.

The technical basis for the MFLs for the Lower Peace River was completed (SWFWMD 2010) and minimum flows were established in 2010 (Rule 40D-8.041(8), FAC). The minimum flows are based on the combined flows in the Lower Peace River, Horse Creek and Joshua Creek. Since their establishment, the minimum flows for the Lower Peace River have been met. In addition, a reevaluation of the Lower Peace minimum flows was recently completed (SWFWMD 2015) and a second reevaluation is scheduled for completion in 2020. Also, the establishment of minimum flows for Lower Shell Creek, Horse Creek and Upper Shell Creek is scheduled for 2020, 2023 and 2025, respectively.

Myakka River

As was called for in the 2000 SWIM Plan Update, MFLs were established for the Upper and Lower Myakka River. In contrast with the Upper Peace River, which was determined to need minimum flow recovery, the establishment of MFLs for the Upper Myakka River identified the need to reduce excessive dry season flows, particularly in the area of Flatford Swamp, which has been adversely impacted by excessive amounts of inflow (Figure 24).

Figure 24– SWFWMD staff in Flatford Swamp (photo from SWFWMD). Presence of standing water and cattails under dead oak trees indicates water levels have been too high for too long (hydroperiods).

The technical basis for the MFLs for the Upper Myakka River was completed (SWFWMD 2005b) and minimum flows were established in 2006 (Rule 40D-8.041(6)(a), FAC). The technical work supporting establishment of minimum flows for the Lower Myakka River was completed as well (SWFWMD 2011) with its MFLs established in 2012 (Rule 40D-8.041(6)(b), FAC). The SWFWMD has determined that MFLs for the Upper and Lower Myakka River are being met.

For the Upper Myakka River, recovery of forested wetlands in the Flatford Swamp portion of the watershed will require a reduction in flows and the shortening of hydroperiods, which is expected to be accomplished through the Aquifer Recharge Project at Flatford Swamp for Saltwater Intrusion Minimum Aquifer Level Recovery. The goal of this SWFWMD Initiative is to divert between 2 and potentially up to 10 million gallons per day (mgd) of flow out of the swamp. In addition to promoting more natural wetland hydroperiods in the swamp, the project is expected to reduce the rate of saltwater intrusion inland from the Gulf of Mexico

Dona Bay / Cow Pen Slough Canal

The technical work supporting establishment of minimum flows for the Dona Bay/Shakett Creek System was completed (SWFWMD 2009) and MFLs for the system were established in 2010 (Rule 40D-8.041(14), FAC). The MFLs for the Dona Bay/Shakett Creek System are currently being met.

Inflows to Dona Bay are controlled by two structures, including a downstream water control structure located in the upper reaches of Shakett Creek (*Figure 25*).

Figure 25 – Water control structure in Shakett Creek (photo from Sarasota County).

In the Dona Bay Watershed Management Plan (KHA 2007) diversions of 5 mgd, 10 mgd, and 15 mgd were associated with benefits to water quality and natural systems in the receiving waters of Dona Bay. Currently, Sarasota County and the SWFWMD are working to implement Phase II of the Dona Bay Restoration Project, which would divert 3 mgd of flows out of the Cow Pen Canal back toward their historical destination of the Myakka River.

Charlotte Harbor Flatwoods Initiative

The Charlotte Harbor Flatwoods Initiative (CHFI) is a multi-stakeholder, multi-phased regional hydrologic restoration effort coordinated by the South Florida Water Management District. The approximately 90-square-mile project area spans both the SWFWMD and the South Florida Water Management District. The CHFI was formed to initiate efforts to restore natural drainage patterns across the Gator Slough watershed. Natural flow-ways originating in the Babcock/Webb Wildlife Management Area (WMA) and areas to the east are bisected by the I-75 and US 41 corridors in the vicinity of the Charlotte/Lee County line (Figure 26). This has resulted in decreased flows into the Yucca Pens/Gator Slough and tidal creeks discharging to eastern Charlotte Harbor and increased hydroperiods in the pine flatwoods and wetlands on WMA lands.

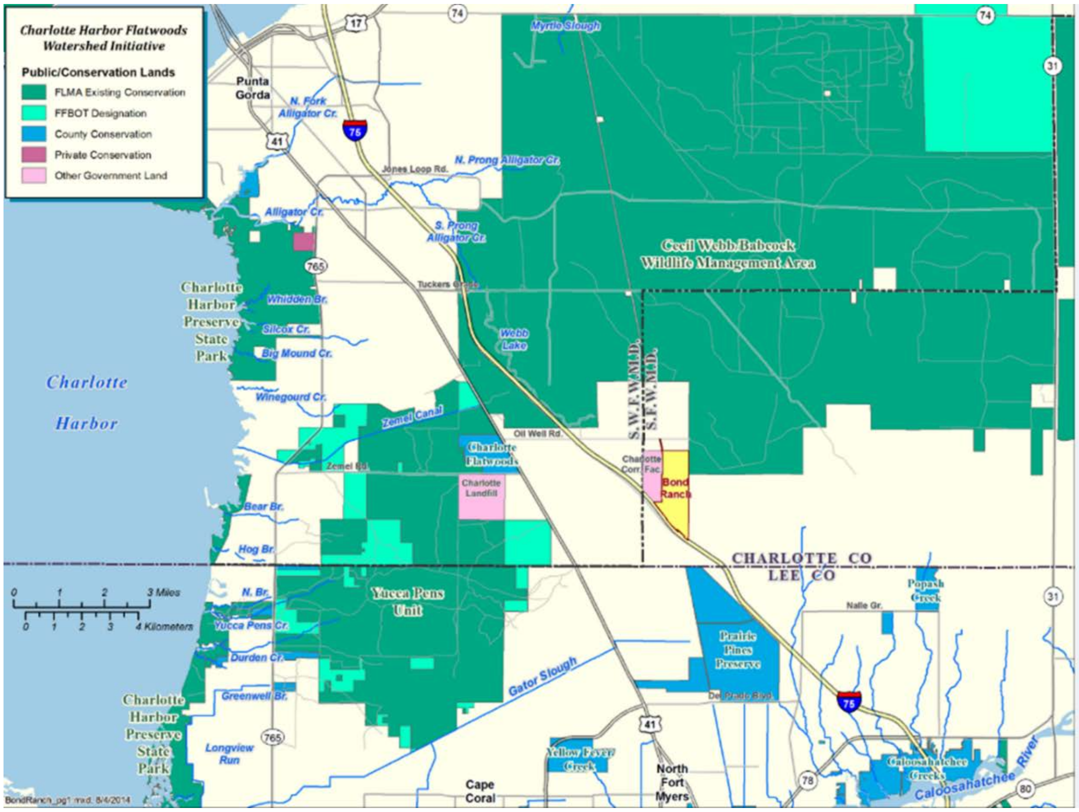


Figure 26 – Public/conservation lands across the Charlotte Harbor Flatwoods Initiative.

Natural Systems Protection and Restoration

Seagrass Mapping

Seagrass meadows are a dominant feature in the shallow waters of Charlotte Harbor and are recognized around the world as indicators of overall estuarine health (Figure 27). Seagrasses are an important coastal resource for recreational and commercial species of finfish and shellfish (Heck et al. 2003). Seagrasses are also important in stabilizing sediments and reducing shoreline erosion (Fonseca and Cahalan 1992). Recently, the ability of seagrass meadows to offset, at least on a local to regional level, the impacts of ocean acidification, has also been documented (Unsworth et al. 2012; Yates et al. 2016).

Figure 27 – Photo of seagrass (Thalassia testudinum) in Charlotte Harbor. Photo from UF/IFAS.

Seagrass meadows not only provide critical habitat in Charlotte Harbor and Lemon Bay, they are also good indicators of overall estuarine health and water quality. This SWIM Plan recognizes the importance of seagrasses to the Charlotte Harbor and Lemon Bay systems and as such, has identified seagrass coverage as one of the quantifiable objectives under the Natural Systems focus area. Seagrass status and trends are discussed below using data and information from the SWFWMD Biennial Seagrass Mapping Program up to 2018.

The SWFWMD 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 (Figure 28). This mapping effort is part of a larger effort by the SWFWMD to map seagrass in estuaries along the entire west-central Florida coast from Waccasassa Bay to the SWFWMD/South Florida Water Management District boundary within Charlotte Harbor and represents one of the most comprehensive and long-term synoptic mapping of seagrass habitat anywhere in the world.

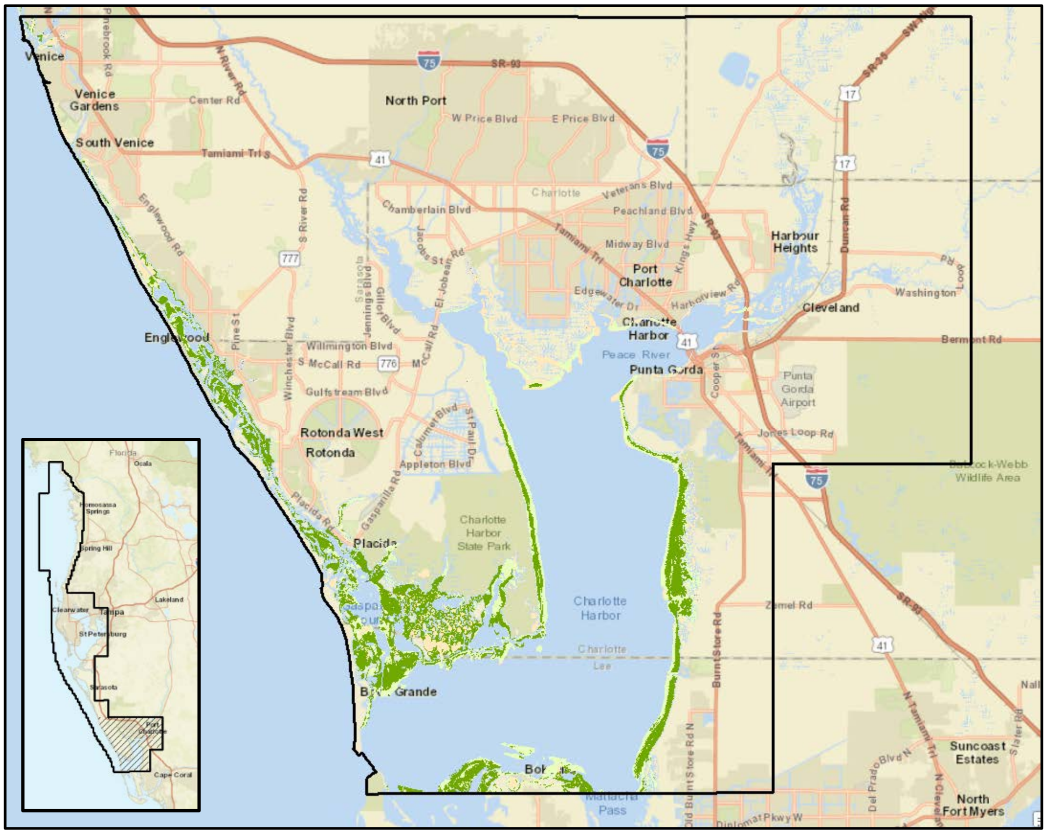


Figure 28 – Charlotte Harbor & Lemon Bay boundaries for SWFWMD Biennial Seagrass Mapping Project. The Dona & Roberts Bay watershed falls within the northern edge of the Lemon Bay seagrass mapping boundary. Shaded green areas represent the extent of seagrass meadows mapped in 2018.

Seagrass habitats are mapped by collecting digital georectified and orthorectified imagery from an aircraft (Figure 29). 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 SWFWMD accepting the map product.

Charlotte Harbor's seagrass acreage has remained relatively intact over time, unlike Tampa Bay, which by the 1980s had lost approximately 40% of the seagrass that was there in the 1950s. Since 2014, mapped seagrass acreage has been greater than any other mapped period since 1988 (Figure 30).

Figure 29 – SWFWMD seagrass mapping based on photointerpretation of aerial imagery. An aircraft is flown at an altitude of 8000-10000 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).

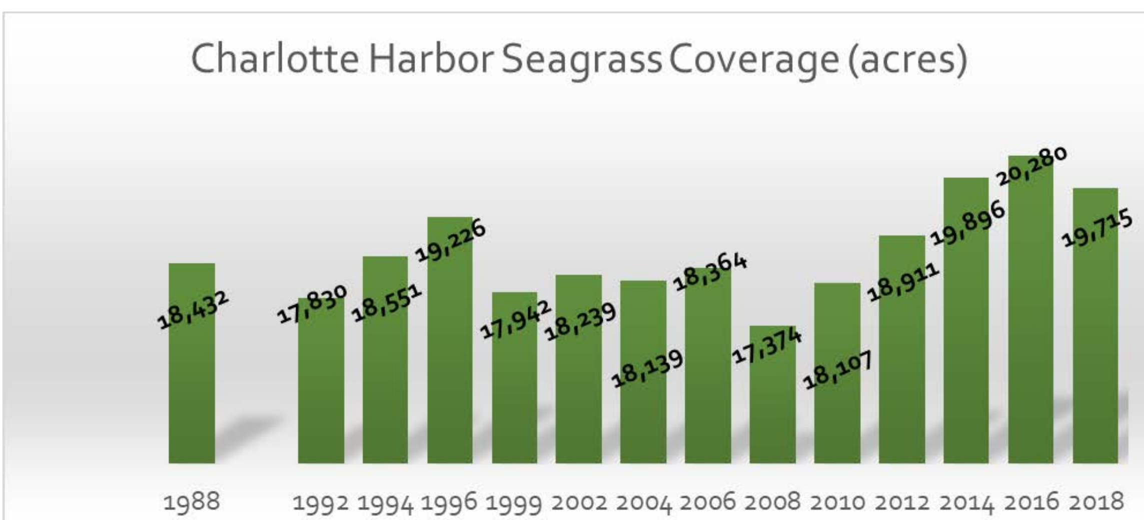


Figure 30 – Mapped seagrass acreage over time for Charlotte Harbor over the period of 1988 to 2018.

Based on the 2018 aerial seagrass survey, Charlotte Harbor continues to have more mapped acres of seagrass than in the 2003 to 2007 reference period (Figure 31). However, there was a decrease in seagrass coverage of 565 acres between 2016 and 2018, a decline of 2.8%, which is slightly higher than the typical error rate of seagrass mapping efforts of approximately 2% (Tomasko et al. 2005). The difference between 2016 and 2018 might be attributed to impacts from Hurricane Irma, which passed over the watershed and open waters of Charlotte Harbor in September of 2017, a few months before the start of the aerial photography used to map seagrasses for the year 2018.

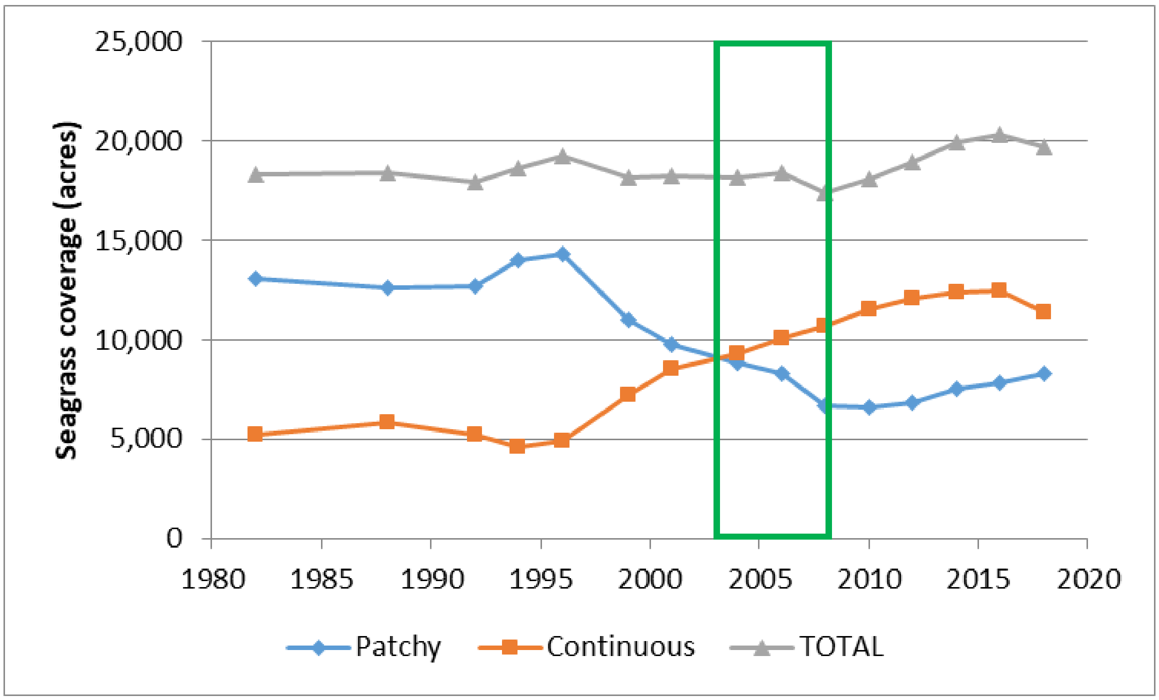


Figure 31 – Seagrass coverage in Charlotte Harbor. Values are in units of acres of patchy, continuous, and total (patchy plus continuous) seagrass. The area in the green box indicates the reference period for the establishment of NNC of 2003 to 2007.

Prior to 2018, the positive trends in total acreage were also associated with a greater percentage of seagrass being mapped as continuous meadows, rather than patchy meadows (Figure 31). Previous studies in Sarasota Bay have shown that the biomass of seagrass meadows increases as nutrient loads decrease (Tomasko et al. 1996), indicating that a transition from patchy to continuous seagrass coverage is indicative of improved water quality. This is consistent with the water clarity and nutrient trend analyses found for Charlotte Harbor.

The decrease from 2016 to 2018 requires careful monitoring to determine if such a decline was due to the impact of Hurricane Irma, rather than a human-caused degradation in water quality. However, the overall pattern of increased coverage and a shift from patchy to continuous coverage suggests that water quality in Charlotte Harbor likely has been as good or better than it was in the reference period of 2003 to 2007, and that water quality is likely better than it was during the decades of the 1980s.

Like Charlotte Harbor, a similar long-term pattern exists for Lemon Bay over the same time period from 1988 to 2018 (Figure 32) where seagrass acreage remains relatively consistent over the mapped period of record. Seagrass acreage was greater for the latter mapping period of 2008 to 2018 when compared to the period 1988 to 2006.

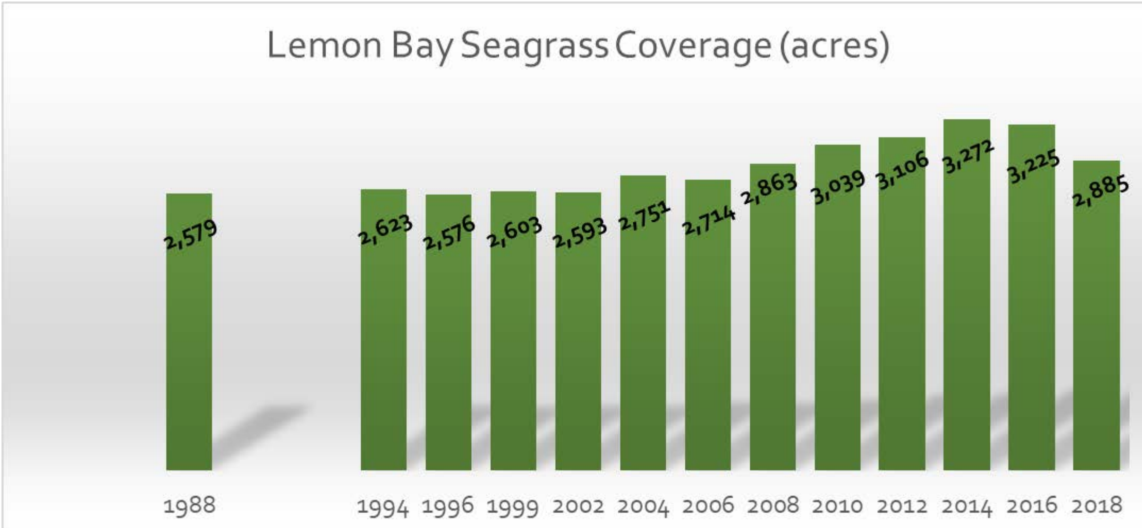


Figure 32 – Mapped seagrass acreage over time for Lemon Bay over the period of 1988 to 2018. Data include Dona Bay and Roberts Bay.

Figure 33 shows that there was more seagrass in Lemon Bay in 2016 than in the 2003 to 2007 reference period for NNC. However, 2018 coverage was 398 acres lower than in 2016, a 10.5% decline (Figure 32). A decrease of 10.5% is substantially greater than the error rate associated with seagrass mapping efforts (Tomasko et al. 2005) thus suggesting that the 2016 to 2018 decline is not an artifact of mapping efforts.

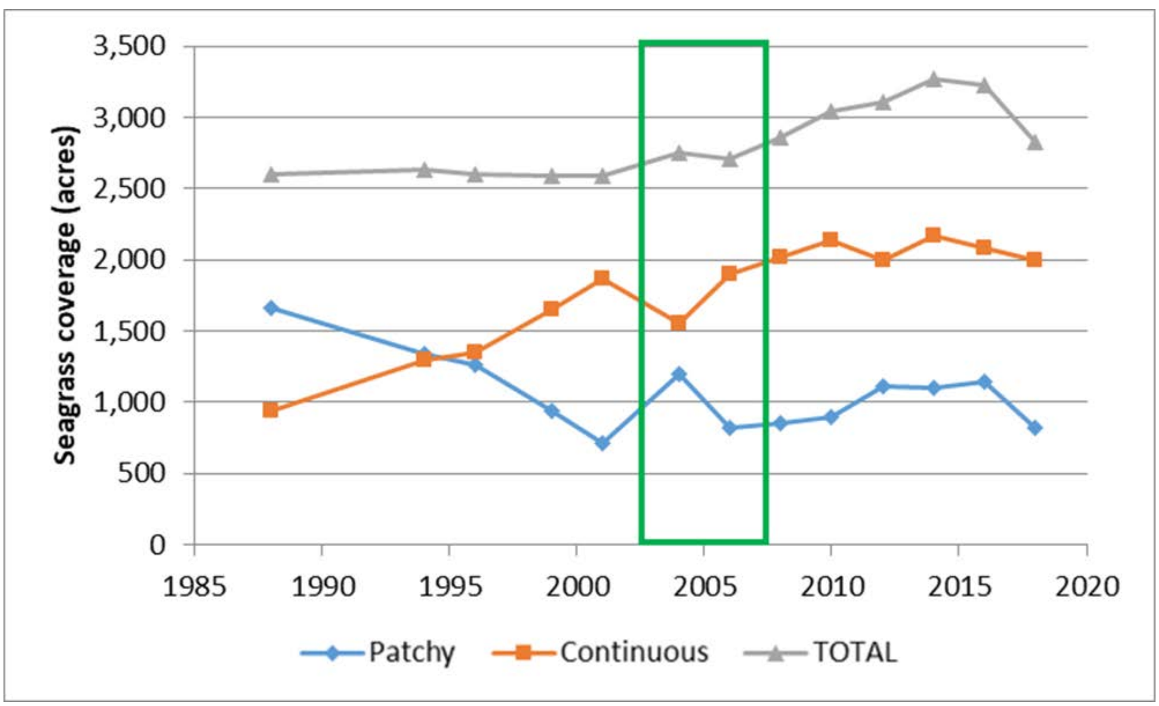


Figure 33 – Seagrass coverage in Lemon Bay. Values are in units of acres of patchy, continuous and total (patchy plus continuous) seagrass. The area in the green box indicates the reference period for the establishment of NNC of 2003 to 2007.

Like Charlotte Harbor, Lemon Bay also exhibits a positive trend in total acreage associated with a greater percentage of seagrass being mapped as continuous meadows, rather than patchy meadows (Figure 33). While total acreage decreased by 10.5% between the years 2016 and 2018, the proportion of seagrass mapped as continuous remains much greater than those areas mapped as patchy (Figure 33). The decline in seagrass coverage from 2016 to 2018 was primarily restricted to the northern portion of Lemon Bay downstream from Forked Creek (Figure 34). Unlike Charlotte Harbor, which is a CDOM rich system, light attenuation in Lemon Bay is far less influenced by CDOM. Therefore, the relationship between light attenuation, chlorophyll, and nitrogen more closely resembles that of Tampa Bay than Charlotte Harbor. The northern portions of Lemon Bay have consistently exceeded the NNC established for TN (Appendix A). In contrast, the southern portion of Lemon Bay has consistently had TN concentrations lower than NNC, except for 2017, which likely reflects the influence of Hurricane Irma. Water quality data from 2018 show TN concentrations had fallen below the NNC TN impairment threshold in southern Lemon Bay but continued to exceed TN threshold values in northern Lemon Bay in 2018.

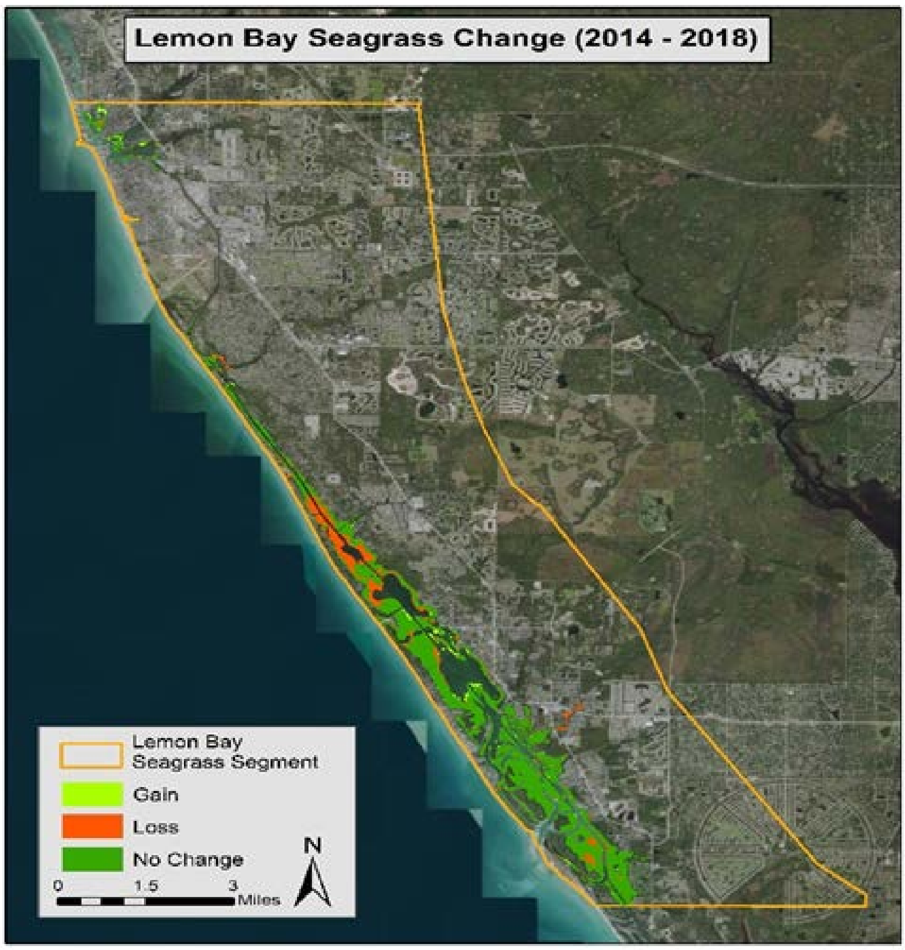


Figure 34 – Spatial distribution of seagrass coverage in Lemon Bay*; including gains, losses, and areas with stable seagrass coverage between 2016 and 2018. GIS data from SWFWMD.*

While 2018 seagrass coverage in Lemon Bay is still higher than the reference period 2003 to 2007 (Figure 33), the finding that the losses were greater than the error rate associated with mapping efforts, and greater, proportionally, than for Charlotte Harbor suggest further investigation. Follow up studies appear to be warranted for that region of Lemon Bay downstream from Forked Creek, to find out if there are any management concerns that need to be addressed in the Forked Creek watershed. In addition, the 2020 seagrass maps will better assess whether the 2016 to 2018 decline was a one-time event or the beginning of a trend. Of significance for the 2020 map is the occurrence and severity of the red tide event through much of 2018–2019.

An emerging issue for both Charlotte Harbor and Lemon Bay is the persistence of drift macroalgae in certain areas. Macroalgae are an increasing feature of shallow-water marine areas across the world and should be monitored carefully (Ansell et al. 1998). Because macroalgae have relatively simple morphology and broad physiological tolerances, many species can outcompete seagrasses for resources such as nutrients (Ansell, et al. 1998). For example, in the Florida Keys National Marine Sanctuary (Collado-Vides, et al. 2007) found species of green and red algae were responding positively to increases in nitrogen availability. However, nutrients are not the only drivers of macroalgal abundance. Cause and effect relationships can be very complicated and usually involve a combination of drivers like circulation patterns, residence time, temperature, salinity, depth and nutrients.

In Charlotte Harbor, biologists with the FFWCC have been sampling the shoreline since 1989. In 2018, they observed an increase in the abundance of a filamentous green macroalgae in certain parts of the estuary (Figure 35).

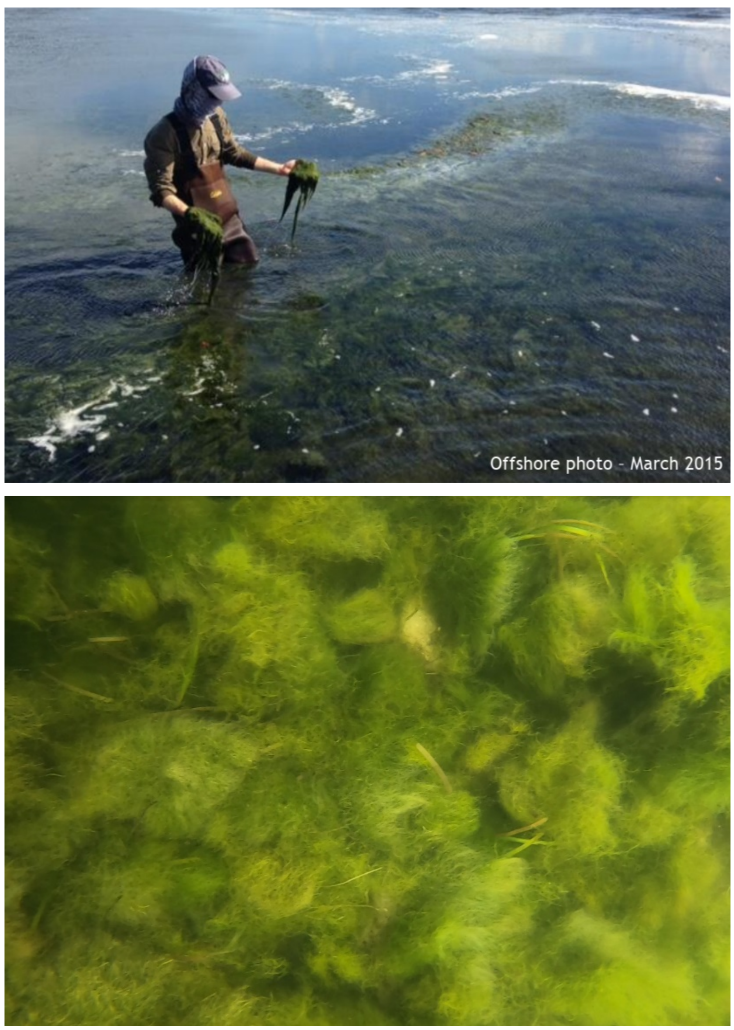


Figure 35 – Nuisance macroalgae in Charlotte Harbor. Top photograph taken by FFWCC biologists of filamentous macroalgae offshore of Hog Island, between the confluence of the Peace and Myakka Rivers in 2015. Bottom photograph of filamentous macroalgae along the east wall of Charlotte Harbor taken by UF/IFAS Extension.

In spring 2019, staff from the Charlotte Harbor Aquatic Preserve noticed increasing filamentous macroalgae along the east wall of Charlotte Harbor. In January 2020 macroalgae along the east wall was still prevalent (Figure 36).

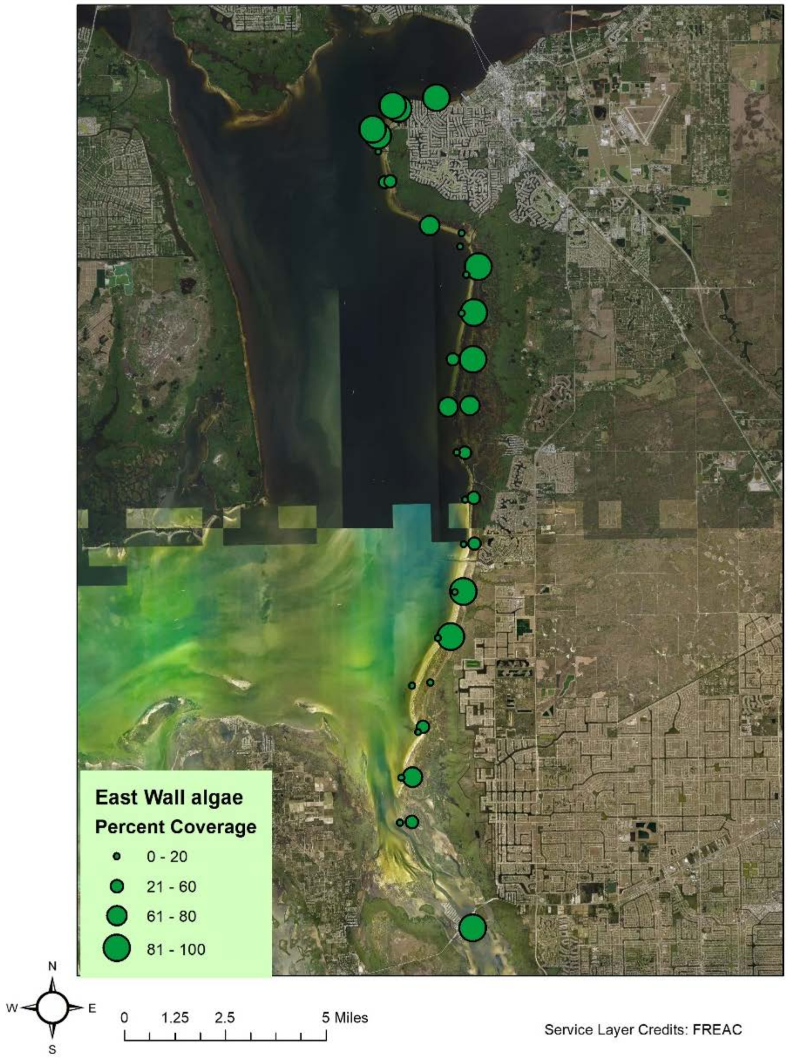


Figure 36 – Percent coverage of macroalgae along the east wall of Charlotte Harbor. Percent coverage is based on visual observation from a boat taken on January 10, 2020. (Map courtesy of Charlotte Harbor Aquatic Preserve).

Accumulations of drift macroalgae appear to be limited to the upper portions of Charlotte Harbor, near the confluence of the Peace and Myakka Rivers, with a secondary center of abundance in the Eastern Branch of Coral Creek, which flows to Gasparilla Sound adjacent to Placida. In the northern portion of Charlotte Harbor, close to the confluence of the Peace and Myakka Rivers, abundance data have been collected since 2006 (Figure 37).

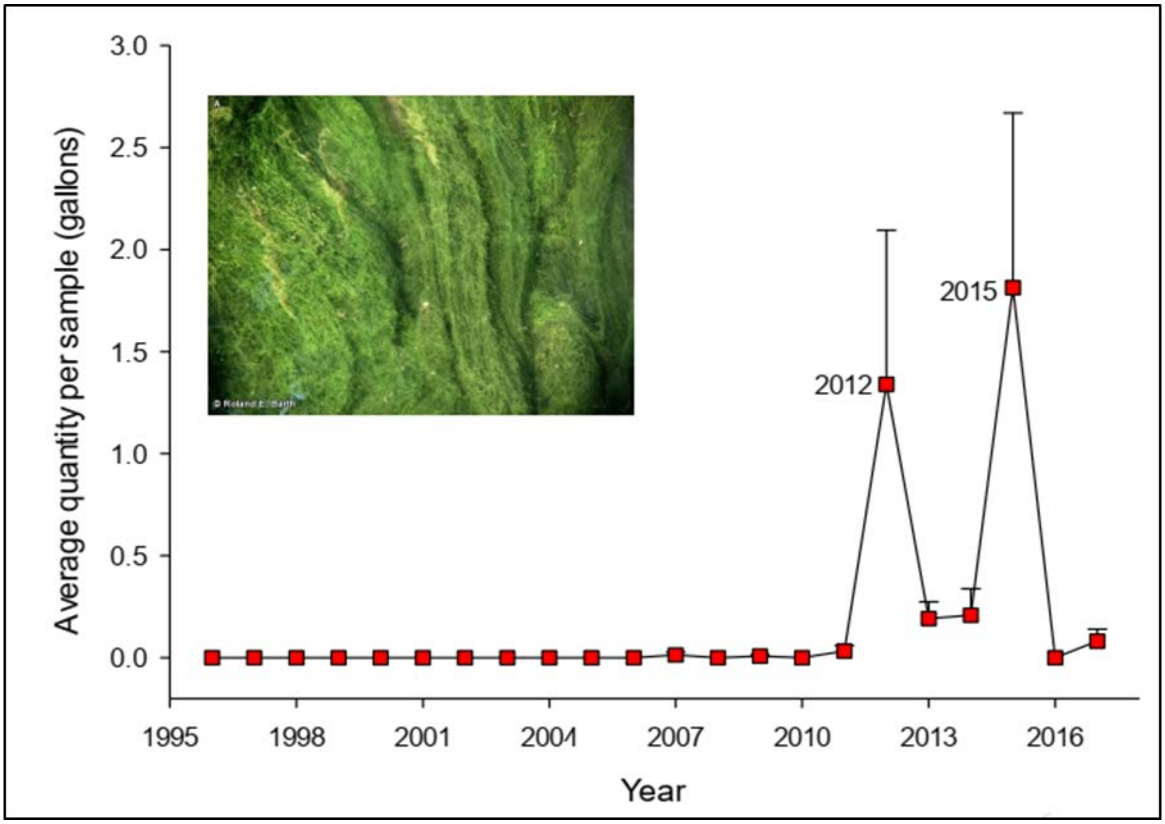


Figure 37 – Abundance of green filamentous algae (gallons) per seine haul over the period of 1996 to 2017. Values are combined from three regions of Charlotte Harbor near the confluence of the Peace and Myakka Rivers. Graph provided by Dave Blewett (FFWCC).

As quantified by FFWCC staff, the abundance of green filamentous macroalgae remained low from 1996 to 2011. Substantial increases were noted in 2012 and 2015, followed by reduced abundances in 2016 and 2017. By 2018, the abundance of green filamentous macroalgae was no longer found at sites along the western wall portion of Charlotte Harbor, where it had previously been recorded in great abundance (D. Blewett, personal communication). While this is good news for the west wall, as discussed above, in 2019 to 2020, drift macroalgae was seen in large abundance along Charlotte Harbor's east wall (Figure 36).

Habitat Protection and Restoration

The SWFWMD and the CHNEP cooperatively funded the Habitat Restoration Needs (HRN) Plan Update for the Charlotte Harbor Watershed (ESA 2019). The HRN was developed to guide conservation, restoration, sustainability, resiliency, and connectivity throughout the CHNEP which includes the Charlotte Harbor and Lemon Bay watersheds. The overarching vision of the HRN Plan is to create a diverse environment of interconnected, healthy habitats that support natural processes, and viable and resilient native plant and animal communities. The intent of the Charlotte Harbor SWIM Plan is to highlight aspects of the HRN Plan that fall within the SWFWMD's area of responsibility.

To focus natural systems restoration programs and projects, the losses of various natural habitat types have been quantified for the years between 1995 and 2009 (the most current land cover data at the time of the project). Percent declines were quantified for the broad categories of Upland Coniferous Forest, Upland Hardwood Forest, Mangrove Swamps, Freshwater Marshes, Saltwater Marshes, and Salt Flats within five segments of the Charlotte Harbor system (Table 6).

Sub-basin	**Habitat Types**					
	Upland Coniferous Forest (4100)	**Upland Hardwood Forest (4200)**	**Mangrove Swamps (6120)**	**Freshwater Marsh (6410)**	**Saltwater Marsh (6420)**	**Salt Flats (6600)**
Charlotte Harbor Proper	81	54	NL	NL	25	NL
Coastal Lower Peace	89	90	NL	NL	NL	NL
Coastal Venice	50	NL	NL	NL	24	NL
Dona & Roberts Bay Watershed	89	NL	1	NL	NL	NL
Gasparilla Sound	56	NL	NL	64	NL	NL

Table 6 – Percent decline of habitat types for sub-basins in the Charlotte Harbor Watershed, between 1995 and 2009. Data are based on GIS mapping efforts conducted for the SWFWMD. Analysis completed by ESA (2018) for the CHNEP. Habitat types are shown along with their FLUCCS codes. "NL" = no evidence of decline.

The results of this analysis show that the largest losses of natural habitats, both in terms of percent loss and acreage lost (not shown), were for the communities of Upland Coniferous Forests and Upland Hardwood Forests. Freshwater marshes declined over the 14 years only in the Gasparilla Sound watershed, while declines in saltmarsh were found for both the lands adjacent to Charlotte Harbor (downstream of the Peace and Myakka Rivers) as well as in the Coastal Venice region. In contrast, no losses of salt flats were found, and declines in mangrove acreage were minor.

The results shown in Table 6 suggest that habitat restoration strategies for the SWFWMD portion of Charlotte Harbor should be focused on restoring lost upland coniferous and upland hardwood forests, as these are the habitat types with the most widespread and severe losses in recent years.

Regional Hydrologic and Natural Systems Restoration Priorities

There are several regional hydrologic and natural systems restoration projects within the Charlotte Harbor watershed. These include the SWFWMD's Flatford Swamp, the Myakka River-Deer Prairie Creek Initiative, and projects within the Myakka State Forest and State Park. Regional restoration projects are being implemented with FDEP in the Myakka River State Park, Charlotte Harbor Preserve State Park and the State Buffer Preserve. The District is also working with local governments to implement regional restoration projects, such as the Dona Bay/Cow Pen Slough Restoration Project. Summaries of some of these projects are included below.

The Myakka River-Deer Prairie Creek Initiative is a partnership between the SWFWMD and Sarasota County. The lands are co-owned by the County and SWFWMD, with SWFWMD responsible for implementation of the resource management and the County responsible for recreation. The Initiative consists of hydrologic and natural systems restoration on the Preserve with the objective to restore land to its natural state and condition. Many impacted wetlands and streams have been identified as candidates for restoration to regain the typical wetland functions of water storage, recharge, water quality improvement, and wildlife habitat. This Initiative will result in the restoration of surface water hydrology and wetland habitats on the Myakka River-Deer Prairie Creek Preserve.

Myakka River State Park (MRSP) was altered by two low-head structures. One alteration was a weir constructed before 1938 on the Upper Myakka Lake and the other was a dam constructed before 1940 near the park's current southern boundary. These modifications altered the quantity and timing of the natural flows, especially in the dry season. In 1938, a low water weir was installed at the south end of the Upper Myakka Lake (UML) when MRSP was being developed by the Civilian Conservation Corps. In 1974, the UML weir was bypassed by a set of culverts to mitigate the negative impacts. This bypass effort was only marginally successful and in 2016 the bypass area experienced a washout event. Before 1940, a low water dam, referred to as Downs' Dam, was installed near the southern boundary of MRSP to hold back freshwater during the dry season (and separate it from any saltwater) Since 2008, the eastern portion of the dam has experienced increased erosion and the water flow bypasses the main structure.

The District has co-funded studies conducted with the FDEP, Division of Recreation and Parks, to investigate restoration options. One of the studies recommended removal of the Upper Myakka Lake structure plans are being developed in conjunction with U.S. Fish and Wildlife Service (USFWS) and FFWCC to implement this recommendation. The Downs' Dam study is on-going at the time of this SWIM plan update. Once completed, the study will provide recommendations for restoration and restoration plans are expected to be developed in conjunction with USFWS and FFWCC to implement the recommendations.

The Alligator Creek project site is located on an approximately 1,600-acre parcel within the Charlotte Harbor Preserve State Park, which is co-owned between SWFWMD and FDEP and managed by FDEP. Near Punta Gorda in Charlotte County, the site contains many habitat types, including tidal creeks, mangrove swamps, salt marshes, salterns, freshwater wetlands, pine flatwoods, scrub, and other uplands. Much of the hydrology of the site was impacted by ditching and dredge-fill activities. A significant volume of the stormwater runoff from developments to the east of Burnt Store Road also discharges onto the Alligator Creek property without adequate water quality treatment. As part of a multi-year, multi-phased effort, the SWFWMD's SWIM Program completed three phases of work, including 12 project areas, to restore hydrologic and habitat connections of degraded and impacted wetlands. The third phase of projects also included a stormwater component to polish the offsite stormwater prior to discharge into Charlotte Harbor.

The Coral Creek Restoration project is another partnership between the SWFWMD's SWIM Program and FDEP located on an approximately 2,600-acre parcel co-owned by the SWFWMD and FDEP. The project site is within the Charlotte Harbor State Buffer Preserve south of the Rotonda subdivision in Charlotte County. The site includes many habitat types and the hydrology of the site has been impacted by ditching, dredge-fill activities. This project implements hydrologic and habitat restoration of degraded lands to restore historic hydrologic regimes and improve upland and wetland habitats for Charlotte Harbor. Two phases of work have been completed and a third, encompassing ~400 acres, is planned for fiscal year 2021. The FDEP is the entity responsible for the management of the site.

The scale of these types of regional hydrologic restoration projects is exemplified by the before and after photos of one phase of the Coral Creek Project. Figure 38 and Figure 39 show the conversion of an area of linear ditches and berms to a much more ecologically healthy and naturally appearing landscape.

Figure 38 – Coral Creek restoration project before construction, aerial photograph of Plot 15 (June 28, 2017). Photo provided by SWFWMD.

Figure 39 – Coral Creek restoration project after construction, aerial photograph of Plot 15 (April 3, 2019). Photo provided by SWFWMD.

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 Charlotte Harbor and Lemon Bay. The quantifiable objectives and management actions listed in this section are grouped into three focus areas: (1) water quality, (2) hydrologic restoration, and (3) natural systems, 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 Lemon Bay. Monitoring and research actions are included for each of the three focus areas and are essential elements to adaptive management.

One of SWFWMD's key programs for building partnerships and working with stakeholders in the Charlotte Harbor watershed, and throughout SWFWMD is the Cooperative Funding Initiative (CFI). The CFI covers up to 50% of the cost of projects that help create sustainable water resources, enhance conservation efforts, restore natural systems, and provide flood protection. All CFI funding decisions are made by volunteer Governing Board members who are well informed on the specific resources and challenges within their areas. The CFI is integral to implementing several management actions for each of the three focus areas of water quality, hydrologic restoration, and natural systems.

Quantifiable Objectives

The Charlotte Harbor SWIM plan includes numeric targets called quantifiable objectives (Table 7). Each objective is set with the intent of maintaining and improving the Charlotte Harbor and Lemon Bay estuaries. These objectives include both short-term and long-term goals to help develop and prioritize management actions and projects.

Water Quality	Target
"Hold the line" on multi-year average Total Nitrogen (TN) loads from gaged portions of the Peace River	Five-year average TN load of 1,800 tons per year
For the gaged portions of the Peace and Myakka Rivers, maintain area-normalized sub-basin TN loads at or below 2009-2015 average levels	Peace River – 2.7 pounds TN per acre per year Myakka River – 2.8 pounds TN per acre per year
Hydrologic Restoration	**Target**
Continue implementation of hydrologic restoration in the Myakka River watershed	Reduce inflows to Flatford Swamp by between 2 and 10 million gallons per day (mgd)
Participate in ongoing hydrologic restoration of Dona Bay watershed	Reduce inflows to Dona Bay by at least 3mgd
Participate in Charlotte Harbor Flatwoods Initiative	Support data collection and modeling to evaluate scenarios to restore historic flow-ways and hydroperiods
Participate in ongoing hydrologic restoration on conservation lands	Increase percent of area with natural hydrologic functioning over the next 10 years
Natural Systems Protection and Restoration	**Target**
Maintain seagrass coverage in Charlotte Harbor and Lemon Bay at 2016 levels	Charlotte Harbor – 20,280 acres Lemon Bay – 3,223 acres
Continue to implement habitat restoration projects throughout watershed within the SWFWMD	Habitat Restoration targets have been established by CHNEP for tidal and freshwater wetlands and uplands throughout the Charlotte Harbor estuarine system.

Table 7 – Quantifiable Objectives

Water Quality

Over the period 1988 to 2016, seagrass acreage in Charlotte Harbor and Lemon Bay steadily increased. Between 2016 and 2018, Charlotte Harbor and Lemon Bay experienced a 2.8% and a 10% loss in mapped seagrass acreage respectively. In Charlotte Harbor, this loss is relatively small, and in the case of Lemon Bay, losses are confined primarily to the north. Nevertheless, any loss should be closely monitored. The 2020 SWFWMD seagrass maps should be completed by early 2021.

To allow Charlotte Harbor to continue to support existing seagrass meadows, the water quality management actions for Charlotte Harbor focus on "holding the line" on nitrogen loads from the gaged Peace River at about 1,800 tons TN per year, based on a 5-year average. This amount is equivalent to the multi-year average TN loads derived for the gaged portions of the Peace River watershed for the periods of 1985 to 1991 and 2009 to 2015. In addition to watershed-wide TN load targets, individual gaged sub-basins would have area-normalized loads commensurate with the "hold the line" average across the watershed, equal to 2.7 pounds of TN per acre per year for the Peace River watershed, and 2.8 pounds of TN per acre per year for the Myakka River watershed.

Based on the results of the 2018 seagrass mapping efforts, special attention is warranted to determine the cause(s) of seagrass loss in northern Lemon Bay adjacent to Forked Creek (Figure 33) and to identify water quality management actions to help improve the situation. The persistent abundance of filamentous macroalgae in parts of Lemon Bay and Charlotte Harbor is also of concern from a water quality perspective and merits careful monitoring to determine what, if any, linkage exists between the occurrence of filamentous macroalgae and water quality conditions. Management actions specific to seagrass and filamentous macroalgae are detailed in the Natural Systems focus area.

In February 2020, the District's Governing Board approved staff recommendations to repeal the Facilitating Agricultural Resource Management Systems rule 40D-26 and establish program responsibilities through a Governing Board Policy. This same approval included language allowing the FARMS program to consider funding projects within the agricultural community focused on water quality improvements.

Table 8 lists the management actions focused on maintaining water quality in the Lemon Bay and Charlotte Harbor watersheds.

Monitoring and Research
Maintain and evaluate streamflow and water quality monitoring activities throughout the Peace and Myakka River watersheds, publish regular updates on watershed-scale nutrient loads, and area-normalized nutrient loads for gaged sub-basins
Support ambient water quality monitoring throughout Charlotte Harbor and Lemon Bay, and publish regular updates on water quality status and trends
Identify localized nutrient load sources near areas of significant seagrass loss and areas of filamentous macroalgae accumulation
Continue to study impacts of existing and future land use on the water quality of Lemon Bay and Charlotte Harbor
Assess potential sources of nutrient loads in the Forked Creek watershed
Assess potential sources of nutrient loads in Coral Creek and the confluence of the Peace and Myakka Rivers
Water Quality Protection and Restoration
Continue outreach and implementation of Best Management Practices (BMPs) through SWFWMD's FARMS program to assist agricultural stakeholders in conserving water and protecting water quality
Work with local, regional and state agencies to implement stormwater (BMPs) in urban areas
Support the development of stormwater master plans
Support stormwater retrofits in target areas

Table 8 – Water Quality Management Actions

Hydrologic Restoration

The hydrologic restoration management actions for Charlotte Harbor include implementing minimum flow recovery strategies and maintaining compliance with established minimum flows in the Upper, Middle and Lower Peace River, as well as in the Lower Myakka River. For the Upper Myakka River, actions are needed to reduce the excess water flowing into Flatford Swamp, by supporting planned and ongoing efforts to reduce inflows by 2 to 10 mgd.

Ongoing hydrologic restoration management actions include working with local, regional, and state agencies to implement Phase II of Sarasota County's Dona Bay restoration plan. Phase II is intended to divert up to 3mgd of flows out of the Shakett Creek watershed and back toward the historical destination of the Myakka River. This would, when completed, be the first project focusing on reducing excessive inflows to Dona Bay, a problem first diagnosed more than 40 years ago by researchers with Mote Marine Lab.

In addition, the action plan for hydrologic restoration should include innovative hydrologic restoration efforts focusing on portions of the watershed not typically addressed in SWIM Plans. For example, hydrologic restoration plans that examine the costs and benefits of increasing dispersed wet weather storage capacity of the watershed and enhancing infiltration of precipitation into the surficial aquifer. Management actions also include controlled burns and active forest management to enhance infiltration of rainfall into the surficial aquifer, to reduce excessive wet season discharges, and, potentially to increase rates of dry season baseflow.

Table 9 lists the management actions focused on maintaining hydrologic restoration in the Lemon Bay and Charlotte Harbor watersheds.

Monitoring and Research
Maintain and evaluate gaged stream flow stations within the Peace and Myakka River watersheds
Work with stakeholders to quantify the effectiveness of forest management BMPs on aquifer recharge and other hydrologic restoration projects involving forest lands
Develop applicable hydrologic modeling to support large hydrologic restoration projects in strategic areas including Charlotte Harbor Flatwoods and the Cecil Webb Wildlife Management Area
Hydrologic Restoration
Support the SWFWMD's Southern Water Use Caution Area (SWUCA) recovery strategy for the Peace and Myakka Rivers
Continue to support water conservation strategies
Explore opportunities for urban stream restoration including the conversion of drainage ditches to multi-stage channels
Education and Outreach
Continue to support water conservation strategies

Table 9 – Hydrologic Restoration Management Actions

Natural Systems Protection and Restoration

The natural systems management actions for Charlotte Harbor and Lemon Bay are focused on coastal, upland and both freshwater and saltwater wetland habitats. These habitats include mangroves, salt marshes, oyster beds, mesic flatwoods, and upland pine communities. Coastal upland and wetland restoration will continue to be important in Charlotte Harbor and Lemon Bay. However, given the large size of the watersheds, the significance of healthy riverine corridors to protecting water quality, and the importance of hydrologic restoration, effort will also focus on the watershed as well as the shoreline and immediately adjacent lands. These efforts will include evaluating differences between various upland forest management techniques, including their ability to enhance rainfall infiltration into the surficial aquifer, increase wet-weather storage, and increase baseflow, which could lead to improved water quality and more natural timing and volumes of inflows to coastal areas.

For natural systems restoration, the SWIM Plan recognizes the Natural System restoration and protection goals and targets from the CHNEP's Habitat Restoration Needs Update Project (ESA 2019). Project types, locations and acreages documented in the Habitat Restoration Needs Update will be used within the boundaries of the SWFWMD to guide ecosystem restoration programs and projects.

Table 10 lists the management actions focused on natural systems in the Lemon Bay and Charlotte Harbor watersheds.

Monitoring and Research
Continue aerial mapping of seagrass and other benthic habitat in Charlotte Harbor and Lemon Bay on a 2-year cycle
Monitor filamentous macroalgae accumulation and distribution in areas of concern within Charlotte Harbor and Lemon Bay
Investigate potential linkages between red tide events and the occurrence of filamentous macroalgae blooms
Work with stakeholders to monitor the impacts of accelerated sea-level rise on coastal ecosystems
Habitat Conservation
Coordinate with the SWFWMD Operations and Land Management Bureau on potential land acquisitions
Habitat Restoration
Where appropriate, support the programs and projects identified in the CHNEP's Habitat Restoration Needs Update Plan
Encourage and support strategic projects that include design elements to restore and improve living shorelines
Coordinate forestry management and hydrologic restoration programs

Table 10 – Natural Systems Management Actions

Projects and Initiatives

Projects and initiatives for Charlotte Harbor and Lemon 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

Peace River and Myakka River Water Quality Monitoring

Lead Entity: SWFWMD

Monitoring water quality is critical in evaluating the environmental and ecological conditions of these rivers. This project is a continuation of an ongoing effort to collect water quality and flow data for the gaged portions of the Peace River and Myakka River watersheds. Sample locations include but may not be limited to the following U.S. Geological Survey (USGS) stream measuring locations:

Peace Creek at Wahneta	Shell Creek near Punta Gorda	Myakka River near Myakka City
Saddle Creek at P-11 Structure	Peace River at Arcadia	Myakka River near Laurel
Peace River at Bartow	Horse Creek near Myakka Head	Charlie Creek near Gardner
Peace River at Ft. Meade	Horse Creek near Arcadia	Peace River at Arcadia
Peace River at Zolfo Springs	Joshua Creek at Nocatee	

Monitoring these rivers should also ensure that flow estimates are available on a time interval consistent with determining compliance with MFLs criteria. Water quality monitoring at gaged sites should be continued on a monthly basis until further data analysis is completed to determine whether sampling every other month produces similar results to monthly data collection. Results from this analysis may allow data collection to be reduced to a bi-monthly schedule.

Pollutant Loading Model Development and Analysis

Lead Entity: SWFWMD

Based on flow and water quality data at gaged locations, this project will produce empirically-derived pollutant loading models to determine if the loads from the Peace River and Myakka River watersheds are increasing, decreasing, or non-trending over time, relative to established targets. In addition, the results will be compiled and constructed in a manner such that basin-specific loads can be assessed and compared against area-normalized targets.

The stations used to develop loading estimates for the Peace River and Myakka River watersheds include the following:

Peace River at Arcadia	Shell Creek near Punta Gorda
Horse Creek near Arcadia	Myakka River near Laurel
Joshua Creek at Nocatee	

The stations used to develop area-normalized rates include the following:

Peace Creek at Wahneta	Shell Creek near Punta Gorda	Myakka River near Myakka City
Saddle Creek at P-11 Structure	Peace River at Arcadia	Myakka River near Laurel
Peace River at Bartow	Horse Creek near Myakka Head	Charlie Creek near Gardner
Peace River at Ft. Meade	Horse Creek near Arcadia	Peace River at Arcadia
Peace River at Zolfo Springs	Joshua Creek at Nocatee	

Loading estimates should be developed at a 5-year interval, and values should be compared to numbers developed in prior estimates for the years 1985 to 1992, and 2009 to 2015.

Optical Model Update for Charlotte Harbor and Lemon Bay

Lead Entity: CHNEP/SWFWMD

This project will update and refine the existing optical model for Charlotte Harbor and Lemon Bay, last updated in 2015. The distribution of seagrass in Charlotte Harbor and Lemon Bay is dependent on the amount of light reaching the bottom. An optical model allows resource managers to understand light loss with depth based on changing water quality conditions. This information is then compared to seagrass data to better explain seagrass status and trends. This optical model is based on empirical data collected as part of the ongoing Coastal Charlotte Harbor Monitoring Network.

Coastal Charlotte Harbor Monitoring Network (CCHMN) – Lemon Bay and Charlotte Harbor Water Quality Monitoring

Lead Entity: CHNEP/SWFWMD

The Coastal Charlotte Harbor Monitoring Network (CCHMN) is a monthly water quality monitoring network managed by the CHNEP and co-funded by the SWFWMD. SWFWMD and its partners have been collecting water quality data since 1993. Since 2001, the CCHMN uses a stratified random sampling design where 60 randomly selected field sites are collected across 10 waterbodies.

To aid in the determination of the status and trends in water quality in both Charlotte Harbor and Lemon Bay, the CHNEP and its partners should continue the CCHMN on a monthly basis.

CHNEP Water Atlas Maintenance and Enhancements

Lead Entity: CHNEP

This initiative supports the CHNEP's efforts to maintain and improve the CHNEP Water Atlas. The Water Atlas is a web-based data management and mapping system that provides historical information, scientific data, water resource maps, resource management actions, volunteer opportunities, and information about current events within the CHNEP study area including Charlotte Harbor and Lemon Bay.

The Water Atlas is a useful tool to find water quality data, status and trend information, and other water quality information related to individual watersheds and receiving waters throughout the Charlotte Harbor system.

Lemon Bay Nutrient Source Assessment in the Forked Creek Watershed

Lead Entity: Sarasota County/SWFWMD

This project will identify potential sources of nutrients loading into the northern region of Lemon Bay within the Forked Creek Watershed. Historically, this 5,863-acre basin consisted of a series of contiguous wetlands and mesic hammocks that extended from the creek's headwaters to its outfall in Lemon Bay. The eastern branch traverses mainly undeveloped range land and sparsely populated land, while the central branch traverses through two urban subdivisions and one sparsely populated section. The flow characteristics of the creek have been greatly diminished because of the invasion of a variety of exotics, debris and storm-damaged trees.

Between 2016 and 2018, Lemon Bay experienced a 10.5% loss in mapped seagrass acreage. Much of this loss is centered on that portion of the bay downstream from Forked Creek. Based on existing water quality data for the period 2016 to 2018, the same region of Lemon Bay has also exceeded the numeric nutrient criteria. Forked Creek is also verified by FDEP as impaired for nutrients.

Urban and Residential Fertilizer Application

Outreach, Coordination and Implementation of Best Management Practices (BMPs)

Lead Entity: FDACS

The SWFWMD will continue to coordinate with FDACS and other stakeholder groups to complete ongoing projects and programs which seek to reduce impacts of various activities negatively affecting the hydrology and water quality discharged from agricultural land uses.

Project types include but are not limited to the following:

- Design, permitting and implementation of BMPs designed to reduce nutrient and TSS loads to receiving waters
- Design, permitting and implementation of BMPs designed to restore hydrologic properties of agricultural lands

Where appropriate, FDACS and its partners should design, permit, implement and monitor the effectiveness of agricultural BMPs, and report on the results to appropriate stakeholders.

Wastewater Treatment Facilities

Coordination and Implementation of Practices and Programs to Minimize Nutrient Loads from Wastewater Treatment Facilities

Lead Entity: CHNEP

The SWFWMD supports the efforts of CHNEP and its partners working with FDEP to continue ongoing projects and programs which seek to reduce impacts of wastewater treatment facilities in the Charlotte Harbor and Lemon Bay watershed. While nutrient reduction guidance as listed in the Grizzle-Figg Act (Florida Statutes 403-086) includes the watershed of Lemon Bay, and the tidally influenced portions of tributaries to Charlotte Harbor, the guidance does not apply to non-tidal portions of tributaries to the Peace and Myakka Rivers.

Stormwater
Develop and Implement Regional Stormwater Management Programs and/or Projects Lead Entity: SWFWMD/CHNEP This initiative involves coordination with the CHNEP and other stakeholder groups to continue ongoing projects and programs which seek to reduce impacts of stormwater from urban land uses. Project types include but are not limited to the following: • Development of regional and local stormwater master plans • Implementation of stormwater ordinances, where appropriate • Design, permitting and implementation of BMPs designed to reduce nutrient and TSS loads to receiving waters • Design, permitting and implementation of cost-effective and regional stormwater treatment systems in priority sub-basins.

Hydrologic Restoration

Monitoring and Research
Assessment of Compliance with MFLs in the Peace River, Myakka River and Dona Bay/Shakett Creek System Lead Entity: SWFWMD This assessment analyzes flow and water withdrawals data collected, modelled and maintained by the USGS, SWFWMD and others and compares the results to existing Minimum Flows and Levels (MFLs) for the Peace River, Myakka River and the Dona Bay/Shakett Creek System. Comparisons will be made over appropriate time periods consistent with the established MFLs. The MFLs status assessments are completed on an annual basis, on a 5-year basis to support regional water supply planning, and on an as-needed basis in association with water-use permit and project evaluations.
Evaluate Benefits of Resource Management Actions Lead Entity: SWFWMD This project evaluates the hydrologic benefits of various resource management activities in upland communities. Field data collection and analysis should be conducted to determine if resource management actions such as prescribed fires and other forest management activities can increase the infiltration rates and aquifer recharge for upland forests in the Charlotte Harbor and Lemon Bay watersheds. In addition, groundwater and surface water sampling efforts should be conducted to determine whether increased infiltration rates result in increases in baseflow in adjacent surface waters, due to upland management practices.

Support Development of an Integrated Surface Water – Groundwater Model for Charlotte Harbor Flatwoods and the Cecil Webb Wildlife Management Area Lead Entity: CHNEP This project will create an updated integrated surface-groundwater hydrological model that will evaluate existing and future conditions scenarios in the Lower Charlotte Harbor Flatwoods area. The outcomes from this project will provide guidance to resource management agencies for restoration and management of surface waters flowing from the Babcock-Webb WMA and Yucca Pens Unit through the tidal creeks discharging into eastern Charlotte Harbor. This project supports the Charlotte Harbor Flatwoods Initiative (CHFI). The SWFWMD is funding data collection for the CHNEP-led Lower Charlotte Harbor Flatwoods Hydrological Modeling Strategic Restoration Planning Project.
Conservation – Public and Self-Supply
Develop and/or Promote Increased Water Use Efficiency Lead Entity: CHNEP/SWFWMD This initiative involves the continuation of ongoing projects and programs which seek to reduce per capita water use, where appropriate. This is a joint effort with the SWFWMD, CHNEP, and other stakeholder groups. Project types include but are not limited to the following. • Facilitate retrofit of inefficient household water devices • Promote low water use landscaping practices, and promote general water conservation principles for homeowners and businesses • Improve, where appropriate, water delivery infrastructure efficiency
Hydrologic Restoration Projects
Continued Implementation of Hydrologic Restoration of the Upper Myakka River Lead Entity: SWFWMD This initiative continues to implement projects designed to restore Flatford Swamp by reducing excessive inflows from the surrounding watershed. These projects are based on a preliminary goal of reducing excessive inflows between 2 and 10 million gallons per day. The SWFWMD will continue to work with its partners to design, permit, construct, hydrologic restoration projects to improve the hydrology of Flatford Swamp and the upper Myakka River. This initiative also includes pre- and post-construction monitoring to evaluate project effectiveness and knowledge management for future projects.
Hydrologic Restoration Projects of the Peace River State Forest and Babcock Ranch Lead Entity: SWFWMD This initiative continues to implement projects designed to improve the hydrologic and ecosystem conditions of the Peace River State Forest and Babcock Ranch. Various human activities over the past several decades have resulted in these lands being severely ditched and drained. The SWFWMD will continue to work with its partners to design, permit, construct, hydrologic restoration projects to improve the hydrology within the Peace River State Forest and Babcock Ranch. This initiative also includes pre- and post-construction monitoring to evaluate project effectiveness and knowledge management for future projects.

Natural Systems Protection and Restoration

Monitoring and Research

Biennial Seagrass Mapping

Lead Entity: SWFWMD

This is an ongoing project that maps seagrass and other benthic habitat via aerial photography throughout the Charlotte Harbor and Lemon Bay estuaries. Mapping seagrass is done through photointerpretation of aerial photographs collected specifically for the purpose of benthic mapping. The SWFWMD 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 SWFWMD 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 photointerpreter.

The SWFWMD will continue to work closely with its partners via the CHNEP and the Southwest Florida Seagrass Working Group to provide feedback and peer review of the map products.

Drift and Filamentous Algae UAV Mapping Pilot Project

Lead Entity: SWFWMD

This is a proposed project that uses unmanned aerial vehicles (UAV) to map the distribution of drift and filamentous algae in targeted regions of Charlotte Harbor and Lemon Bay. Persistent filamentous algae blooms have been observed along Charlotte Harbor's east wall and in parts of Lemon Bay. It is unknown why these algae blooms have persisted but over time they can smother seagrass and cause other ecological shifts. Because of the ephemeral nature of drift algae, biennial aerial photography does not provide enough temporal resolution to track the movement of these drift algae. More frequent flights using traditional manned fixed wing aircraft are cost prohibitive. However, using UAVs can provide a more cost-effective approach. Additionally, UAVs fly at much lower altitudes than manned fixed wing aircraft and therefore can provide digital imagery at a much greater pixel resolution.

Results from this project will provide knowledge management to guide the SWFWMD in future UAV mapping missions designed to track the status and trends in drift and filamentous algae.

Nutrient Linkages to Filamentous Algae Occurring in Charlotte Harbor and Lemon Bay

Lead Entity: SWFWMD

This is a proposed project to investigate potential linkages between nitrogen loads and the occurrence of filamentous algae in Charlotte Harbor and Lemon Bay. Filamentous algae have been observed in in greater abundance since 2012 in Charlotte Harbor. Increased abundance of filamentous algae has been observed in upper Charlotte Harbor, near the confluence of the Peace and Myakka Rivers, and in Lemon Bay in the vicinity of Coral Creek.

While the FFWCC fisheries monitoring program has been monitoring the abundance of filamentous algae in Charlotte Harbor and Lemon Bay, little is known as to the possible mechanisms driving their occurrence and distribution. Filamentous algae occurrence is at least partially a function of nutrient availability, and therefore it is important to identify nutrient sources. Working with researchers from various Florida universities, nitrogen isotopic sampling of nuisance algae could be useful in identifying the sources of nitrogen. For example, fertilizer and sewage have distinct nitrogen isotopic signatures. Other potential nutrient sources include reuse water, wastewater treatment plants, residential fertilizer, and golf courses, among others.

Linkages with existential events like red tide and tropical storms should also be investigated.

Understanding the Effects of Sea-Level Rise on Coastal Ecosystems

Lead Entity: CHNEP

This initiative builds upon the CHNEP Habitat Restoration Needs Plan published in 2019, and the CHNEP Habitat Resiliency to Climate Change Project and takes a closer look at the impacts of climate change and sea-level rise to coastal ecosystems. This is a cooperative effort between the CHENP and its partners including the SWFWMD to identify specific habitat types like tidal freshwater wetlands and hardened shorelines that are especially vulnerable to sea-level rise, and develop project-specific guidelines to help manage and where applicable offset these impacts.

Evaluate Methods to Incentivize Shoreline Conservation and Improvements

Lead Entity: CHNEP

This initiative develops guidance for local homeowners, businesses, and local governments on techniques that could be used to increase the habitat value of existing modified shorelines, and programs that could be used to incentivize the protection of existing natural shoreline features. This initiative is in cooperation with CHNEP and local stakeholders.

Habitat Conservation

Land Acquisition

Lead Entity: SWFWMD

This initiative continues to promote SWFWMD efforts to conserve natural lands using conservation easements and land acquisition. Part of this initiative includes developing strategies to identify priority wetland and upland parcels of opportunity throughout the Charlotte Harbor and Lemon Bay watersheds.

Section 373.139, Florida Statutes, authorizes the Governing Boards of the water management districts to acquire the fee or other interest 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.

Habitat Restoration

Implement the Habitat Restoration Needs Plan for the SWFWMD Portion of the CHNEP Area

Lead Entity: SWFWMD/CHENP

This initiative identifies SWFWMD-specific elements of the Habitat Restoration Needs (HRN) Plan for the CHNEP Area published in March 2019. The HRN Plan was developed to guide habitat conservation, restoration, sustainability, and connectivity throughout the CHNEP area. This area includes parts of the state that are outside the SWFWMD boundary. Therefore, this initiative will only consider elements of the HRN Plan that fall within its boundary.

In cooperation with local stakeholders, the SWFWMD should work to identify projects to assist in meeting the targets identified in the HRN Plan. The project types expected are likely to involve both uplands and wetlands, and to include projects aimed at restoring shoreline communities in tidal areas and restoring upland communities to include hydrologic restoration. Specific projects that are identified, should include some low-impact public use and access, and public education and outreach.

Natural Systems Projects on SWFWMD Lands within the Charlotte Harbor and Lemon Bay Watersheds – Feasibility and Conceptual Design

Lead Entity: SWFWMD

This proposed project will identify potential natural systems and hydrologic restoration projects on SWFWMD-owned lands within the Charlotte Harbor and Lemon Bay watersheds. The study will prioritize potential restoration activities and provide conceptual design plans with engineer's estimate of probable cost for select locations.

Literature Cited

Ansell, A., R. Gibson, M. Barnes, and U. Press. 1998. Ecological impact of green macroalgal blooms. Oceanography and Marine Biology: an annual review 36: 97-125.

Basso, R., and R. Schultz. 2003. Long-term variation in rainfall and its effect on Peace River Flow in West-Central Florida. Southwest Florida Water Management District. Brooksville, Florida.

Coastal Environmental. 1996. Living resource-based freshwater inflow and salinity targets for the tidal Peace River. Final Report to: Surface Water Improvement and Management Section, Southwest Florida Water Management District. Tampa, FL.

CDM. 1998. The study of seasonal and spatial patterns of hypoxia in Upper Charlotte Harbor. Report to Southwest Florida Water Management District. Brooksville, FL.

Charlotte Harbor Environmental Center. 2001. Annual Report on Water Quality Status and Trends in the Peace and Myakka River Basins. Report for Charlotte Harbor National Estuary Program.

Chislock, M.F., E. Doster, R. A. Zitomer, and A. E. Wilson. 2013. Eutrophication is a leading cause of impairment of many freshwater and coastal marine ecosystems in the world. Why should we worry about eutrophication and how is this problem managed? Nature Education Knowledge 4: 7.

Collado-Vides, L., V.G. Caccia, J.N. Boyer, and J.W. Fourqurean. 2007. Tropical seagrass-associated macroalgae distributions and trends relative to water quality. Estuarine, Coastal and Shelf Science 73: 680-694.

Environmental Science Associates (ESA). 2018. CHNEP land use changes by sub-basin. Preliminary data assessment and analysis for Charlotte Harbor Estuary Program. Punta Gorda, FL.

ESA. 2019. Habitat Restoration Needs Plan for the Coastal and Heartland National Estuary Partnership Area. Report to the Coastal and Heartland National Estuary Partnership. Punta Gorda, FL.

Florida Department of Environmental Protection (FDEP). 2009. State of Florida Numeric Nutrient Criteria Development Plan, ed. D.o.E.A.a.R. Bureau of Assessment and Restoration Support, 129. Tallahassee, FL.

FDEP. 2013. Numeric Nutrient Criteria for Springs Coast, ed. D.o.E.A.a. Restoration, 114. Tallahassee, FL: FDEP.

Fonseca, M.S. and J.A., Cahalan. 1992. A preliminary evaluation of wave attenuation by 4 species of seagrass. Estuarine, Coastal and Shelf Science. 35: 565-576.

Hammett, K.M. 1990. Land use, water use, streamflow characteristics, and water quality characteristics of the Charlotte Harbor inflow area. Florida, U.S. Geological Survey. Water Supply Paper 2359-A. Tallahassee, Florida. 64 p.

Heck, K., Hays, G., and R. Orth. 2003. Critical evaluation of the nursery role hypothesis for seagrass meadows. Marine Ecology Progress Series. 253: 123-136.

Janicki Environmental, Inc. 2011. Proposed Numeric Nutrient Criteria for the Charlotte Harbor National Estuary Program Estuarine System. Report for the Charlotte Harbor National Estuary Program. Ft. Myers, FL. 100pp.

Janicki Environmental, Inc. and Jones Edmunds & Associates, Inc. 2010. Lemon Bay Watershed Management Plan. Sarasota County. 954 pp.

KHA. 2007. Dona Bay Watershed Management Plan. Sarasota County. 142 pp.

McPherson, B.F. and R.L. Miller. 1987. The vertical attenuation of light in Charlotte Harbor, a shallow, subtropical estuary, south-western Florida. Estuarine, Coastal and Shelf Science. 25, 721-737.

PBS&J. 1998. Trend analysis of tree mortality in the Upper Myakka River watershed. Southwest Florida Water Management District. Brooksville, FL

Southwest Florida Water Management District (SWFWMD). 1993. Charlotte Harbor SWIM Plan. Surface Water Improvement and Management Department. Southwest Florida Water Management District, Tampa, FL.

SWFWMD. 2002. Upper Peace River – An analysis of minimum flows and levels. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2005a. Proposed minimum flows and levels for the middle segment of the Peace River, from Zolfo Springs to Arcadia. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2005b. Proposed minimum flows and levels for the upper segment of the Myakka River, from Myakka City to SR 72. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2006. Southern Water Use Caution Area recovery strategy, March 2016 final report. Brooksville, Florida.

SWFWMD. 2009. Proposed Minimum Flows and Levels for Dona Bay/Shakett Creek below Cow Pen Slough. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2010. Proposed minimum flows and levels of the Lower Peace River and Shell Creek. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2011. The determination of minimum flows for the Lower Myakka River. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2015. Initial reevaluation of Minimum Flows and Levels for the Lower Peace River. Southwest Florida Water Management District. Brooksville, Florida.

SWFWMD. 2020. Water budget evaluation for a proposed reservation for Lake Hancock and Lower Saddle Creek in Polk County, Florida. Southwest Florida Water Management District. Brooksville, Florida.

Tomasko, D.A. and M.O. Hall. 1999. Productivity and biomass of the seagrass *Thalassia testudinum* along a gradient of freshwater influence in Charlotte Harbor, Florida. Estuaries. 22, 592-602.

Tomasko, D., C. Corbett, H. Greening, and G. Raulerson. 2005. Spatial and temporal variation in seagrass coverage in Southwest Florida: assessing the relative effects of anthropogenic nutrient load reductions and rainfall in four contiguous estuaries. Marine Pollution Bulletin 50: 797-805.

Turner, R.E., N.N. Rabalais, B. Fry, C.S. Milan, N. Atilla, J.M. Lee, C. Normandeau, T.A. Oswald, E.M. Swenson, and D.A. Tomasko. 2006. Paleo-indicators and water quality change in the Charlotte Harbor estuary (Florida). Limnology and Oceanography 51: 518-533

Unsworth, R.K.F., Collier, C.J., Henderson, G.M., and L.J. McKenzie, 2012.Tropical seagrass meadows modify seawater carbon chemistry: implications for coral reefs impacted by ocean acidification. Environ. Res. Lett.7(9pp.).

Yates, K., Moyer, R., Moore, C., Tomasko, D., Smiley, N., Torres-Garcia, L., Powell, C. Chappel, A., and I. Bociu., 2016. Ocean acidification buffering effects of seagrass in Tampa Bay. Pp. 273-284. In: Burke, M. (Ed.). Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS. 28-30 September 2015, St. Petersburg, FL. 373 pp.

APPENDICES

Appendix A: Primary Issues and Drivers Affecting the Charlotte Harbor System

Memorandum

To: Lizanne Garcia

From: David Tomasko, Ph.D., Emily Keenan, M.S.

Date: 06/03/2020

Re: Task 2 Deliverable

This Technical Memorandum is intended to meet the contractual obligations for Task 2 of the Agreement (No. 14MA0000047) between the Southwest Florida Water Management District (DISTRICT) and ESA SCHEDA to provide services in connection with the Charlotte Harbor Protection and Restoration Planning - Swim Plan Update.

Task 2 of this Agreement involved the identification of the primary Issues and Drivers affecting the Charlotte Harbor system. To fulfill this task, ESA SCHEDA focused on an assessment of the three identified major focus areas of 1) Water Quality, 2) Hydrologic Alterations, and (3) Natural Systems.

Each of these topics are reviewed, and results summarized so that the major stressors to the Charlotte Harbor ecosystem are identified, and projects or project "types" are summarized for potential inclusion in the updated Surface Water and Improvement and Management (SWIM) Plan for Charlotte Harbor.

Issues and Drivers – Water Quality

As outlined in the Agreement, ESA SCHEDA summarized the impairment status of water quality, as related to the guidance contained within the Numeric Nutrient Concentration (NNC) criteria listed in Rule 62-302.531, Florida Administrative Code (FAC). Water quality was evaluated for the latest impairment cycle (Cycle 3) which extends from January 1, 2009 to June 30, 2016. To ensure consistency with any assessments that could be conducted by the Florida Department of Environmental Protection (FDEP), ESA SCHEDA analyzed data provided by FDEP in their latest Impaired Waters Rule data set. This ensured that any data deemed suspect or not relevant by FDEP would not be used to characterize the status and trends (if any) in recent water quality, in keeping with the standard approach FDEP uses to determine the impairment status of waterbodies.

The NNC criteria evaluation was carried out for the Water Body Identification number waterbodies (aka WBIDs) listed in Table 1.

Table 1 – List of WBIDs reviewed for NNC criteria status.

WBID Number	WBID Name
2056A	PEACE RIVER ESTUARY (LOWER SEGMENT)
2056D	ALLIGATOR BAY
1991B	MYAKKA RIVER
2018A	ROBERTS BAY
2002	DONA BAY
2056C1	PEACE RIVER ESTUARY (UPPER SEGMENT NORTH)
1991C	MYAKKA RIVER
2065C	CHARLOTTE HARBOR (MIDDLE SEGMENT2)
2056B	MIDDLE PEACE RIVER ESTUARY (MIDDLE SEGMENT)
2055	TIPPECANOE BAY
2065A	CHARLOTTE HARBOR (UPPER SEGMENT)
1991E	MYAKKA RIVER (TIDAL SEGMENT)
2065B	CHARLOTTE HARBOR (MIDDLE SEGMENT1)
1983B	LOWER LEMON BAY
1991G	MYAKKA RIVER BELOW BLACKBURN BRIDGE
2060A1	MYAKKA CUTOFF (WESTERN PORTION)
1991A	MYAKKA RIVER
2002A	LYONS BAY
2075B	DON PEDRO ISLAND
2065D	CHARLOTTE HARBOR (LOWER SEGMENT1)
1983A1	LEMON BAY (NORTH SEGMENT)
1983A	UPPER LEMON BAY
2075D	MANASOTA KEY
2075A	LITTLE GASPARILLA ISLAND
2056C2	PEACE RIVER ESTUARY (UPPER SEGMENT SOUTH)

This evaluation of NNC criteria for Total Nitrogen (TN), Total Phosphorus (TP) and chlorophyll-a determined that there is a discrepancy between the boundaries of the areas used for the derivation of NNC criteria, compared to the boundaries of the WBIDs to which the NNC criteria could be applied. Figures 1 and 2 show a comparison of the boundaries of the regions from which NNC criteria were derived, compared to the boundaries of the WBIDs where the NNC criteria were applied for Lemon Bay and Charlotte Harbor, respectively. Although the expectation might be that NNC criteria developed at the regional level would not be applied at the smaller WBID level, this apparently was done in the Comprehensive Verified Impaired list from December 18, 2017.

Figure 1 – Comparison of boundaries of regions from which NNC criteria were derived (left) vs. the boundaries of the WBIDs for which the NNC criteria were applied (right) for Lemon Bay.

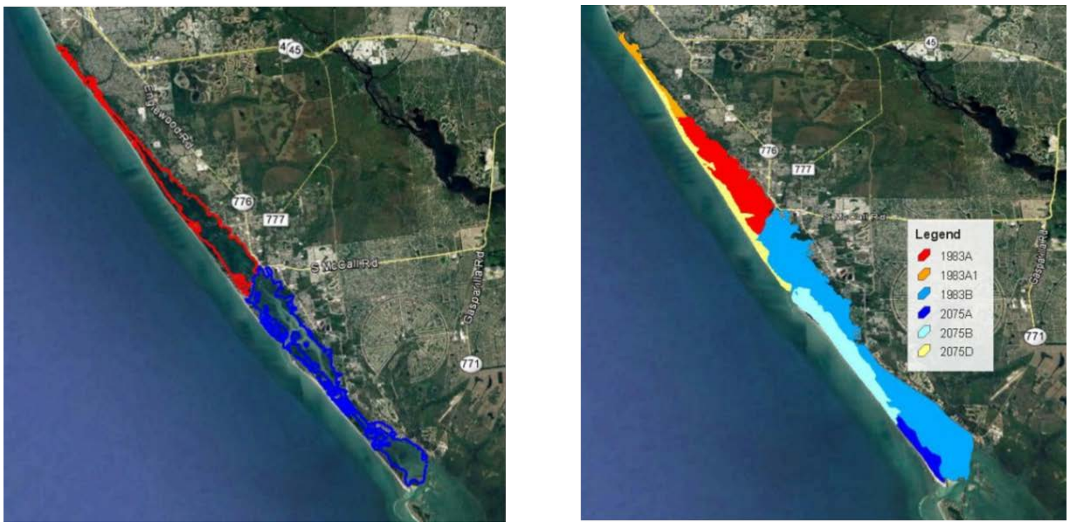
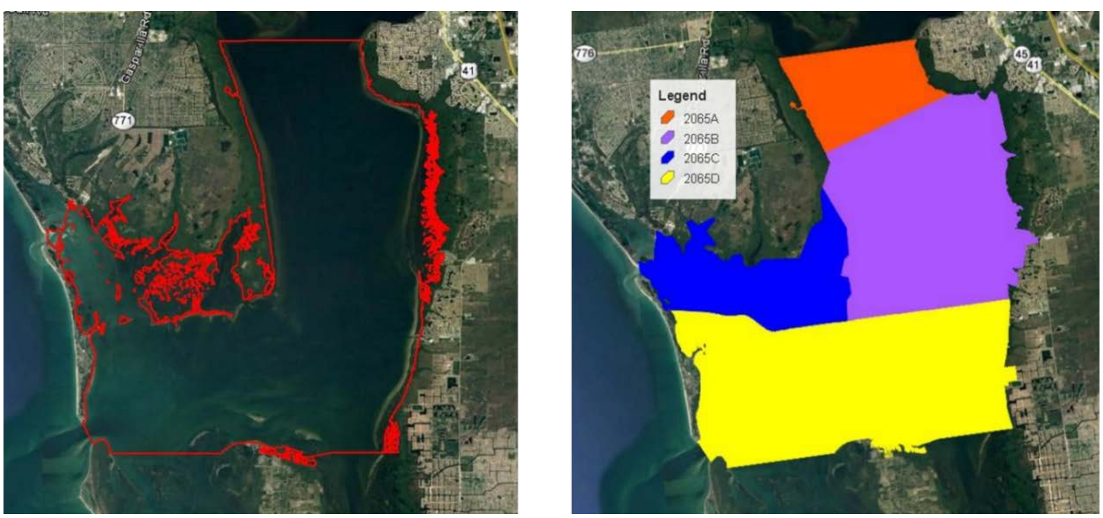


Figure 2 – Comparison of boundaries of regions from which NNC criteria were derived (left) vs. the boundaries of the WBIDs for which the NNC criteria were applied (right) for Charlotte Harbor.



For both Lemon Bay and Charlotte Harbor, individual WBIDs are in regions that would be expected to differ from the wider region from which NNC criteria were derived. The most significant example would be for Charlotte Harbor, where WBIDs 2065A and 2065B are closer to sources of freshwater inflow, and farther from the tidal flushing at Boca Grande Pass and Gasparilla Pass. As the NNC criteria for both Lemon Bay and Charlotte Harbor are single concentrations, rather than loads or salinity-normalized values, it would be expected that WBIDs 2065A and 2065B would be more likely to exceed NNC criteria than WBIDs 2065C and 2065D.

Table 2 displays results from the NNC criteria evaluation, with results shown for data aggregated at the regional scale, at which the criteria were derived, and the WBID level, at which the criteria were applied.

Table 2 – Results of NNC criteria evaluation for TN, TP, and chlorophyll-a at both regional and WBID levels. Results are based on analysis of data for the period of January 1, 2009 to June 30, 2016. WBIDs with insufficient data for comparison with NNC criteria are marked with "ID".

			Total Nitrogen		Total Phosphorus		Chlorophyll-a	
WBID	Nutrient Region	WBID Name	Region	WBID	Region	WBID	Region	WBID
2065A	Charlotte Harbor Proper	CHARLOTTE HARBOR (UPPER SEGMENT)	Not impaired	Impaired	Not impaired	Not impaired	Impaired	Impaired
2065B		CHARLOTTE HARBOR (MIDDLE SEGMENT1)		Impaired		Not impaired		Impaired
2065C		CHARLOTTE HARBOR (MIDDLE SEGMENT2)		Not impaired		Not impaired		Impaired
2065D		CHARLOTTE HARBOR (LOWER SEGMENT1)		Not impaired		Not impaired		Not impaired
2002	Dona and Roberts Bay	DONA BAY	Impaired	Impaired	Not impaired	Not impaired	Impaired	Impaired
2002A		LYONS BAY		Impaired		Not impaired		Impaired
2018A		ROBERTS BAY		Impaired		Not impaired		Impaired
1983B	Lower Lemon Bay	LOWER LEMON BAY	Not impaired	Not impaired	Not impaired	Not impaired	Not impaired	Not impaired
2075A		LITTLE GASPARILLA ISLAND		ID		ID		ID
2075B		DON PEDRO ISLAND		Not impaired		Not impaired		Not impaired
2075D		MANASOTA KEY		ID		ID		ID
1991A	Tidal Myakka River	MYAKKA RIVER	Not impaired	Not impaired	Not impaired	Not impaired	Impaired	Not impaired
1991B		MYAKKA RIVER		Impaired		Not impaired		Impaired
1991C		MYAKKA RIVER		ID		ID		ID
2055		TIPPECANOE BAY		Not impaired		Not impaired		Impaired
2060A1		MYAKKA CUTOFF (WESTERN PORTION)		Not impaired		Not impaired		Not impaired
2056A	Tidal Peace River	PEACE RIVER ESTUARY (LOWER SEGMENT)	Not impaired	Not impaired	Not impaired	Not impaired	Impaired	Impaired
2056B		MIDDLE PEACE RIVER ESTUARY (MIDDLE SEGMENT)		Impaired		Not impaired		Impaired
2056C2		PEACE RIVER ESTUARY (UPPER SEGMENT SOUTH)		Impaired		ID		Impaired
2056D		ALLIGATOR BAY		Not impaired		Not impaired		Impaired
1983A	Upper Lemon Bay	UPPER LEMON BAY	Impaired	Impaired	Not impaired	Not impaired	Impaired	Impaired
1983A1		LEMON BAY (NORTH SEGMENT)		Impaired		Not impaired		Impaired

The results shown in Table 2 suggest a disconnect between impairment determinations for TN and TP, compared to chlorophyll-a. In addition, there can be disconnects between impairment determinations at the regional vs. WBID levels. For example, Charlotte Harbor Proper is impaired for chlorophyll-a at the regional level, but it is not impaired for either TN or TP at the regional level. Within the Charlotte Harbor region, the two WBIDs in the lowest salinity portions of the estuary (WBIDs 2065A and 2065B) are both impaired for TN, while the two WBIDs in the highest salinity portions of the estuary (WBIDS 2065C and 2065D) are not impaired for TN. These results were reviewed by FDEP staff in Tallahassee, and found to be in-line with WBID-level impairment determinations made by FDEP, using data independently downloaded and analyzed from Impaired Waters Rule Run 55.

When the data are examined at the spatial level at which the criteria were derived – the regional level – there is a disconnect between determinations of impairment for nutrients and chlorophyll-a for Charlotte Harbor Proper, the Tidal Myakka River, and the Tidal Peace River. For those three regions, the finding of impairment for chlorophyll-a is not matched with a similar finding of impairment for either TN or TP. This finding is consistent with prior work by McPherson and Miller (1987) who determined that the amount of colored dissolved organic matter (CDOM) was the primary light attenuator in Charlotte Harbor, and that levels of CDOM were sufficiently high as to reduce the ability of phytoplankton to assimilate incoming nutrient loads. The lack of a clear relationship between nutrient supply, chlorophyll-a concentrations and water clarity had previously been noted by Tomasko and Hall (1999) who suggested that seagrasses were not the best biological indicator of ecosystem health in Charlotte Harbor.

In response to the findings of McPherson and Miller (1987) that CDOM was the dominant light attenuator, and the determination by Tomasko and Hall (1999) that seagrass productivity was influenced mostly by salinity and levels of CDOM, rather than phytoplankton abundance, another approach to determine sensitivity to nutrient loads was undertaken. In a study completed by CDM (1998) it was determined that the phenomenon of bottom water hypoxia was mostly a natural event, driven by salinity stratification under conditions of high inflows. However, it was concluded increasing oxygen demand in bottom sediments over time could intensify and increase the duration of the natural hypoxic bottom water condition. To determine if there was any evidence of a potential increase in sediment oxygen demand (SOD) researchers from Louisiana State University tested the bottom sediments for potential increases in SOD, by looking for trends in the nitrogen and/or organic loads to bottom sediments over time. They determined that there was evidence of an increase in nitrogen and organic contents in more recent sediments in Charlotte Harbor, and that SOD levels could be higher in recent years, thus exacerbating hypoxic conditions during salinity stratification (Turner et al. 2006).

Based on the findings of Turner et al. (2006) and the Charlotte Harbor National Estuary Program (NEP) Policy Committee, the SWFWMD Governing Board supported adoption of a “hold the line” approach to nitrogen loads to Charlotte Harbor from the Peace River watershed. The determination of the need to hold the line on nutrient loads to Charlotte Harbor, and the basis for the SWFWMD projects developed to reduce impacts of nitrogen loads from Lake Hancock, was thus informed by the potential link between bottom water hypoxia and the apparent increase in organic loads to the sediments of Charlotte Harbor (Turner et al. 2006). This approach is very different than the nutrient management paradigm contained within the NNC criteria for determining impairment status, which is focused on water quality in surface samples and seagrass coverage, rather than SOD and bottom water hypoxia.

Based on the results shown in Table 2, and the issue of bottom water hypoxia, current NNC criteria may not provide adequate information to determine appropriate management actions to protect Charlotte Harbor. For example, if it is determined that the region-wide impairments for chlorophyll-a in Charlotte Harbor and the tidal Myakka and Peace Rivers require a management response, what should such a response be, if those same waters are not similarly impaired for either TN or TP? And since FDEP only uses surface water samples to determine impairment status, how is the link between nutrients, SOD and bottom water hypoxia to be accounted for?

To examine nutrient issues in greater detail, trend analysis was conducted using all available water quality data for TN, TP and chlorophyll-a at both the regional and WBID levels. To increase the sample size for trend analysis, data were examined for the years 2000 to 2017, using water quality data provided by DEP for WBID-level analyses. This period of record was chosen, as it corresponds to the period of record just after the last SWIM Plan was produced, and results here can be compared with findings from that plan. For chlorophyll-a, any values reported as “below minimum detection limit” were given a value equal to half the minimum detection limit, per FDEP protocol.

The water quality trends in the open waters of Charlotte Harbor, as outlined in the 2000 SWIM Plan include the following:

- TP concentrations declined significantly during the period of 1976 to 1996;
- There were no trends in Total Kjeldahl Nitrogen (TKN) over the period of 1976 to 1996;
- Chlorophyll-a concentrations displayed no trend over the period of 1976 to 1996;
- Salinity decreased over the years 1976 to 1996, which was concurrent with a positive trend in streamflow in the Lower Peace River over the same period;
- Dissolved oxygen values declined significantly during 1976 to 1996, which was thought to be linked to an increasing frequency of stratification-driven hypoxia, which would be expected under conditions of increased flow; and
- There was no apparent trend in the number of months with hypoxic conditions during the period 1975 to 1989 (CDM, 1998).

To build on the trends identified in the 2000 SWIM Plan, two statistical tests were used for data from 2000 to 2017; linear regression and the Seasonal Kendall Tau test. Linear regression is an appropriate statistical test if the data set examined meets four requirements: 1) the relationship between time and the water quality data is linear, 2) the data points of time and water quality are measured independent of each other, 3) the data are normally distributed, and 4) the data sets display equal variation (they are homoscedastic). While these requirements were met for some of the data sets examined, they were not met for most of the data sets. In addition to linear regression, analysis was conducted using the Seasonal Kendall Tau test. This test does not require the data to be linearly correlated or normally distributed, as it uses ranks of data, compared to actual values. The Seasonal Kendall Tau test does not compare years against each other, it compares “seasons”. In this way, all the Januarys between 2000 to 2017 are compared against each other, etc. After the ranks of each month are compared against each other, a weighted average value is derived that would determine, in effect, if “enough” months are changing in a similar enough fashion that one could conclude that the system as a whole is changing over time.

For chlorophyll-a examined at a regional level, linear regression was either not appropriate, or it failed to find a significant trend over time for Charlotte Harbor, Gasparilla Sound, Dona Bay, Lemon Bay, Lyons Bay, the tidal Myakka River, the tidal Peace River, and Roberts Bay. For those same regions, the Seasonal Kendall Tau test found only one trend – decreasing concentrations of chlorophyll-a for the tidal Peace River.

At a regional level, linear regression found evidence of decreasing values of TN for the years 2000 to 2017 for Gasparilla Sound and the Tidal Peace River, but no trends for any of the other regions. For those same regions, the Seasonal Kendall Tau test found evidence for decreasing trends for TN in Charlotte Harbor and the tidal Peace and Myakka Rivers, but an increasing trend of TN in Lemon Bay.

At the regional level, linear regression found evidence of decreasing values for TP in Charlotte Harbor, Gasparilla Sound and Lemon Bay. Using the Seasonal Kendall Tau test, decreasing TP values were found in Charlotte Harbor, Lemon Bay, and both the tidal Peace and tidal Myakka Rivers.

Water clarity was examined at the regional level, using data on Secchi disk depths. Linear regression was not found to be an appropriate test for most of the analyses, as data failed to meet requirements of normality and/or homogeneity of variance. Using the Seasonal Kendall Tau test, results indicated trends of improving water clarity (increasing Secchi disk depths) in Charlotte Harbor, Lemon Bay, and the tidal Peace and Myakka Rivers.

Overall, the results of trend analysis can be summarized as follows:

- There is no evidence of degrading water clarity over the period of 2000 to 2017 for any of the estuarine nutrient regions examined;
- There is evidence of improving water clarity over those same years for Charlotte Harbor, the tidal Peace and Myakka Rivers, and Lemon Bay;
- There is no evidence of increasing concentrations of chlorophyll-a over the period of 2000 to 2017 for any of the regions examined;
- There is evidence of declining concentrations of chlorophyll-a over those same years in the tidal reaches of the Peace River;
- There is no evidence of increasing concentrations of TN over the period of 2000 to 2017 for any of the regions examined except for Lemon Bay;
- There is evidence of declining concentrations of TN over those same years in the tidal reaches of the Peace and Myakka Rivers, Charlotte Harbor, and Gasparilla Sound; and
- There is no evidence of increasing concentrations of TP over the period of 2000 to 2017 for any of the regions examined.

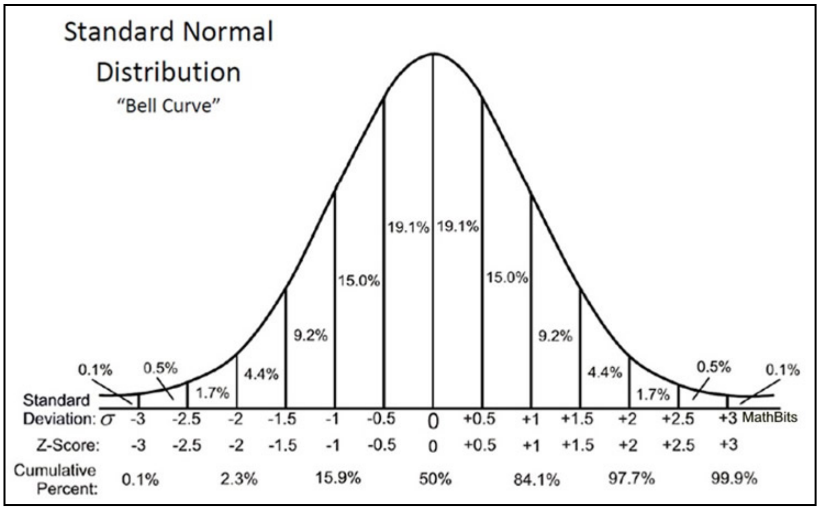
There is evidence of declining concentrations of TP over those same years in the tidal reaches of the Peace and Myakka Rivers, Charlotte Harbor, Gasparilla Sound, and Lemon Bay. With the exception of Lemon Bay, the results of the trend analysis suggest that water quality over the past 17 years is either non-trending or trending towards improvements across the region. These findings are somewhat in conflict with the assessment of the NNC criteria displayed in Table 2.

The reasons for the apparent disconnect between trend analysis and the NNC criteria analysis could be because the NNC criteria were based on a statistical distribution of data, rather than being tied to trend analysis and/or a dose-response assessment. In a report prepared for the Charlotte Harbor NEP (Janicki, 2011), the NNC criteria were developed to compare results to a "reference period" of 2003 to 2007. The reference period was selected based upon the determination that seagrass coverage during those years was similar to, or trending towards, the historical amount of seagrass in both Charlotte Harbor and Lemon Bay.

The NNC criteria (Janicki, 2011) were statistically based, in that the values chosen for TN, TP and chlorophyll-a represented the mean of annual means (n=5) plus one-half of the standard deviation of that mean of annual means, for both Lemon Bay and Charlotte Harbor.

As illustrated in Figure 3, values higher than one-half of the standard deviation above the mean would be expected to occur approximately 31 percent of the time, by chance alone.

Figure 3 – Distribution of data with various distances from the mean, in terms of standard deviations.



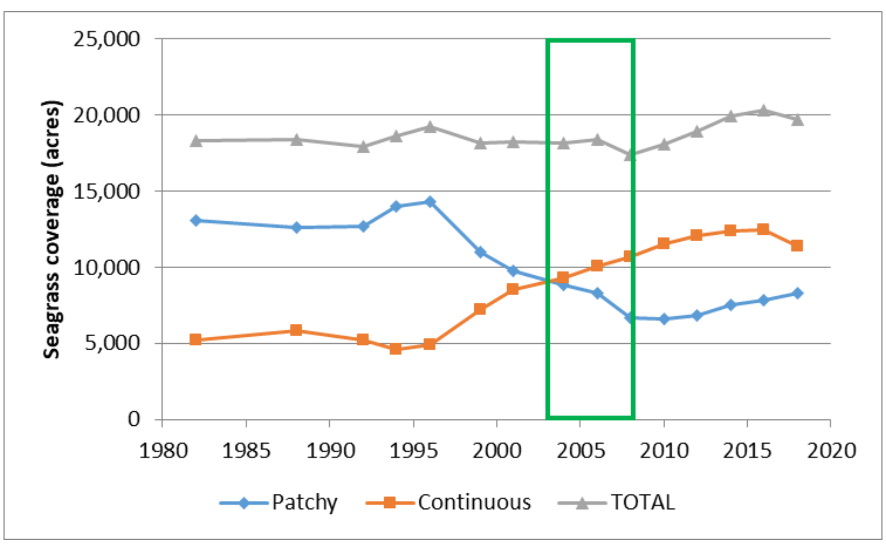
For both Charlotte Harbor and Lemon Bay, the determination of impairment for chlorophyll-a could be a statistical artifact based on a combination of high variability (for chlorophyll-a) and a roughly one in three chance that criteria would be impaired in any given year, even if water quality was not degraded.

To assess the validity of NNC results, which suggested impairments for chlorophyll-a in Charlotte Harbor, the amount of seagrass coverage was analyzed, as seagrass coverage is the ecosystem feature that is intended to be protected by NNC. This assessment was conducted using data from SWFWMD seagrass mapping efforts up to the year 2018.

Seagrass Mapping Results

For Charlotte Harbor, Figure 4 displays the trends over time for seagrass in Charlotte Harbor over the period of 1982 to 2018.

Figure 4 – Seagrass coverage in Charlotte Harbor. Values are in units of acres of patchy, continuous, and total (patchy plus continuous) seagrass. The area in the green box indicates the reference period of 2003 to 2007.

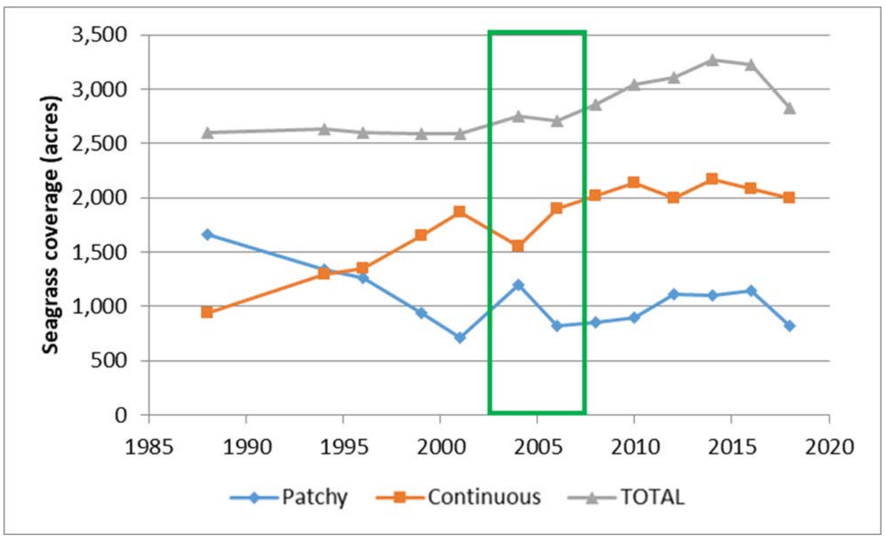


Prior to 2018, the positive trends in total acreage were also associated with a greater percentage of seagrass being mapped as continuous meadows, rather than patchy meadows (Figure 4). Previous studies in Sarasota Bay have shown that the biomass of seagrass meadows increases as nutrient loads decrease (Tomasko et al. 1996) indicating that a transition from patchy to continuous seagrass coverage is indicative of improved water quality, which is consistent with the water clarity and nutrient trend analyses found for Charlotte Harbor.

The decrease from 2016 to 2018 requires careful monitoring to determine if such a decline was due to the impact of Hurricane Irma, rather than a human-caused degradation in water quality. However, the overall pattern of increased coverage and a shift from patchy to continuous coverage suggests that water quality in Charlotte Harbor likely has been as good or better than it was in the reference period of 2003 to 2007, and that water quality is likely better than it was during the decades of the 1980s up to the present.

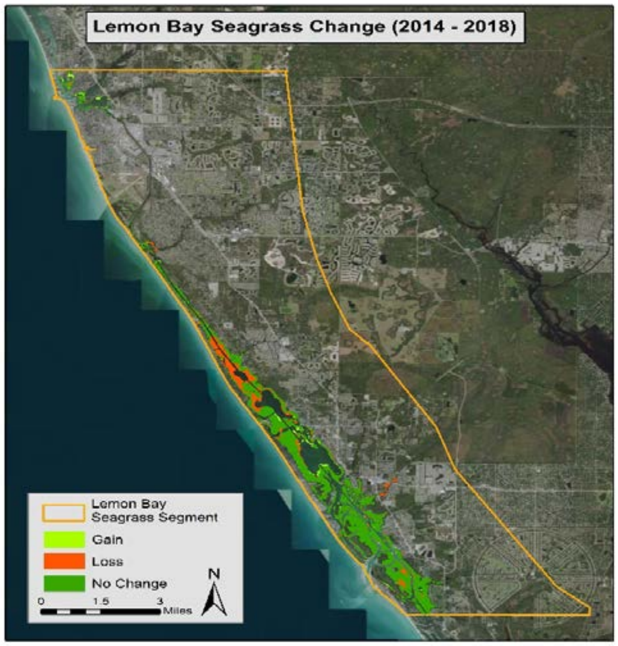
For Lemon Bay, Figure 5 displays the trends over time for seagrass in Lemon Bay over the period of 1988 to 2018.

Figure 5 – Seagrass coverage in Lemon Bay. Values are in units of acres of patchy, continuous, and total (patchy plus continuous) seagrass meadows. The area in the green box indicates the reference period of 2003 to 2007.



Up until 2014, Lemon Bay exhibited a positive trend in total acreage associated with a greater percentage of seagrass being mapped as continuous meadows, rather than patchy meadows (Figure 5). And while total acreage decreased by 10.5% between the years 2016 and 2018, the proportion of seagrass mapped as continuous remains much greater than those areas mapped as patchy. The decline in seagrass coverage from 2016 to 2018 was primarily restricted to the northern portion of Lemon Bay downstream from Forked Creek (Figure 33).

Figure 6 – Spatial distribution of gains, losses, and areas with stable seagrass coverage in Lemon Bay between 2014 and 2018. Based on GIS data from SWFWMD.



Unlike Charlotte Harbor, which is a CDOM rich system, light attenuation in Lemon Bay is far less influenced by CDOM. Therefore, the relationship between light attenuation, chlorophyll, and nitrogen more closely resembles that of Tampa Bay than Charlotte Harbor. The northern portions of Lemon Bay have consistently exceeded the NNC criteria established for TN (Table 2). In contrast, the southern portion of Lemon Bay has consistently had TN concentrations lower than NNC criteria, except for 2017, which likely reflects the influence of Hurricane Irma. Water quality data from 2018 show TN concentrations had fallen below the NNC TN impairment threshold in southern Lemon Bay but continued to exceed TN threshold values in northern Lemon Bay every year between 2012 and 2018 (Sarasota County Water Atlas; https://www.sarasota.wateratlas.usf.edu/bay-conditions/)

In areas such as the east wall of Charlotte Harbor (Figure 7) and Upper Lemon Bay (Figure 8), the seagrass meadows seem to be impacted by an abundance of macroalgae that could be related to nutrient enrichment, among other factors.

Figure 7 – Attached and drift macroalgae growing in a previously mapped seagrass meadow in eastern Charlotte Harbor, south of Punta Gorda Isles. Photo from D. Tomasko (3/11/2020).

Figure 8 – Drift macroalgae growing in a previously mapped seagrass meadow in Upper Lemon Bay, close to the mouth of Forked Creek. Photo from D. Tomasko (3/11/2020).

The photos shown in Figures 7 and 8 suggest that macroalgae and/or epiphytic algae could be a mechanism of seagrass decline in both Charlotte Harbor and Lemon Bay. This finding is consistent with prior work in the seagrass meadows of nearshore portions of the Florida Keys, where macroalgae and/or epiphytic algae were found to be better indicators of nutrient enrichment than phytoplankton (e.g., Tomasko and Lapointe 1991, Lapointe et al. 1994). The NNC criteria developed for Lemon Bay and Charlotte Harbor only quantify the amount of nitrogen, phosphorus or algae (e.g., Chlorophyll-a) floating in the water column. Therefore, macroalgae and epiphytic algae such as are displayed in Figures 7 and 8 are not quantified through the use of NNC criteria, although they could contribute to the seagrass losses seen in Upper Lemon Bay and the nearshore areas of Charlotte Harbor between Punta Gorda Isles and Pirate Harbor.

Pollutant Loading Model

To further aid in the interpretation of data on NNC impairments and seagrass, ESA SCHEDA completed an empirical pollutant loading model for the gaged Peace and Myakka River watershed for the years of 2009, 2010, 2011, 2012, 2013, 2014, and 2015. Results were compared between this effort and prior loading models conducted for both SWIM and the Charlotte Harbor NEP. The mean annual loads for TN, TP and Total Suspended Solids (TSS) were then compared to prior loading model values, as well as annual average values for chlorophyll-a for the tidal Peace River and Charlotte Harbor nutrient regions.

The pollutant loading model was completed using similar methods as had been previously used by the Charlotte Harbor Environmental Center (2001). Briefly stated, the loading model was constructed in the following manner:

- Flows and water quality data were compiled for gaged locations within the Peace and Myakka River watersheds. These stations included the following locations:
  - Peace Creek at Wahneta
  - Saddle Creek at P-11 structure
  - Peace River at Bartow
  - Peace River at Ft. Meade
  - Peace River at Zolfo Springs
  - Peace River at Arcadia
  - Horse Creek near Myakka Head
  - Horse Creek near Arcadia
  - Charlie Creek near Gardner
  - Joshua Creek at Nocatee
  - Shell Creek near Punta Gorda
  - Myakka River at Myakka City
  - Myakka River near Laurel

For the Myakka River, the farthest downstream gage site (Myakka River at Laurel) only gages 42 percent of the river's 602 square mile watershed (Hammett 1990). Therefore, load estimates from the Myakka River do not represent as complete an assessment as is possible with the Peace River, where approximately 89 percent of the watershed is gaged. For these reasons, TN, TP and TSS loads from the Myakka River watershed are compared against values on an area-normalized basis, but they aren't included in the graphics shown below.

At each location, average monthly flow values were obtained from the U.S. Geological Survey (USGS), and the monthly (if available) water quality data from these same locations was then multiplied by the monthly average flow to derive a monthly average load for TN, TP and Total Suspended Solids (TSS). These monthly values were then summed for a given year to develop annual estimates of TN, TP and TSS loads for the years of 2009 to 2015. In addition, the average annual loads for each gaged location were then divided by the size of the watershed upstream from the gage, so that an area-normalized load could be developed for TN, TP and TSS. These area-normalized loads were then compared to prior estimates for Water Year (WY) 1998, WY 1999, and estimates of area-normalized loads based on results from Coastal Environmental, Inc. (1995) which developed loading estimates for the seven-year period of 1985 to 1991. Results from WY 1998 reflect the influence of the 1997 to 1998 El Niño event, during which rainfall in the Peace River watershed exceeded 60 inches. Rainfall in excess of 60 inches has been recorded 17 times during the past 100 years (data from watermatters.org). As such, results from WY 1999 represent a very high, yet not unprecedented, amount of rainfall.

Figures 9 and 10 show area-normalized TN loading rates for gaged locations in the Peace River watershed with and without, respectively, results from WY 1998.

Figure 9 – Area normalized TN loads for the Peace River watershed by gaged location. Values are in units of pounds of TN per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.

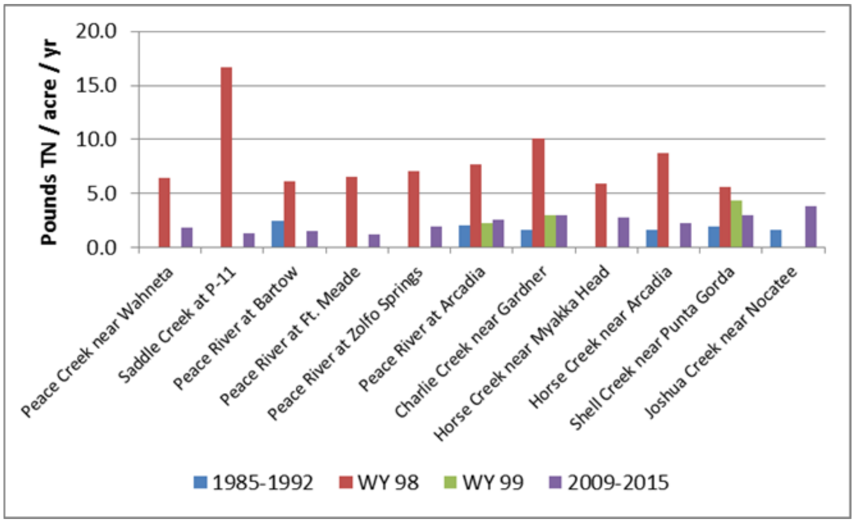
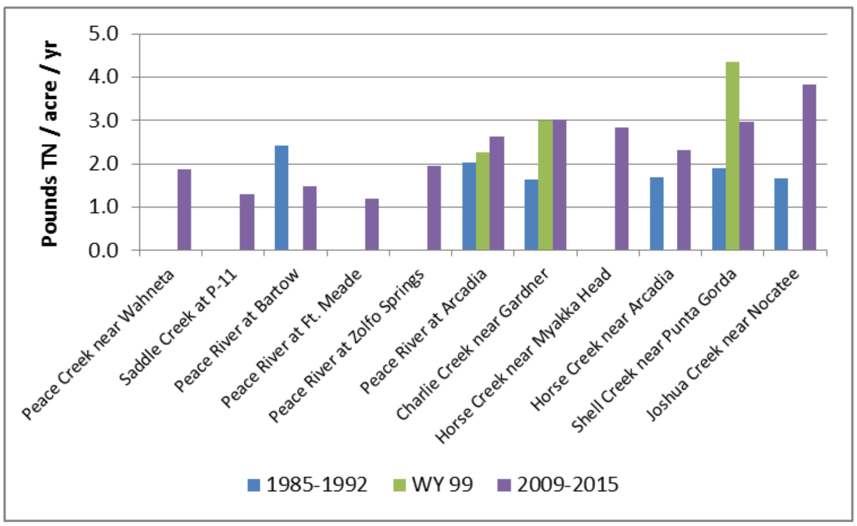


Figure 10 – Area normalized TN loads for the Peace River watershed by gaged location, without showing results from WY 1998. Values are in units of pounds of TN per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.



In WY 1998, the gage at Saddle Creek at the P-11 structure was clearly providing the highest loading of TN compared to all other stations along the Peace River. This location is the first station downstream of discharges from Lake Hancock into the Peace River basin. Results from WY 1998 showed the importance of focusing on discharges from Lake Hancock, which led to two District-sponsored projects, the Lake Hancock Lake Level Modification Project and the Lake Hancock Outfall Treatment Project. The Lake Level Project, completed in 2013 and operational in 2015, increases the control elevation at the lake outfall structure to store more water in the rainy season to increase discharges to the Peace River in the dry season. Recent data suggests the increased volume and depth of the lake has resulted in water quality improvements. Construction of the Lake Hancock Outfall Treatment Project was completed in 2014. Operation of the system has been limited to promoting growth and coverage of emergent wetland vegetation. Once fully operational, low flows from the lake (52 cubic feet per second and less) will be discharged from the treatment wetland.

Recent results (Figure 9) show that with the decreases in TN loading at the P-11 structure, the highest TN loadings are now occurring in basins farther downstream, with the highest area-normalized TN loading rates being found in Joshua Creek, Charlie Creek and Shell Creek. Results shown in Figure 10 suggest that TN loading rates may have increased over time in Joshua Creek, comparing prior estimates to values from 2009 to 2015.

Area-normalized TN loading rates for the Myakka River at Myakka City and Myakka River at Laurel averaged 3.67 and 2.78 lbs TN / acre / yr, respectively. These values would suggest that the Upper Myakka River generates more nitrogen per acre than farther downstream at Laurel. Based on yields at Laurel, the Myakka River watershed generates less nitrogen per acre than at Horse Creek at Myakka Head, Joshua Creek, Charlie Creek and Shell Creek.

Figures 11 and 12 show area-normalized TP loading rates for gaged locations in the Peace River watershed with and without, respectively, results from WY 1998.

Figure 11 – Area normalized TP loads for the Peace River watershed by gaged location. Values are in units of pounds of TP per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.

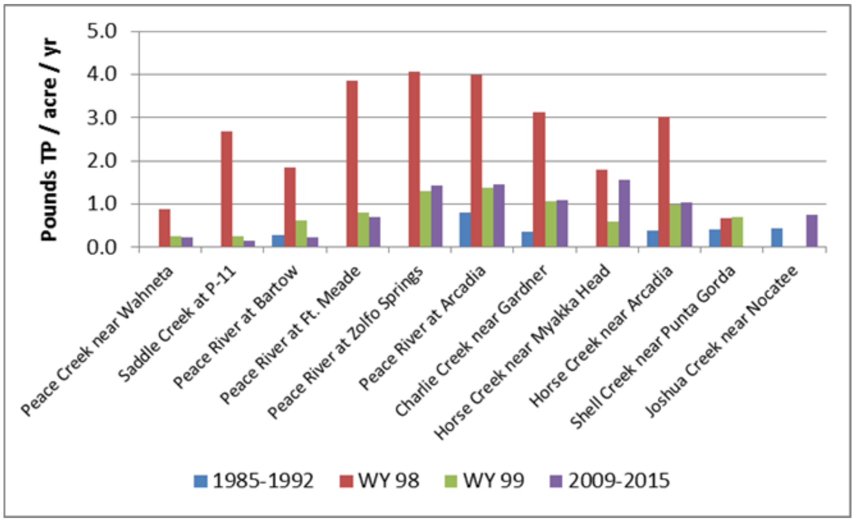
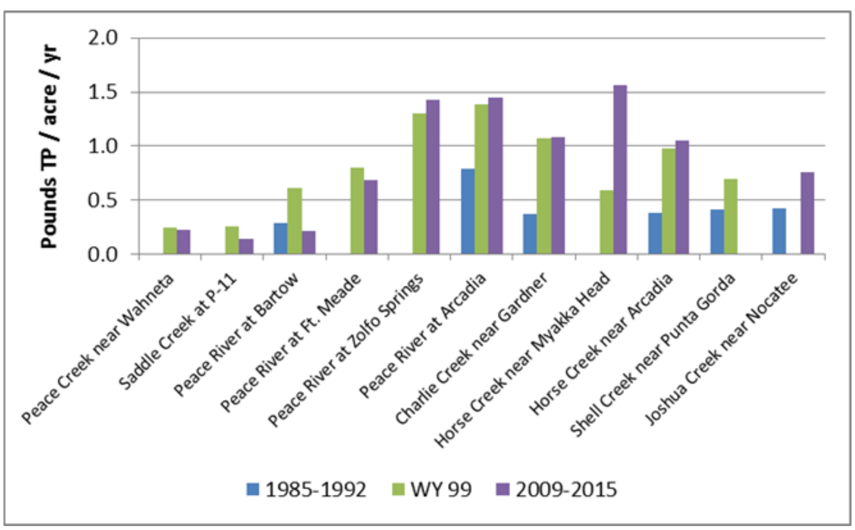


Figure 12 – Area normalized TP loads for the Peace River watershed by gaged location, without results from WY 1998. Values are in units of pounds of TP per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.



In WY 1998 and in the most recent assessment, the highest values for area-normalized TP loading rates were generally in the Middle reaches of the Peace River watershed, at the Peace River at Ft. Meade down to the Peace River at Arcadia gages.

Area-normalized TP loading rates for the Myakka River at Myakka City and Myakka River at Laurel averaged 1.50 and 1.27 lbs TP / acre / yr, respectively. These values would suggest that the Upper Myakka River generates more phosphorus per acre than farther downstream at Laurel. Based on yields at Laurel, the Myakka River watershed generates less phosphorus per acre than at Horse Creek at Myakka Head, as well as the Peace River gaged locations at Zolfo Springs and Arcadia.

Figures 13 and 14 show area normalized TSS loading rates for gaged locations in the Peace River watershed with and without, respectively, results from WY 1998.

Figure 13 – Area normalized TSS loads for the Peace River watershed by gaged location. Values are in units of pounds of TSS per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.

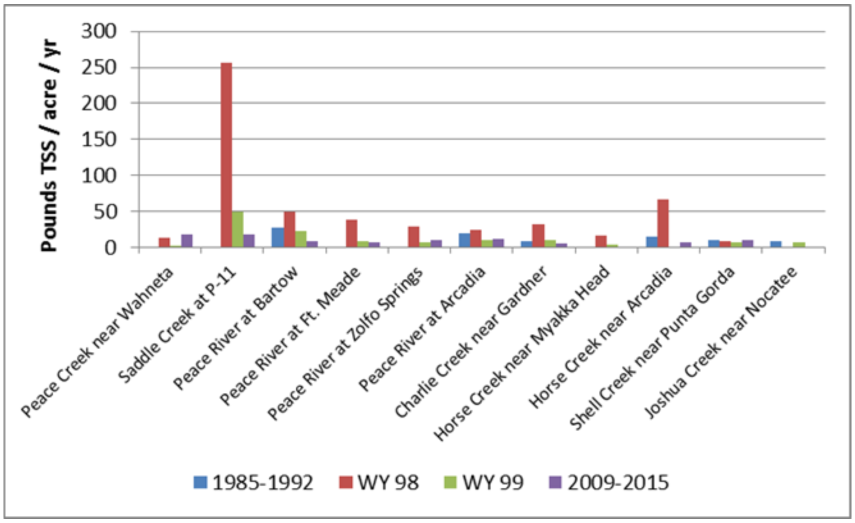
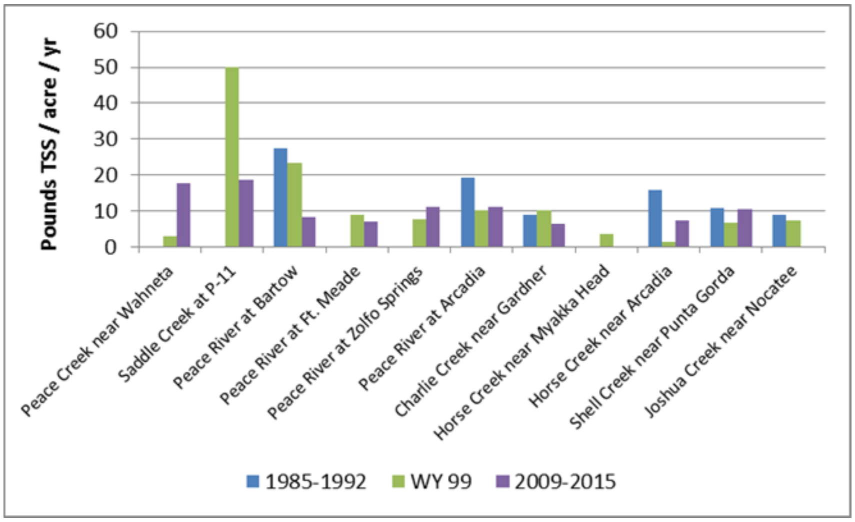


Figure 14 – Area normalized TSS loads for the Peace River watershed by gaged location, without results from WY 1998. Values are in units of pounds of TSS per acre per year. Gaged locations are arrayed along the x-axis from upstream to downstream within the watershed.



In WY 1998 and in the most recent assessment, the highest values for area-normalized TSS loading rates were in the Upper Peace River watershed, particularly at the Saddle Creek at P-11 location. These results suggest that although discharges from Lake Hancock may have improved to the point that Lake Hancock is no longer the highest loading basin for TN to the Peace River, it is still a major source of TSS loads to the Peace River.

Area-normalized TSS loading rates for the Myakka River at Myakka City and Myakka River at Laurel averaged 12.94 and 14.51 lbs TSS / acre / yr, respectively. These values would suggest that the Upper and Lower Myakka River watershed generates similar rates of TSS per acre. Based on yields at Laurel, the Myakka River watershed generates less TSS per acre than at Saddle Creek, Peace Creek and Joshua Creek, but higher than values in most of the mainstem of the Peace River.

Table 3 summarizes the annual nitrogen load estimates for 2009 to 2016 for the following gages: Peace River at Arcadia, Horse Creek near Arcadia, Joshua Creek near Nocatee, and Shell Creek near Punta Gorda. When these gage sites are summed, they equal approximately 89 percent of the total Peace River watershed. These annual loads were then compared to annual average chlorophyll-a values for the same calendar years for the two NNC regions of Charlotte Harbor Proper and the tidal Peace River.

Table 3 – TN loads (tons per year) for 2009 to 2016 for the gaged Peace River, and annual average chlorophyll-a values for the Charlotte Harbor and Tidal Peace River regions used to derive NNC criteria.

Year	TN Load estimates (tons / yr)					Annual Average Chl-a (µg / liter)	
	Peace River at Arcadia	Horse Creek near Arcadia	Joshua Creek near Nocatee	Shell Creek near Punta Gorda	Sum gauged Peace River	Charlotte Harbor Proper	Tidal Peace River
2009	984	137	126	325	1,572	10.45	14.93
2010	1,090	158	213	241	1,702	7.63	16.75
2011	892	110	146	225	1,373	6.88	16.86
2012	1,006	188	170	369	1,733	6.75	11.44
2013	1,581	207	241	636	2,666	8.65	10.28
2014	1,017	115	65	306	1,504	7.23	12.01
2015	1,467	211	176	384	2,238	6.80	8.61
Mean	**1,148**	**161**	**162**	**355**	**1,827**	**7.77**	**12.98**

On average, the Peace River at Arcadia contributes more of the TN load than any of the other gaged locations within the basin, because its 1,367 square mile watershed is more than three time as large as the next largest sub-basin, the 373 square mile watershed for Shell Creek near Punta Gorda. The sub-basins of Horse Creek and Joshua Creek are similar in terms of their contributions to TN loads. However, Joshua Creek's higher than expected (for the Peace River) area-normalized TN loads (Figure 10) results in a similar load as Horse Creek, even though it has a smaller watershed.

The TN load from the gaged portions of the Peace River watershed, over the years 2009 to 2015, averaged 1,827 tons / yr. In comparison, the average TN load from those same locations, summed over the years 1985 to 1991, comes to 1,820 tons / year (Coastal Environmental Inc., 1995) a value less than 5 percent different.

The two time periods of 1985 to 1991 and 2009 to 2015 represent seven years each, separated by 25 years. The two estimates were made using the same approach – combining measured flows and water quality data at four gages that combined equal 89 percent of the Peace River watershed. The fact that the average values of the two reports, separated by 25 years, are within 5 percent of each other indicates that the Peace River's TN loads have not trended over time.

Based on the reduction of TN loads from Saddle Creek at the P-11 this basin may no longer require as much attention as 20 years ago. The focus can now be shifted to the basins that have been identified as higher TN loading sources, such as Joshua Creek.

As a final assessment, annual TN loads for the gaged Peace River were compared against the annual average chlorophyll-a values for the NNC regions of Charlotte Harbor and the Tidal Peace River in Figures 15 and 16, respectively. The results displayed here show no obvious relationship between TN loads and chlorophyll-a in either the open waters of the Harbor, or the tidal Peace River. These results are consistent with earlier work in Charlotte Harbor, where it was determined that the nitrogen load – chlorophyll – water clarity – seagrass paradigm developed for Tampa Bay did not work for Charlotte Harbor (McPherson and Miller 1987, CDM 1998, Tomasko and Hall 1999). The results shown here, and the prior work noted above put into question the premise of the NNC for Charlotte Harbor, that there is a link between nutrient supply and seagrass coverage that is expected to function similarly as it does in Tampa Bay.

Figure 15 – Plot of annual TN load from the gaged Peace River vs. annual average chlorophyll-a value for the same year for the Charlotte Harbor NNC region.

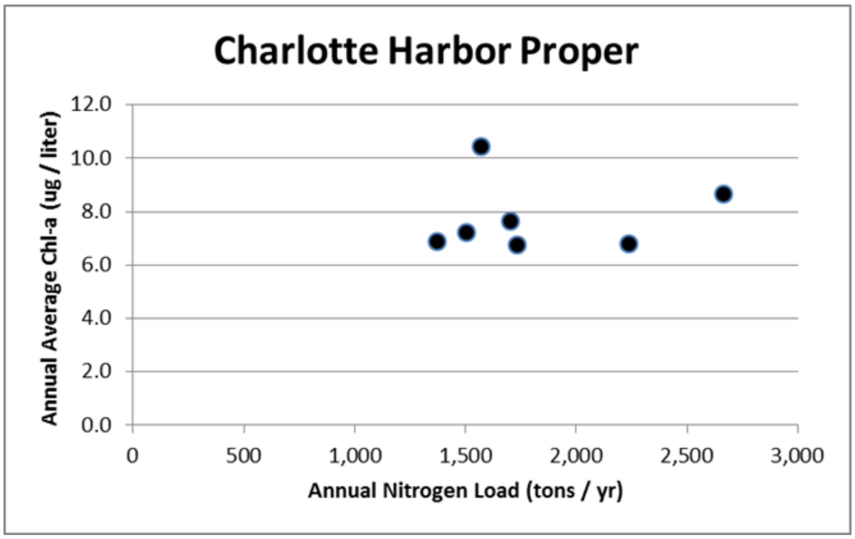
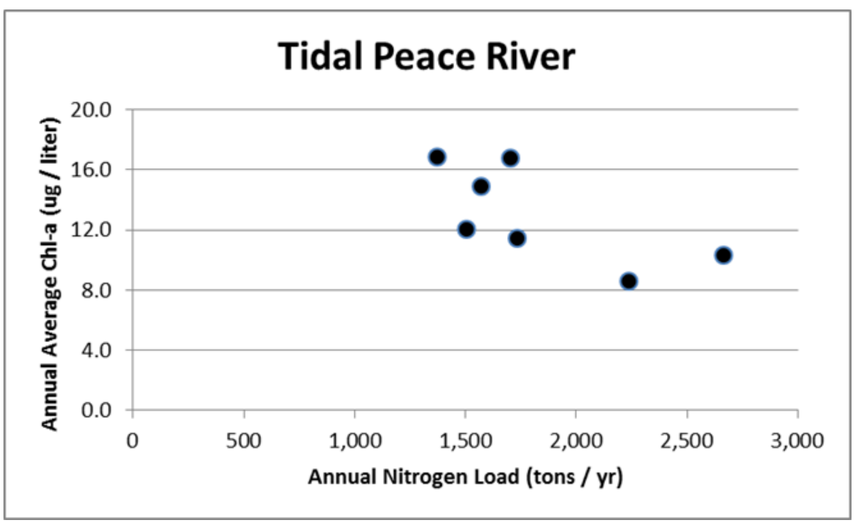


Figure 16 – Plot of annual TN load from the gaged Peace River vs. annual average chlorophyll-a value for the same year for the Tidal Peace River NNC region.



Issues and Drivers – Hydrologic Alterations

Within the District's boundaries for the Charlotte Harbor watershed, there are a variety of documented alterations to hydrology. In the Upper Peace River, reductions in stream flow have been found to be greater than that which can be attributed to changes in rainfall alone (SWFWMD 2002). In the lower reaches of the Peace River, long-term trends in streamflow are more closely aligned with trends in rainfall (Basso and Schultz 2003). In the Upper Myakka River, an extensive die-off of trees in Flatford Swamp has been linked to increased excess flows, which have impacted the hydroperiod and water levels in the swamp (PBS&J 1998). Downstream, in the Lower Myakka River, flows are not as impacted by excess dry season flows, and no similar stresses occur. Construction of the Cow Pen Canal in 1960 expanded the size of the Dona Bay watershed from 15 to 75 square miles. This five-fold increase in the size of the watershed has impacted Dona Bay due to excessive freshwater inflows, particularly during the wet season.

The 2000 Charlotte Harbor SWIM Plan identified several management actions, primarily related to the establishment of minimum flows, for hydrologic restoration of tributaries to the harbor. These actions are listed below along with relevant project and resource status updates.

- Establishment of minimum flows for the Upper, Middle and Lower Peace River including Shell, Horse and Joshua creeks
    - Technical work supporting establishment of minimum flows for the Upper Peace River was completed (SWFWMD 2002), and minimum flows were established for three upper river gage sites (at Bartow, Fort Meade and Zolfo Springs) in 2007 (Rule 40D-8.041(7), FAC).
    - The minimum flows for the Upper Peace River are being met at the Zolfo Springs gage site, but not at the Fort Meade and Bartow gages.
    - Technical work supporting establishment of minimum flows the Middle Peace River was completed (SWFWMD 2005a), and minimum flows were established for the gage site at Arcadia in 2006 (Rule 40D-8.041(5), FAC).
    - The minimum flows for the Middle Peace River are being met.
    - Technical work supporting establishment of minimum flows the Lower Peace River was completed (SWFWMD 2010), and minimum flows were established in 2010 (Rule 40D-8.041(8), FAC). The minimum flows are based on the combined flows in the Lower Peace River (at Arcadia), Horse Creek (near Arcadia) and Joshua Creek (at Nocatee).
    - The minimum flows for the Lower Peace River are being met.
    - A reevaluation of the Lower Peace minimum flow was completed in 2015 (SWFWMD 2015) and a second reevaluation is scheduled for completion in 2020.
    - Establishment of minimum flows for Lower Shell Creek, Horse Creek and Upper Shell Creek is, respectively, scheduled for 2020, 2023 and 2025.
- Establishment of minimum flows for the Myakka River and continuation of efforts to reduce excessive dry season flows in the Upper Myakka River
    - Technical work supporting establishment of minimum flows for the Upper Myakka River was completed (SWFWMD 2005b), and minimum flows were established in 2006 (Rule 40D-8.041(6)(a), FAC).
    - Technical work supporting establishment of minimum flows for the Lower Myakka River was completed (SWFWMD 2011), and minimum flows were established in 2012 (Rule 40D-8.041(6)(b), FAC).
    - The minimum flows for the Upper and Lower Myakka River are being met.
- Assess the potential for hydrologic restoration of Cow Pen Slough
    - Technical work supporting establishment of minimum flows for the Dona Bay/Shakett Creek System was completed (SWFWMD 2009), and minimum flows were established in 2010 (Rule 40D-8.041(14), FAC).
    - The minimum flows for the Dona Bay/Shakett Creek System are being met.

A major District Initiative to address recovery of flows and levels in the Upper Peace River and the region is implementation of the Southern Water Use Caution Area (SWUCA) Recovery Strategy (SWFWMD 2006). The primary mechanism for recovering minimum flows in the Upper Peace River is the recently completed Lake Hancock Lake Level Modification Project. This project included modifications to the P-11 structure that controls water levels in Lake Hancock to allow for increased wet weather storage and subsequent delivery of these stored quantities of water during the dry season. Development of a reservation for the water stored in Lake Hancock and released to Lower Saddle Creek for recovery of the Upper Peace River (SWFWMD 2020) is expected to be completed in 2020.

For the Upper Myakka River, excessive amounts of inflow have led to hydroperiods associated with substantial wetland tree mortality (PBS&J 1998). Recovery of forested wetlands in the Flatford Swamp portion of the watershed will require a reduction in flows and the shortening of hydroperiods, which is expected to be accomplished through the Aquifer Recharge Project at Flatford Swamp for Saltwater Intrusion Minimum Aquifer Level Recovery. The goal of this District Initiative is to divert between 2 and potentially up to 10 million gallons per day (mgd) of flow out of the swamp. In addition to promoting more natural wetland hydroperiods in the swamp, the project is expected to reduce the rate of saltwater intrusion inland from the Gulf of Mexico.

In the Dona Bay Watershed Management Plan (KHA 2007) diversions of 5, 10 and 15mgd were associated with benefits to water quality and natural systems in the receiving waters of Dona Bay. Currently, Sarasota County and the District are working to implement Phase II of the Dona Bay Restoration Project, which would divert 3 mgd of flows out of the Cow Pen Canal back toward their historical destination of the Myakka River.

The Charlotte Harbor Flatwoods Initiative (CHFI) is a multi-stakeholder, multi-phased regional hydrologic restoration effort coordinated by the South Florida Water Management District (SFWMD), and the approximately 90-square mile project area spans both the South Florida Water Management District and the SWFWMD The SWFWMD participates on the stakeholders group.

The SFWMD completed the Yucca Pens Hydrologic Restoration Plan (Plan) in January 2010, which is Phase I of the CHFI. The goal of the Plan is to restore historic sheet flow to the Yucca Pens area. Development and topographic changes since the 1950s have blocked, constricted, and concentrated what were formerly sheet flow areas draining in a southeasterly or southerly direction. Restoration of the historic flow will reduce the amount of water that has been redirected to Gator Slough and lessen the impact of damaging point discharges through the Gator Slough Canal to Matlacha Pass and Charlotte Harbor.

In 2016, the SWFWMD collected LiDAR data over the project area to supplement water quantity and flow data collection efforts by other partners in the CHFI. Ultimately, this improved topographic information can be used for modeling of potential restoration projects and strategies.

Issues and Drivers – Natural Systems

The District and the Charlotte Harbor NEP are cooperatively funding the Habitat Restoration Needs Update for the Charlotte Harbor Watershed. This fiscal year 2016 project is expected to be complete in late 2019. The purpose of the study is to identify habitat restoration acreage targets within the SWFWMD jurisdiction of the Charlotte Harbor watershed. Preliminary deliverables for the project include an assessment of land use and land cover changes within the watershed, the results of which are summarized in this section.

Land use in the main sub-basins of the Peace and Myakka Rivers varies substantially. Table 4 summarizes the main land use/land cover classifications of the major sub-basins for the Peace and Myakka Rivers, based on mapping results from 2009.

Table 4 – Land use/land cover (percent of sub-basin) for the main gaged sub-basins in the Peace and Myakka Rivers. Data from SWFWMD.

Sub-basin	Agriculture	Barren Land	Rangeland	Transportation and Utilities	Upland Forests	Urban and Built-Up	Water	Wetlands
Saddle Creek at P-11	9	< 1	< 1	4	4	54	16	13
Peace River at Bartow	20	< 1	1	3	4	43	14	15
Peace River at Zolfo Springs	39	< 1	3	1	3	28	4	22
Peace River at Arcadia	53	< 1	8	1	6	7	< 1	25
Charlie Creek	55	< 1	5	< 1	8	7	1	24
Horse Creek	43	< 1	11	< 1	7	15	< 1	24
Joshua Creek	71	< 1	5	1	4	6	< 1	13
Shell Creek	55	< 1	13	< 1	9	4	1	18
Upper Myakka River	41	< 1	12	< 1	10	14	1	22
Lower Myakka River	25	< 1	13	1	16	19	3	23

The dominant land use in both the Peace and Myakka Rivers is agricultural land, especially if the category of "rangeland" is included. Upland forests are a small portion of the watershed, as are the categories of barren land and transportation and utilities (i.e., power line corridors). Urban and Built-up areas are the dominant land use category only in the uppermost portions of the Peace River watershed, in the sub-basins of Saddle Creek at P-11 and the Peace River at Bartow.

As part of the habitat restoration needs update, ESA SCHEDA completed an assessment of the amount of habitat loss between 1995 and 2009 for the major land use / land cover categories throughout the Charlotte Harbor watershed (ESA 2018). Table 5 shows the percent decline in coverage between 1995 and 2009 for the categories of Upland Coniferous Forest, Upland Hardwood Forest, Mangrove Swamps, Freshwater Marshes, Saltwater Marshes, and Salt Flats within five segments of the Charlotte Harbor system.

Table 5 – Percent decline of various habitat types for different sub-basins in the Charlotte Harbor watershed, between 1995 and 2009. Data are based on GIS mapping efforts conducted for the SWFWMD. Analysis completed by ESA (2018) for the CHNEP. Habitat types are shown along with their FLUCCS codes. "NL" = no evidence of decline.

Sub-basin	Habitat Types					
	Upland Coniferous Forest (4100)	Upland Hardwood Forest (4200)	Mangrove Swamps (6120)	Freshwater Marsh (6410)	Saltwater Marsh (6420)	Salt Flats (6600)
Charlotte Harbor Proper	81	54	NL	NL	25	NL
Coastal Lower Peace	89	90	NL	NL	NL	NL
Coastal Venice	50	NL	NL	NL	24	NL
Dona and Roberts Bay	89	NL	1	NL	NL	NL
Gasparilla Sound	56	NL	NL	64	NL	NL

The results shown in Table 5 suggest that habitat restoration strategies for the SWFWMD portion of Charlotte Harbor might consider including efforts to restore lost upland coniferous forests, as this is the habitat that has the most widespread and severe loss between 1995 and 2009. Each of the sub-basins listed in Table 5 have lost at least 50% of its Upland Coniferous Forests, during that 14-year time period. Declines in Upland Hardwood Forests were also found in the Charlotte Harbor Proper and Coastal Lower Peace sub-basins, also in amounts exceeding 50 percent.

Mangrove loss was detected in only one of the ten sub-basins (Dona and Roberts Bays) and was within the range of expected error for this type of mapping effort (1%). Freshwater marsh losses were substantial in the Gasparilla Sound sub-basin, while saltwater marsh losses were found in the Charlotte Harbor Proper and Coastal Venice sub-basins. The loss of saltmarsh in the Coastal Venice sub-basin (6.4 acres) was less than the 21-acre increase in mangrove forests in that same sub-basin, over the same time frame. Although more detailed analysis is required, these results could be suggestive of a replacement of salt marsh with mangroves, at least in some locations. No losses of salt flats were found in any of the sub-basins examined.

The substantial losses of uplands are indicative of the increase in development in the watershed, but results in Table 5 suggest that most of the "development" involved a shift from forested uplands (both coniferous and hardwood) to agricultural land uses. These results would support a focus on preserving and/or restoring upland features in the watershed, which have been lost at rates in excess of wetland systems, particularly estuarine wetlands. Since the final report is not expected prior to completion of the SWIM Plan, conclusions and recommendations from the final report of the Habitat Restoration Needs project will be incorporated by reference.

Summary of Issues and Drivers

The general findings of Task 2 activities include the following:

Water Quality

- NNC criteria are developed and applied at different spatial scales, resulting in a disconnect between the impairment status of local waters and the health of seagrass and trends of overall improving water quality.
- Even for waterbodies where assessments of impairment are consistent at regional and WBID levels (such as Upper Lemon Bay) positive trends in seagrass coverage suggest that impairment determinations based on NNC are not appropriate.
- The finding that nitrogen loads from the gaged Peace River have changed by less than 5% over the past 25 years suggests that the Pollutant Load Reduction Goal (PLRG) for Charlotte Harbor, which was based on a "hold the line" strategy, has been met.
- Combined, the results of the water quality, seagrass mapping and pollutant loading model efforts shown here suggest that Charlotte Harbor, as a whole, is not experiencing degraded water quality, nor is it showing signs of declining ecosystem health.
- However, attention should be paid to areas of above-normal nitrogen loading, such as Joshua, Shell and Charlie Creeks, to determine causes and management actions related to elevated area-normalized nitrogen loads.
- While improving water quality in Lake Hancock seems to be associated with the decreased nitrogen loads at the Saddle Creek at P-11 gage, that location continues to be an area of elevated area-normalized TSS loads, which would be expected to be addressed when the Lake Hancock Outfall Treatment Marsh becomes fully operational.

Hydrologic Alteration

- Minimum flows have been set for the Upper, Middle and Lower reaches of the Peace river, the Upper and Lower reaches of the Myakka River, and the Dona Bay/Shakett Creek System.
- In the Upper Peace River, the hydrologic alteration of greatest concern has been a decline in streamflow in the dry season.

- The Lake Hancock Lake Level project is completed and is assisting with restoring minimum flows to the Upper Peace River. Development of a reservation for water stored in Lake Hancock and released to Lower Saddle Creek for Upper Peace River recovery is expected to be complete in 2020.
- In the Upper Myakka River, the hydrologic alteration of greatest concern has been an increase in streamflow in the dry and wet seasons, particularly in Flatford Swamp.
- Efforts are ongoing to reduce inflows into Flatford Swamp by between 2 and 10mgd.
- In Dona Bay, the minimum flows allow for diversion of the totality of excess inflows brought about by the expansion of the bay's watershed through the construction of the Cow Pen Canal.
- Efforts are ongoing to reduce inflows into Dona Bay, by diverting 3mgd of flow away from Shakett Creek and Dona Bay, back towards the historical destination of the Myakka River.

Natural Systems

- The dominant land use throughout the Charlotte Harbor watershed is agricultural land such as row crops, citrus, and pastureland. The second most common land use is rangeland.
- Urban land uses are the dominant land use in the Upper Peace River, but not the Middle and Lower portions of the watershed.
- In each sub-basin examined, wetland coverage exceeds that of upland forests.
- Between 1995 and 2009, upland coniferous and hardwood forests have declined across more of the watershed than any other habitat type, mostly due to transitioning to agricultural land uses.

Literature Cited

Basso, R., and R. Schultz. 2003. Long-term variation in rainfall and its effect on Peace River Flow in West-Central Florida. Southwest Florida Water Management District. Brooksville, Florida.

CDM. 1998. The study of seasonal and spatial patterns of hypoxia in Upper Charlotte Harbor. Report to Southwest Florida Water Management District. Brooksville, FL.

Charlotte Harbor Environmental Center. 2001. Annual Report on Water Quality Status and Trends in the Peace and Myakka River Basins. Report for Charlotte Harbor National Estuary Program.

Coastal Environmental, Inc. 1995. Estimates of Total Nitrogen, Total Phosphorus and Total Suspended Solids Loadings to Charlotte Harbor, Florida. Report to Southwest Florida Water Management District, SWIM Program.

Environmental Science Associates. 2018. CHNEP land use changes by sub-basin. Preliminary data assessment and analysis for Charlotte Harbor Estuary Program. Punta Gorda, FL.

Hammett, K.M. 1990. Land use, water use, streamflow characteristics, and water quality characteristics of the Charlotte Harbor inflow area. Florida, U.S. Geological Survey. Water Supply Paper 2359-A. Tallahassee, Florida. 64 p.

Janicki Environmental, Inc. 2011. Proposed Numeric Nutrient Criteria for the Charlotte Harbor National Estuary Program Estuarine System. Report for the Charlotte Harbor National Estuary Program. Ft. Myers, FL

KHA. 2007. Dona Bay Watershed Management Plan. Sarasota County. 142 pp.

Lapointe, B.E., Tomasko, D.A., and W.R. Matzie. 1994. Eutrophication and trophic state classification of seagrass communities in the Florida Keys. Bull. Mar. Sci. 54: 696-717.

McPherson, B.F. and R.L. Miller. 1987. The vertical attenuation of light in Charlotte Harbor, a shallow, subtropical estuary, south-western Florida. Estuarine, Coastal and Shelf Science. 25, 721-737.

PBS&J. 1998. Trend analysis of tree mortality in the Upper Myakka River watershed. Southwest Florida Water Management District. Brooksville, FL

Southwest Florida Water Management District. 2000. Charlotte Harbor Surface Water Improvement and Management (SWIM) Plan – November 2000. Southwest Florida Water Management District. Brooksville, Florida. 94 pp.

Southwest Florida Water Management District. 2002. Upper Peace River – An analysis of minimum flows and levels. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2005a. Proposed minimum flows and levels for the middle segment of the Peace River, from Zolfo Springs to Arcadia. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2005b. Proposed minimum flows and levels for the upper segment of the Myakka River, from Myakka City to SR 72. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District, 2006. Southern Water Use Caution Area recovery strategy, March 2016 final report. Brooksville, Florida.

Southwest Florida Water Management District. 2009. Proposed Minimum Flows and Levels for Dona Bay/Shakett Creek below Cow Pen Slough. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2010. Proposed minimum flows and levels of the Lower Peace River and Shell Creek. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2011. The determination of minimum flows for the Lower Myakka River. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2015. Initial reevaluation of Minimum Flows and Levels for the Lower Peace River. Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. 2020. Water budget evaluation for a proposed reservation for Lake Hancock and Lower Saddle Creek in Polk County, Florida. Southwest Florida Water Management District. Brooksville, Florida.

Tomasko, D.A., and B.E. Lapointe. 1991. Productivity and biomass of *Thalassia testudinum* as related to water column nutrient availability and epiphyte levels: field observations and experimental studies. Mar. Ecol. Prog. Ser. 75: 9-17.

Tomasko, D.A. and M.O. Hall. 1999. Productivity and biomass of the seagrass *Thalassia testudinum* along a gradient of freshwater influence in Charlotte Harbor, Florida. Estuaries. 22, 592-602.

Tomasko, D.A., Dawes, C.J. and M.O. Hall. 1996. The effects of anthropogenic nutrient enrichment on turtle Grass (*Thalassia testudinum*) in Sarasota Bay, Florida. Estuaries 19: 448-456.

Turner, R.E., N.N. Rabalais, B. Fry, C.S. Milan, N. Atilla, J.M. Lee, C. Normandeau, T.A. Oswald, E.M. Swenson, and D.A. Tomasko. 2006. Paleo-indicators and water quality change in the Charlotte Harbor estuary (Florida). Limnology and Oceanography 51: 518-533

Appendix B: Charlotte Harbor Technical Advisory Committee Membership

COASTAL & HEARTLAND NATIONAL ESTUARY PARTNERSHIP TECHNICAL ADVISORY COMMITTEE MEMBERSHIP AS OF 1/13/2020	
Member	Organization
Kevin Kalasz	US Fish and Wildlife Services (USFWS)
Dan Schabilion	USDA Natural Resource Conservation Service (USDA)
Patty Metz	United States Geological Survey (USGS)
Erin Campbell	US Army Corps of Engineers (USACE)
Mark Sramek	NOAA Nation Marine Fisheries Service (NMFS)
Melynda Brown	Florida Department of Environmental Protection (FDEP)
Dave Blewett	Florida Fish & Wildlife Conservation Service (FWC)
Yesenia Escribano	Florida Department of Agriculture and Consumer Services (FDACS)
Betty Staugler	Florida Sea Grant
Jeff Devine	West Coast Inland Navigation District (WCIND)
Jim Beever	Southwest Florida Regional Planning Council (SWFRPC)
Amanda Kahn	South Florida Water Management District (SFWMD)
Lizanne Garcia	**Southwest Florida Water Management District (SWFWMD)**
Donald Duke	Florida Gulf Coast University (FGCU)
Jamie Scudera	Charlotte County
Rick Armstrong	Lee County
Ernesto Lasso de la Vega	Lee County Mosquito/Hyacinth Control District
Greg Blanchard	Manatee County
Tabitha Biehl	Polk County
Ashlee Edwards	Sarasota County
Kraig Hankins	City of Cape Coral
Francis Lugo	City of North Port
Holly Milbrandt	City of Sanibel
Devon Moore	City of Winter Haven
Rae Burns	Town of Fort Myers Beach
Samuel Stone	Peace River Manasota Regional Water Supply Authority
Steve Suau	Progressive Water Resources
Justin Saarinen	**Environmental Associates Scheda**
Dave Ceilly	Johnson Engineering
Shelley Thornton	Mosaic Company
David Nellis	Nellis Enterprises
Rick Bartelson	Sanibel – Captive Conservation Foundation
Dave Sumpter	Wildlands Conservation
Vacant	US Environmental Protection Agency
Vacant	Central Florida Regional Planning Council (CFRPC)
Vacant	Peace River Valley Citrus Growers Association
Vacant	City of Punta Gorda
Vacant	City of Fort Myers
Co-chairs of this committee are represented in bold text.	

Appendix C: Permitted Point Sources within the Charlotte Harbor Watershed

This appendix lists point sources of nutrients within the Charlotte Harbor Watershed. The data in these table were downloaded September 4, 2019 from the FDEP's Geospatial Open Data website http://geodata.dep.state.fl.us/ and only includes information on facilities within the Charlotte Harbor watershed boundaries of the Southwest Florida Water Management District.

Table C-1 Wastewater Permits.

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA014126	Englewood Water District	Domestic WWTP	3
FLA014116	Harbor View Trailer Park	Domestic WWTP	0.024
FL0040291	Charlotte County Utilities - Eastport WWTP	Domestic WWTP	6
FLA014113	Shell Creek Park Campground	Domestic WWTP	0.02
FLA014092	Villas Del Sol WWTP	Domestic WWTP	0.0285
FLA014089	Gasparilla Mobile Estates	Domestic WWTP	0.025
FLA014095	Knight Island Utilities Inc	Domestic WWTP	0.055
FLA014083	Burnt Store WWTP	Domestic WWTP	0.25
FLA014105	Pelican Harbor MHP	Domestic WWTP	0.02
FLA014072	Paradise Park Condominium	Domestic WWTP	0.024
FLA014078	Hideaway Bay Beach Club Condo. Association, Inc	Domestic WWTP	0.021
FLA014098	Rotonda WRF - Charlotte County Utilities Department	Domestic WWTP	1
FLA014122	River Forest Village	Domestic WWTP	0.035
FLA014070	Lazy Lagoon Mobile Park	Domestic WWTP	0.07
FLA014088	Palms & Pines Inc	Domestic WWTP	0.015
FLA118371	Punta Gorda, City of - WWTP	Domestic WWTP	3.2
FLA014062	North Charlotte Waterworks, Inc. WWTP	Domestic WWTP	0.06
FLA014067	Bay Palms Mobile Home Park	Domestic WWTP	0.01
FLA014060	Riverwoods Utilities	Domestic WWTP	0.41
FLA014048	Charlotte County Utilities - Westport WWTP	Domestic WWTP	1.2
FLA011957	Craig's RV Park WWTF	Domestic WWTP	0.04
FLA011986	Spring Lake Youth Academy WWTF	Domestic WWTP	0.0025
FLA011959	Cross Creek CC & RV Resort WWTF	Domestic WWTP	0.04
FLA478300	Sorrells Limestone Heights	Domestic WWTP	0.022
FLA011960	DeSoto Village WWTF	Domestic WWTP	0.03
FLA011968	Pit Stop	Domestic WWTP	0.01
FLA011963	Arcadia Village WWTF	Domestic WWTP	0.06
FLA011967	Toby's Plantation RV Resort WWTF	Domestic WWTP	0.04
FLA011962	Little Willie's RV Resort WWTF	Domestic WWTP	0.04
FLA119644	Lake Suzy Utility WWTF	Domestic WWTP	0.087
FLA011953	Sunrise MHP WWTF	Domestic WWTP	0.015
FLA530808	Desoto County Regional WWTF	Domestic WWTP	0.75
FL0027511	Arcadia City of - William Tyson WWTF	Domestic WWTP	2
FLA011969	Live Oak RV Resort	Domestic WWTP	0.04

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA011987	Desoto Correctional Institution	Domestic WWTP	0.4275
FLA011956	Oak View MHP WWTP	Domestic WWTP	0.02
FLA011994	Peace River Heights WWTF	Domestic WWTP	0.04
FLA012002	Florida SKP Co-Op, Inc.	Domestic WWTP	0.015
FLA011997	Brookside Bluff R V Resort	Domestic WWTP	0.05
FLA119911	Bowling Green City Of WWTF	Domestic WWTP	0.32
FLA011996	Little Charlie Creek RV Park	Domestic WWTP	0.05
FLA119903	Zolfo Springs City Of WWTF	Domestic WWTP	0.2
FLA277355	Vandolah Road WWTF	Domestic WWTP	0.05
FLA290980	Wauchula Hills WWTP	Domestic WWTP	0.36
FLA119890	Wauchula City Of WWTF	Domestic WWTP	1.2
FLA012022	Hardee Correctional Institution	Domestic WWTP	0.212
FLA014351	Country Club Of Sebring WWTP	Domestic WWTP	0.085
FLA014328	Western Blvd WWTP	Domestic WWTP	0.2
FLA012623	Four Corners Mine WWTF	Domestic WWTP	0.0075
FLA130532	Palm Shores Mobile Village WWTF	Domestic WWTP	0.0175
FLA013097	Peace Creek Park	Domestic WWTP	0.015
FLA016650	Towerwood MHP WWTF	Domestic WWTP	0.05
FLA013048	Lake Region Mobile Home Park WWTF	Domestic WWTP	0.08
FL0036048	Winter Haven, City of - WWTP#3	Domestic WWTP/Wastewater Residuals Application Site	7.5
FLA013021	Stay Plus Inn WWTF	Domestic WWTP	0.03
FLA013107	Hidden Cove WWTF	Domestic WWTP	0.02
FLA013096	Enchanted Grove MH & RV Park WWTF	Domestic WWTP	0.015
FLA013106	Warner University	Domestic WWTP	0.086
FLA013000	Tower Manor MHP	Domestic WWTP	0.025
FLA016559	City of Auburndale Regional WWTF	Domestic WWTP	1.6
FLA013017	Royal Oaks MH Co-op WWTF	Domestic WWTP	0.015
FLA012975	Lake Alfred, City of	Domestic WWTP	0.6
FLA013094	Ten Rocks MHP	Domestic WWTP	0.01
FLA013066	Four Lakes Golf Club	Domestic WWTP	0.0985
FLA016634	Cypress Gardens MH & RV Park WWTF	Domestic WWTP	0.047
FLA013103	Swiss Golf Club	Domestic WWTP	0.176
FLA013109	Orange Acres Ranch MHP WWTF	Domestic WWTP	0.035
FLA013043	GrowHealthy Properties LLC	Domestic WWTP	0.0125
FLA013100	Highland Apartments	Domestic WWTP	0.03
FLA016529	Fort Meade, City of	Domestic WWTP	1
FLA013051	Lincoln MHP	Domestic WWTP	0.005
FLA017408	Hines Energy Complex WWTF	Domestic WWTP	0.01
FLA013126	Lake Henry Estates WWTF	Domestic WWTP	0.065
FLA012951	Polk County - Combeewood WWTF	Domestic WWTP	0.062
FLA013099	Fairview Village Circle	Domestic WWTP	0.0125
FLA012976	Bartow City of WRF	Domestic WWTP	8
FLA013069	Valencia Estates MHP WWTF	Domestic WWTP	0.017
FLA013036	Florida Sheriff's Youth Villa	Domestic WWTP	0.01
FLA012943	Heritage Place WWTF	Domestic WWTP	0.06

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA011044	Minerva MHP WWTF	Domestic WWTP	0.01
FLA013028	Cutrale Citrus Juices USA	Domestic WWTP	0.025
FLA760838	Streamsong	Domestic WWTP	0.1
FLA013042	Country Club of Winter Haven WWTF	Domestic WWTP	0.01
FLA129844	Lake Wales, City of	Domestic WWTP	2.52
FLA013027	Lakeside Ranch Estates WWTF	Domestic WWTP	0.035
FLA013009	Village Of Lakeland	Domestic WWTP	0.07
FLA013120	Happy Days Trailer Park WWTF	Domestic WWTP	0.05
FLA013045	Sanlan Ranch Campground	Domestic WWTP	0.06
FL0039772	Lakeland, City of - Glendale WRF	Domestic WWTP	13.7
FL0021466	Auburndale, City of - Allred WWTF	Domestic WWTP	1.4
FLA013093	Carefree RV Country Club	Domestic WWTP	0.075
FLA012985	Lakeland, City of - Northside WWTF	Domestic WWTP	8
FLA129747	Winter Haven, City of - WWTP #2	Domestic WWTP	1.7
FLA012947	Boswell Elementary School WWTF	Domestic WWTP	0.0125
FLA013118	Good Life RV Resort WWTF	Domestic WWTP	0.07
FLA013033	Plantation Landings WWTF	Domestic WWTP	0.08
FLA013004	Twin Fountains Mobile Condominium WWTF	Domestic WWTP	0.035
FLA013035	The Vanguard School of Lake Wales, Florida, Inc.	Domestic WWTP	0.02
FLA012968	Waverly Wastewater Treatment Facility	Domestic WWTP	0.13
FLA013081	Grove Shores Mobile Colony	Domestic WWTP	0.017
FLA013074	Cypress Gardens Campground & RV Park	Domestic WWTP	0.025
FLA013095	Central Leisure Lake LLC	Domestic WWTP	0.018
FLA013003	Camp 'N Aire Campground WWTF	Domestic WWTP	0.0127
FLA013061	Eaton Park MHP	Domestic WWTP	0.015
FLA013098	Garden Mobile Village WWTF	Domestic WWTP	0.01
FLA013062	Anglers Cove West	Domestic WWTP	0.05
FLA013087	Village Water WWTF	Domestic WWTP	0.075
FLA013076	Winterset Shores Estates	Domestic WWTP	0.007
FLA013082	Sweetwater Golf & Tennis Club	Domestic WWTP	0.07
FLA013102	Swiss Village MHP	Domestic WWTP	0.141
FLA012958	Oscar J Pope Elementary School	Domestic WWTP	0.008
FLA012955	Combee Elementary School WWTF	Domestic WWTP	0.02
FLA013073	Paradise Island Campground WWTF	Domestic WWTP	0.0114
FLA013105	Woodland Lakes MHP WWTF	Domestic WWTP	0.035
FLA013372	Bee Ridge WRF	Domestic WWTP	12
FLA013432	2224 South Trail WWTF	Domestic WWTP	0.003
FLA013405	Venice Ranch MHE WTP	Domestic WWTP	0.035
FLA013389	King's Gate Club, Inc.	Domestic WWTP	0.05
FLA013374	State College of Florida	Domestic WWTP	0.014
FLA013438	Myakka MHP WWTF	Domestic WWTP	0.0083
FLA013378	North Port, City of - WWTP	Domestic WWTP	2
FLA984841	Southwest WRF	Domestic WWTP	4
FLA013408	Campvenice Retreat WWTF	Domestic WWTP	0.01

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA013436	Kings Gate RV Park	Domestic WWTP	0.04
FLA013492	Myakka River State Park	Domestic WWTP	0.015
FLA013418	Japanese Gardens MHP WWTF	Domestic WWTP	0.048
FL0041441	Venice, City of - Eastside AWWTF	Domestic WWTP	6
FLA043494	Venice Gardens Water Reclamation Facility	Domestic WWTP	2
FLA017028	Our Lady of Perpetual Help WWTF	Domestic WWTP	0.0041
FLA013398	Florida Pines, Inc.	Domestic WWTP	0.0105
FLA804746	City of Punta Gorda Biosolids	Wastewater Residuals Application Facility	Not provided by FDEP
FLA858838	VCH MANAGEMENT NORTH BMF	Wastewater Residuals Application Facility	Not provided by FDEP
FLA335550	VCH Management East Side BMF	Wastewater Residuals Application Facility	Not provided by FDEP
FLA858820	2 x 4 Ranch BMF	Wastewater Residuals Application Facility	Not provided by FDEP
FLA318582	Wauchula City Of WWTF	Wastewater Residuals Application Facility	Not provided by FDEP
FLA288233	Hart - Albriton	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB01401	To Ranch LAS (Mann Septic LAS)	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB04293	Dawes Ranch BLAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLA690392	CHRIS WALKER RANCH	Wastewater Residuals Application Facility	Not provided by FDEP
FLA918491	Peace River Ranch BLAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB01385	Berns Septic LAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLA290131	Carter 7 C Ranch RAF	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB01418	Louie Burton LAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLA290386	JMC Ranch RAF	Wastewater Residuals Application Facility	Not provided by FDEP
FLA690163	B-Bar-J Ranch	Wastewater Residuals Application Facility	Not provided by FDEP
FLA289914	5R Ranch RAF	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB01383	Central Florida Septic LAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLA992950	Averett SMF Land Application Site	Wastewater Residuals Application Facility	Not provided by FDEP
FLA290165	Winter Haven, City of - WWTP#3	Wastewater Residuals Application Facility	Not provided by FDEP

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA818925	Albritton Biosolids Land Application Site	Wastewater Residuals Application Facility	Not provided by FDEP
FLA950955	Southeastern Septic Septage Management Facility	Wastewater Residuals Application Facility	Not provided by FDEP
FLA311898	Circle Cross RAF	Wastewater Residuals Application Facility	Not provided by FDEP
FLAB01381	Brooker Septic Services LAS	Wastewater Residuals Application Facility	Not provided by FDEP
FLA779466	Charlotte County Bio Recycling Center	Residuals/Septage Management Facility	Not provided by FDEP
FLA016228	A - 1 Quality Service Lime Stabilization RMF	Residuals/Septage Management Facility	Not provided by FDEP
FLA467049	AMS Central RMF	Residuals/Septage Management Facility	Not provided by FDEP
FLA992941	Averett SMF	Residuals/Septage Management Facility	Not provided by FDEP
FLA994235	Mann Septic Tank Service Lime Stabilization Facility	Residuals/Septage Management Facility	Not provided by FDEP
FLA994341	Louie Burton Septic Tank Service	Residuals/Septage Management Facility	Not provided by FDEP
FLA994324	Berns Septic Co.	Residuals/Septage Management Facility	Not provided by FDEP
FLA992682	Central Florida Septic Tank Co., Inc.	Residuals/Septage Management Facility	Not provided by FDEP
FLA302341	Brooker Septic WWTF	Residuals/Septage Management Facility	Not provided by FDEP
FLA607240	Unity Envirotech Of Central Florida RMF	Residuals/Septage Management Facility	Not provided by FDEP
FLA837067	Mulberry Biosolids Management Facility	Residuals/Septage Management Facility	Not provided by FDEP
FLA176303	Sarasota County - South Master Reuse System	Domestic WWTP Reuse	8.157
FLA120197	Lake Branch Dairy	Industrial Wastewater/Animal Feeding Operation	Not provided by FDEP
FLG110527	Argos USA - Punta Gorda Ready Mix	Concrete Batch General Permit	Not provided by FDEP
FLG110177	CEMEX LLC - Port Charlotte Facility	Concrete Batch General Permit	Not provided by FDEP
FLG110778	Colonial Construction, Inc	Concrete Batch General Permit	Not provided by FDEP
FLG110027	Argos USA Port Charlotte	Concrete Batch General Permit	Not provided by FDEP
FLG110031	Preferred Materials Punta Gorda	Concrete Batch General Permit	Not provided by FDEP
FLG110059	CEMEX LLC - Punta Gorda Plant	Concrete Batch General Permit	Not provided by FDEP

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLG110645	Titan Florida LLC, Punta Gorda Ready Mix Plant	Concrete Batch General Permit	Not provided by FDEP
FLG110032	Preferred Materials Placida	Concrete Batch General Permit	Not provided by FDEP
FLG110897	Colonial Precast Concrete LLC	Concrete Batch General Permit	Not provided by FDEP
FLG110195	Jahna Concrete Inc - Zolfo Springs Plant	Concrete Batch General Permit	Not provided by FDEP
FLG110311	Argos Ready Mix LLC - Lake Wales Facility	Concrete Batch General Permit	Not provided by FDEP
FLG110530	Argos USA - Bartow	Concrete Batch General Permit	Not provided by FDEP
FLG110099	Cemex Construction Materials Florida, LLC/Main Ave. Facility	Concrete Batch General Permit	Not provided by FDEP
FLG110679	Pump - Crete Inc - Winter Haven Facility	Concrete Batch General Permit	Not provided by FDEP
FLG110469	CEMEX LLC - Auburndale CBP	Concrete Batch General Permit	Not provided by FDEP
FLG110003	Pump - Crete Inc - Pine Road	Concrete Batch General Permit	Not provided by FDEP
FLG110260	Argos Ready Mix LLC	Concrete Batch General Permit	Not provided by FDEP
FLG110916	Valmont Newmark Small Pole Facility	Concrete Batch General Permit	Not provided by FDEP
FLG110529	Argos USA SR 630 RMP	Concrete Batch General Permit	Not provided by FDEP
FLG110840	Smyrna Ready Mix Concrete LLC	Concrete Batch General Permit	Not provided by FDEP
FLG110243	Titan Floirda LLC Venice Ready Mix Plant	Concrete Batch General Permit	Not provided by FDEP
FLG110166	Preferred Materials Inc - Venice Jackson Road Ready Mix	Concrete Batch General Permit	Not provided by FDEP
FLG110080	Argos USA - Venice Plant	Concrete Batch General Permit	Not provided by FDEP
FLA182648	Brighton Dairy #1	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA518611	Pine Island Dairy	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA183326	Zolfo Springs Dairy	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA120081	V & W Farms, Inc	Industrial Wastewater/Concentrated Animal Feeding Operation	0.144
FLA120189	Melear Dairy #1 & #2	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA182656	Crewsville Dairy Inc	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA183075	Lake Branch Dairy	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA405582	Ten Mile Grade Dairy	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA372986	ESDA Inc	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA182699	Cameron Dakin Dairy	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA182966	Farren Dakin Dairy, LLC	Industrial Wastewater/Concentrated Animal Feeding Operation	Not provided by FDEP
FLA188506	Quality Material	Industrial Wastewater	Not provided by FDEP
FLA848352	R & D CATTLE EXCAVATION	Industrial Wastewater	Not provided by FDEP
FLA140945	North Charlotte Waterworks, Inc. WWTP	Industrial Wastewater	Not provided by FDEP
FLA140937	Alligator Mobile Home Park	Industrial Wastewater	Not provided by FDEP
FLA295574	Touch Of Class Car Wash	Industrial Wastewater	Not provided by FDEP
FLA623644	Infinity Lakes Sand Mine-Rock Crushing	Industrial Wastewater	Not provided by FDEP
FL0035378	Charlotte Harbor Water Assoc Inc	Industrial Wastewater	Not provided by FDEP
FLA869210	Waterside Excavation	Industrial Wastewater	Not provided by FDEP
FLAB03448	Charlotte County Fleet Maintenance Facility	Industrial Wastewater	Not provided by FDEP
FLA119849	Peace River Citrus Products, Inc.	Industrial Wastewater	Not provided by FDEP
FLA006401	Golden Ranch Farms, LLC	Industrial Wastewater	0.017
FLA189995	Desoto County Transportation Division	Industrial Wastewater	0.04
FLA012007	Mancini Packing Company	Industrial Wastewater	Not provided by FDEP
FL0131474	Florida's Natural Growers - Lake Wales Plant	Industrial Wastewater	Not provided by FDEP
FLA013250	Cutrale Citrus Juices USA	Industrial Wastewater	0.15
FLA471895	Easy Care Car Wash North	Industrial Wastewater	Not provided by FDEP
FLA670197	Metromont Bartow Plant	Industrial Wastewater	Not provided by FDEP
FLA176061	Performance Car Wash	Industrial Wastewater	Not provided by FDEP
FLA013150	Dundee Citrus Growers Association Dundee Facility	Industrial Wastewater	Not provided by FDEP

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FLA013312	Mastertaste Inc, DBA Kerry Inc.	Industrial Wastewater	Not provided by FDEP
FLA524794	KMR Concrete	Industrial Wastewater	0.063
FL0133132	UFP Auburndale, LLC	Industrial Wastewater	Not provided by FDEP
FL0003051	Florida Distillers Company - Auburndale	Industrial Wastewater	2
FLA013192	Clear Springs Packing, LLC	Industrial Wastewater	Not provided by FDEP
FL0029017	Florida Distillers Company -Lake Alfred	Industrial Wastewater	Not provided by FDEP
FLA548006	Innovative Concrete Technologies, Corporation	Industrial Wastewater	Not provided by FDEP
FLA742996	Organic Matters, Inc	Industrial Wastewater	Not provided by FDEP
FLA013186	Dundee Citrus Growers Association - Packinghouse Plant	Industrial Wastewater	Not provided by FDEP
FLA013215	Bartow Citrus Products LLC	Industrial Wastewater	Not provided by FDEP
FLA013273	The Florida Brewery Inc	Industrial Wastewater	Not provided by FDEP
FLA017061	FPL Toledo Blade Service Center	Industrial Wastewater	2.6
FLA639036	Heron Creek Golf and Country Club	Industrial Wastewater	Not provided by FDEP
FLAB07038	Tommy's Express Car Wash	Industrial Wastewater	Not provided by FDEP
FL0035335	Venice, City of - RO Plant	Industrial Wastewater	Not provided by FDEP
FL0188859	King's Gate Club, Inc.	Industrial Wastewater	Not provided by FDEP
FLA477419	Venice Golf & Country Club	Industrial Wastewater	0.046
FL0189065	Venice Ranch MHE WTP	Industrial Wastewater	Not provided by FDEP
FLA014066	Seaside Service System Inc	Underground Injection Control Facility/Underground Injection Control	0.033
FLA160962	Sarasota County - Venice Gardens DIW	Underground Injection Control Facility	Not provided by FDEP
FLA180360	Harbor Cove ROC, Inc	Underground Injection Control Facility	Not provided by FDEP
FL0027600	Mosaic Fertilizer, LLC - Ft Green Mine Complex	Industrial Wastewater	Not provided by FDEP
FL0037958	Mosaic Fertilizer, LLC - South Ft Meade Mine	Industrial Wastewater	0.392
FL0035271	Mosaic Fertilizer LLC - Hardee Mine Complex	Industrial Wastewater	0.01
FL0040177	Mosaic Fertilizer LLC - Hardee Mine Complex	Industrial Wastewater	Not provided by FDEP

Facility ID	Facility Name	Facility Type	Permitted Capacity (mgd)
FL0036412	Mosaic Fertilizer LLC - Four Corners Mine	Industrial Wastewater	0.042
FLA267911	Mosaic Fertilizer, LLC - Bartow Closed North Gyp Stack	Industrial Wastewater	0.036
FL0001902	U S Agri-Chemicals Corporation - Ft Meade Chemical Plant	Industrial Wastewater	1.65
FL0160083	Estech, LLC - Agricola Closed Stack	Industrial Wastewater	Not provided by FDEP
FL0757471	Novaphos Development, LLC	Industrial Wastewater	Not provided by FDEP
FL0001961	US Agri-Chemicals Corporation - Bartow Chemical Plant	Industrial Wastewater	Not provided by FDEP
FL0037958	Mosaic Fertilizer, LLC - South Ft Meade Mine	Industrial Wastewater	Not provided by FDEP
FLA279765	Vandolah Power Co LLC	Industrial Wastewater	Not provided by FDEP
FL0041751	Hardee Power Station	Industrial Wastewater	Not provided by FDEP
FL0044229	Seminole Electric Cooperative Inc - Payne Creek Power Plant	Industrial Wastewater	Not provided by FDEP
FL0043869	Tampa Electric Company - Polk Power Plant	Industrial Wastewater	Not provided by FDEP
FLA187348	Hines Energy Complex WWTF	Industrial Wastewater	Not provided by FDEP
FL0026298	Larsen Memorial Plant	Industrial Wastewater	Not provided by FDEP
FLA286958	G.W. Buck Mann Ranch BLAS	Wastewater Residuals Application Facility	Not provided by FDEP

Based on an email from FDEP South District Office staff on January 7, 2020 the facilities listed in Table C-2 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-2 Wastewater Facilities Operating Under a Consent Order

Facility Name	Facility ID	Consent Order Number
Rotonda WRF	FLA014098	18-0036
Charlotte County Utilities- Burnt Store WWTP	FLA014083	18-0036
East Port WRF	FL0040291	18-0036
William Tyson WWTP	FL0027511	18-0037
Fairmount Utilities WWTP	FLA014387	18-0081
Bee Ridge WRF	FLA013372	19-0255
Venice Gardens WRF	FLA043494	19-0225
Central County WRF	FLA013455	19-0225
Pit Stop	FLA011968	16-0296
R&D Cattle	FLA848352	19-0305
Alpha CML/Purple Rock Manufacturing	9815438	18-1377

Table C-3 Power Plants

PLANT_NAME	UTILITY_NA	SCO_NUMBER
Hardee Power Station	Hardee Power Partners, Ltd. (Subsidiary of Invenergy, LLC)	PA 89-25
Richard J. Midulla Generating Station	Seminole Electric Company, Inc.	PA 89-25SA
Polk Power Station	Tampa Electric Company	PA 92-32
Hines Energy Complex	Duke Energy Florida, Inc.	PA 92-33
C.D. McIntosh Power Plant	Lakeland Electric	PA 74-06
Tiger Bay Cogeneration Facility	Duke Energy Florida, Inc.	PA 97-37
Osprey Energy Center	Calpine Construction Finance Company, LP	PA 00-41

Table C-4 MS4 Permittees

PERMIT_ID	PERMITTEE	PERMIT NAME	FDOT DISTRICT
FLR04E043	Charlotte County	Charlotte County	
FLR04E039	Punta Gorda, City of	City of Punta Gorda	
FLS000015	Fort Meade	Polk County and Co Permittees	
FLS000015	Dundee, Town of	Polk County and Co Permittees	
FLS000015	Eagle Lake, City of	Polk County and Co Permittees	
FLS000015	Auburndale, City of	Polk County and Co Permittees	
FLS000015	Bartow, City of	Polk County and Co Permittees	
FLS000015	Haines City, City of	Polk County and Co Permittees	
FLS000015	Lakeland, City of	Polk County and Co Permittees	
FLS000006	Hillsborough County	Hillsborough County and Co Permittees	District 7
FLS000015	Lake Hamilton, Town of	Polk County and Co Permittees	
FLS000015	Lake Alfred, City of	Polk County and Co Permittees	
FLS000015	Lake Wales, City of	Polk County and Co Permittees	
FLS000004	Sarasota County	Sarasota County and Co Permittees	District 1
FLS000035	Lee County	Lee County and Co Permittees	District 1
FLS000036	Manatee County	Manatee County and Co Permittees	District 1
FLS000015	Polk County	Polk County and Co Permittees	Florida Turnpike/District 1
FLR04E148	Highlands County	Highlands County	District 1 FLR04E147
FLS000004	North Port, City of	Sarasota County and Co Permittees	
FLS000015	Winter Haven, City of	Polk County and Co Permittees	
FLS000004	Venice, City of	Sarasota County and Co Permittees	
FLR04E150	Avon Park, City of		

Appendix D: Jurisdictional Authority within the Charlotte Harbor Watershed

Five levels of government are involved in resource management and regulatory activities within the Charlotte Harbor 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 Southwest and Central Florida Regional Planning Councils (SWFRPC and CFRPC), as well as state and federal agencies.

FEDERAL

Federal jurisdiction in Charlotte Harbor Watershed involves the regulatory responsibilities of the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Coast Guard, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Department of the 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 (USGS) and the National Oceanic and Atmospheric Administration, also contribute to the collection of technical data concerning Charlotte Harbor Watershed and its watershed. Land based conservation measures within the watershed may be addressed by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (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

The USACE received jurisdiction over Inland Waters of the United States, for navigation purposes, in Section 9 and 10 of the Rivers and Harbors Act of 1899. A revision of the Rivers and Harbors Act in 1968 extended USACE jurisdiction allowing them to consider the fish and wildlife, conservation, pollution, aesthetics, ecology and other relevant factors of a project. The USACE regulatory program was further expanded in 1972 with the passage of the Federal Water Pollution Control Act Amendments, also known as the Clean Water Act (CWA). The discharge of dredge and fill into United States waters is regulated by the USACE under Section 404 of this act. The USACE jurisdiction was extended to wetlands due to a Supreme Court order in 1975 and Amendments to the CWA in 1977. Projects constructed by the USACE for local flood protection are subject to regulations prescribed to cover operation and maintenance. These regulations are contained in Sections 208.10 and 208.11, Title 33 of the Code of Federal Regulations.

U.S. Environmental Protection Agency

The EPA (Southeast Regional Office, Region IV, Atlanta, Georgia) has jurisdiction over surface waters in the state. Enforcement authority was given under the Clean Water Act of 1972 and broadened under its revision in 1977. Key activities include the issuance of National Pollution Discharge Elimination System (NPDES) permits and restoration of surface and groundwater. The agency also reviews USACE permit activities, sets minimum quality standards, and sets guidelines for state environmental 64 programs. The EPA also funds sewerage facilities' studies through the SWFRPC and the CFRPC, and system improvements through the Florida Department of Environmental Protection (FDEP). Authority regarding the discharge of oil or hazardous substances into surface water is divided between the EPA and the U.S. Coast Guard.

U.S. Coast Guard

In inland waters the Coast Guard Auxiliary performs boating safety inspections and search and rescue missions. The Auxiliary is a volunteer group reimbursed expenses when assigned missions by the U.S. Coast Guard.

U.S. Department of the Interior

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 USGS conducts investigations concerning hydrology, hydrogeology, water use, and ground and surface water quality. The USFWS 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

The USFWS is responsible for oversight of the federal program for fish and wildlife as authorized in the Coastal Resources Barrier Act, National Environmental Protection Act, Migratory Bird Act, Endangered Species Act, and Fish and Wildlife Coordination Act. Under provisions of the Fish and Wildlife Coordination Act, the USFWS must be consulted before the USACE can submit a plan for Congressional approval. The USFWS comments on the impacts of proposed projects on endangered species, migratory birds, and other fish and wildlife and their habitats. The USFWS is directed to prepare environmental impacts assessments or statements for proposed USACE projects under provisions of the National Environmental Protection Act, and the USFWS is authorized under the Endangered Species Act to issue a "Jeopardy Opinion" against any proposed project which will negatively affect an endangered species.

U.S. Geological Survey

The USGS is the nation's largest water, earth, and biological science and civilian mapping agency. The 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

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

The NRCS is an agency of the USDA that 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 Charlotte Harbor Watershed and estuary. The FDEP is the lead state agency in the protection and management of Crystal River/Kings Bay. Other relevant entities include the Florida Fish and Wildlife Conservation Commission (FFWCC), the Marine Fisheries Commission, Florida Department of Agriculture and Consumer Services (FDACS), Florida Department of Health and Rehabilitative Services, Florida Sea Grant Program, and the Florida Department of Transportation.

Florida Department of Agriculture and Consumer Services

The FDACS, through its Division of Agriculture Environmental Services regulates the registration and use of pesticides, including the purchase of restricted pesticides, maintains registration and quality control of fertilizers, regulates pest control operations, mosquito control, and evaluates and manages environmental impacts associated with agrochemicals.

The 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 involving agriculture. The OAWP has developed Best Management Practices (BMPs) addressing both water quality and water conservation on a site-specific, regional and watershed basis for commercial agricultural operations. The office is directly involved with statewide programs to implement the Federal Clean Water Act's Total Maximum Daily Load (TMDL) requirements for agriculture. The OAWP works cooperatively with agricultural producers and industry groups, the FDEP, the university system, the Water Management Districts, and other interested parties to develop and implement BMP programs that are economically and technically feasible. The office facilitates the participation of Soil and Water Conservation Districts in water-related issues at the County or watershed level.

Through the Florida Forest Service (FFS), the FDACS is responsible for developing, implementing, and monitoring BMP's through the Silviculture BMP Program to control forestry-related non-point source pollution. The FFS manages Florida's 34 State Forests and several other parcels of public land. The Division of Plant Industry is responsible for, among other duties, regulation of the movement of noxious weeds, and, with input from the Endangered Plant Advisory Council, protecting endangered, threatened or commercially exploited plant species.

Florida Department of Environmental Protection

The FDEP, itself a result of the merger of the old Department of Environmental Regulation and the Department of Natural Resources, is the lead state agency involved in water quality, pollution control, and resource recovery programs. The Department 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 department also interacts closely with other federal and state agencies on water-related matters, and the Department and the District share responsibilities in non-point source management and wetland permitting. The Division of State lands oversees the management of state lands, including state parks. The Division of Recreation and Parks and the Florida Coastal Office (formerly Coastal and Aquatic Managed Areas) are directly responsible for day to day land management in this watershed. The FDEP Bureau of Geology reviews leasing requests involving nearshore and state waters. The Bureau of Beaches and Shores oversees beach re-nourishment activities. 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 Recreation and Parks

This Division of the FDEP has management authority of state parks and within the Charlotte Harbor watershed there are six state parks. These include the following, Highlands Hammock State Park, Stump Pass Beach State Recreational Area, Paynes Creek Historic State Park, Charlotte Harbor Preserve State Park, Myakka River State Park and Don Pedro Island State Park. The most significant of these are the Myakka River State Park and the Charlotte Harbor Preserve State Park.

The Myakka River, Florida's first state-designated wild and scenic river, flows through 58 square miles of the Myakka River State Park one of Florida's oldest and largest parks. This state park is steeped in history. Shortly after, the Great Depression struck America, President Roosevelt signed into law the New Deal, a government program intended to boost the economy and spirit of the American population during these dark years. One program funded was the Civilian Conservation Corps (CCC). Myakka is one of eight Florida state parks developed by the CCC during the 1930s and many of the CCC built structures are still used today.

Charlotte Harbor Preserve State Park is comprised of 43,404 acres and protects more than 100 miles of shoreline along Charlotte Harbor in Charlotte and Lee Counties. It is the third largest Florida State Park and provides numerous recreational opportunities including hiking, fishing, paddling, and observing wildlife. The Charlotte Harbor Environmental Center (CHEC) is locate in the Park near Punta Gorda. CHEC is a nonprofit group that offers a visitor center, environmental education programs, interpretive guided hikes and 6 miles of marked trails.

Office of Resilience and Coastal Protection

The Office of Resilience and Coastal Protection manages more than 4.9 million acres of submerged lands and coastal uplands in Florida, including forty-one aquatic preserves throughout the State. All but four of these submerged lands of exceptional beauty are located along Florida's 8,400 miles of coastline, in the shallow waters of marshes and estuaries. The other four are located inland, near springs and rivers. Aquatic preserves protect Florida's living waters to ensure they will always be home for bird rookeries and fish nurseries, freshwater springs and salt marshes, and seagrass meadows and mangrove forests. There are three aquatic preserves in Charlotte Harbor, including Gasparilla Sound – Charlotte Harbor Aquatic Preserve (84,501 acres), Cape Haze Aquatic Preserve (12,716 acres) and Lemon Bay Aquatic Preserve (7226 acres).

Division of Water Resource Management

The South and Southwest District Offices in Tampa have responsibility for proprietary and regulatory permitting issues in the Charlotte Harbor Watershed area.

Florida Department of Health

The primary environmental directive of the Florida Department of Health (FDOH) is to prevent disease of environmental origin. Environmental health activities focus on 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. FDOH responsibilities 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). The Onsite Sewage Program is administered by the Environmental Health Section of the FDOH office in each county.

The primary statutes providing FDOH authority are to be found 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.

Florida Fish and Wildlife Conservation Commission

Florida voters elected in 1998 to replace The Florida Game and Fresh Water Fish Commission (GFC) and the Marine Fisheries Commission (MFC) with the FFWCC, effective July 1, 1999. The result is that Florida has placed responsibility for conserving the state's freshwater aquatic life, marine life and wild animal life all under a single agency.

The new FFWCC basically encompasses all the programs of the old GFC and MFC, plus some employees and programs from the FDEP. FDEP's Florida Coastal Office (formerly Coastal and Aquatic Managed Areas) and some other elements stayed with FDEP's Division of Marine Resources. The Florida Marine Research Institute (FMRI), the Office of Fisheries Management and Assistance Services (OFMAS) and the Bureau of Protected Species Management were transferred to the new agency. OFMAS, with some MFC staff, will be the new agency's Division of Marine Fisheries.

All employees from FDEP's Division of Law Enforcement, except for the Park Patrol, the Bureau of Emergency Response, the Office of Environmental and Resource Crimes Investigations and some field investigators now are part of the FFWCC.

Former Marine Patrol officers will continue to concentrate on enforcing saltwater laws, and former wildlife officers will continue to focus on freshwater and wildlife laws. However, when there is a need to reallocate law enforcement officers to deal with an emergency, the agency can do so. The Marine Patrol serves as an enforcement agency for the Florida Endangered and Threatened Species Act and the Oil Spill Prevention and Pollution Control Act. The Florida Marine Patrol also enforces state motorboat laws and the saltwater fisheries regulations of the Commission.

The FDEP Bureau of Protected Species Management, with responsibility for managing imperiled marine life, is now part of the FFWCC's Office of Environmental. The old GFC's Endangered Species Section is part of the new agency's Division of Wildlife.

Meanwhile, the Bureau of Marine Resource Regulation and Development which has jurisdiction over processing plants and shellfish management, is now part of the Florida Department of Agriculture and Consumer Services.

The Commission'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 Commission is directed by law 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

The Florida 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 Charlotte Harbor 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 Charlotte Harbor's natural resources.

REGIONAL AGENCIES

Several regional agencies exist within the SWFWMD boundaries of the Charlotte Harbor watershed. These are the Tampa Bay Regional Planning Council (Manatee County) Southwest Florida Regional Planning Council (SWFRPC) (Charlotte and Sarasota Counties), Central Florida Regional Planning Council, the SWFWMD, and the Peace River Manasota Regional Water Supply Authority (Authority).

Tampa Bay Regional Planning Council

The Tampa Bay Regional Planning Council (TBRPC) was established in 1962 and includes Citrus, Hernando (added in 2015), Hillsborough, Manatee, Pasco, and Pinellas Counties. 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.

Southwest Florida Regional Planning Council

In accordance with Section 186.505, Florida Statutes, the SWFRPC was created by an interlocal agreement between Charlotte, Collier, Glades, Hendry, Lee and Sarasota Counties in 1973. The agency is directed by a Council, composed of county commissioners and municipal elected officials, representatives of the Florida Department of Transportation, the FDEP, and water management districts. The SWFRPC acts as a regional information clearinghouse, conducts research to develop and maintain area wide goals, objectives, and policies, and assists in implementing several local, state, and federal programs.

Central Florida Regional Planning Council

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 of 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

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 District 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 Charlotte Harbor Watershed watershed within its boundaries.

Peace River Manasota Regional Water Supply Authority

The Authority is a regional water supply authority whose primary function is to ensure future water supply and the development, recovery, storing and supplying of water resources for county or municipal purposes in such a manner as will give priority to encouraging conservation and adverse environmental effects of excessive or improper withdrawals of water from concentrated areas. 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 and amended in 2005. Parties to the amended interlocal agreement include Charlotte County, DeSoto County, Manatee County, and Sarasota County. The Authority's boundaries consist of all DeSoto County, Manatee County, and Sarasota County, and those parts of Charlotte County which are under the jurisdiction of the SWFWMD, pursuant to Section 373.069(1)(d), Florida Statutes.

West Coast Inland Navigation District

The West Coast Inland Navigation District (WCIND) is a multi-county special taxing body, covering Manatee, Sarasota, Charlotte, and Lee counties, encompassing an estimated 1.1 million people. WCIND was established by the Florida Legislature in 1947 to complement the USACE—sharing the cost of planning, construction, and maintenance of a 152-mile long, 100-foot wide, 9-foot-deep Gulf Intracoastal Waterway (GICW) between the mouth of the Caloosahatchee River and the Anclote River. The WCIND began maintenance of the GICW upon its completion in 1967. Subsequently, in 1979, its responsibilities were broadened to include improving and maintaining public channels connected to the GICW—and any waters that made a significant contribution to waterway traffic or commerce. WCIND was also empowered to assist member counties in navigation projects, waterway research, erosion and accretion studies, and environmental restoration projects. In 1989, WCIND was authorized to participate in even more waterway-related activities, including the promotion of inlet management, and the posting and maintenance of channel markers and manatee protection speed zone signs. Additionally, the WCIND has initiated programs to encourage boating safety and environmental stewardship through distributing boater and waterway guides and resource maps.

LOCAL GOVERNMENTS

There are 28 local governments that have jurisdiction within the SWFWMD's boundaries of Charlotte Harbor. These include 7 counties and 19 municipalities. Each of these local governments have a role in protecting Charlotte Harbor. 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.

Charlotte County

Charlotte County, established in 1921, has an estimated (2017) population of 172,720 and a land area of 690 square miles. It is served by two general-purpose local governments, the Charlotte County Board of County Commissioners, and the City of Punta Gorda.

Sarasota County

Sarasota County, established in 1921, has an estimated (2017) population of 407,260 and a land area of 573 square miles. It contains five general-purpose local governments (the Board of County Commissioners, the City of Sarasota, the City of Venice, the City of North Port, and the Town of Longboat Key, which is shared with Manatee County). Except for the City of Sarasota and the Town of Longboat Key, the above-mentioned entities have jurisdiction within the Charlotte Harbor Surface Water Improvement Management (SWIM) Plan area.

Polk County

Polk County, established in 1861, has an estimated (2017) population of 661,645 and a land area of 2,010 square miles. The county is served by seventeen general-purpose local governments: The Board of County Commissioners, and the towns of Bartow, Davenport, Eagle Lake, Lake Wales, Fort Meade, Frostproof, Haines City, Highland Park, Lake Alfred, Lake Hamilton, Auburndale, Lakeland, Mulberry, Polk City, and Winter Haven.

DeSoto County

DeSoto County has an estimated (2017) population of 35,621 and a land area of 639 square miles. The county is served by a Board of County Commissioners and the town of Arcadia.

Hardee County

Hardee County, created in 1887, has an estimated (2017) population of 27,426 and a land area of 630 square miles. The county is served by a Board of County Commissioners, and contains the towns of Bowling Green, Wauchula, and Zolfo Springs.

Highlands County

Highlands County has an estimated (2017) population of 102,138 and a land area of 1,106 square miles. The county is served by a Board of County Commissioners and contains the cities of Sebring and Avon Park. Only the western-most area of the County, which comprises less than 85 square miles and a small portion of Avon Park are within the Charlotte Harbor Watershed.

Manatee County

Manatee County has an estimated (2017) population of 368,782 and a surface area of 747 square miles. It is served by a Board of County Commissioners and contains the city of Bradenton and several smaller towns and municipalities. The City of Bradenton is not located within the Charlotte Harbor watershed.

Appendix E: List of Acronyms

Abbreviation	Description
SWIM	Surface Water Improvement and Management
District	Southwest Florida Water Management District
SWFWMD	Southwest Florida Water Management District
CHNEP	Coastal and Heartland National Estuary Partnership
CCMP	Comprehensive Conservation and Management Plan
SFWMD	South Florida Water Management District
PLRG	Pollutant Load Reduction Goal
TN	Total Nitrogen
mgd	million gallons per day
BMPs	Best Management Practices
FARMS	Facilitating Agricultural Resource Management Systems
SWUCA	Southern Water Use Caution Area
FDEP	Florida Department of Environmental Protection
FFWCC	Florida Fish and Wildlife Conservation Commission
FDACS	Florida Department of Agriculture and Consumer Services
Authority	Peace River Manasota Regional Water Supply Authority
TP	Total Phosphorus
TKN	Total Kjeldahl Nitrogen
DO	Dissolved Oxygen
Kd	light attenuation
SOD	sediment oxygen demand
LSU	Louisiana State University
WBIDs	Water Body Identification units
TSS	Total Suspended Solids
NNC	Numeric Nutrient Criteria
CHFI	Charlotte Harbor Flatwoods Initiative
WMA	Wildlife Management Area
FLUCCS	Florida Land Use Cover Classification Scheme
HRN	Habitat Restoration Needs
CFI	Cooperative Funding Initiative
CCHMN	Coastal Charlotte Harbor Monitoring Network
MFLs	Minimum Flows and Levels
UAV	unmanned aerial vehicles
FAC	Florida Administrative Code
CDOM	colored dissolved organic matter
NEP	National Estuary Program
USGS	U.S. Geological Survey
WY	Water Year
Plan	Yucca Pens Hydrologic Restoration Plan
SWFRPC	Southwest Florida Regional Planning Councils
CFRPC	Central Florida Regional Planning Councils
USDA	U.S. Department of Agriculture
NRCS	Natural Resources Conservation Service
USACE	U.S. Army Corps of Engineers
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
NPDES	National Pollution Discharge Elimination System
USFWS	U.S. Fish and Wildlife Service
OAWP	Office of Agricultural Water Policy
TMDL	Total Maximum Daily Load
FFS	Florida Forest Service

Abbreviation	Description
CCC	Civilian Conservation Corps
CHEC	Charlotte Harbor Environmental Center
FDOH	Florida Department of Health
GFC	Florida Game and Fresh Water Fish Commission
MFC	Marine Fisheries Commission
FMRI	Florida Marine Research Institute
OFMAS	Office of Fisheries Management and Assistance Services
TBRPC	Tampa Bay Regional Planning Council
WCIND	West Coast Inland Navigation District
GICW	Gulf Intracoastal Waterway