State of the Resource Report for Clearwater Harbor and Saint Joseph Sound

Prepared for:
Pinellas County Department of Environment and Infrastructure

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Foreword

This document is provided in fulfillment of Task 7 of the Comprehensive Conservation and Management Plan for Saint Joseph Sound and Clearwater Harbor; Contract No: 089-0222-P.

Acknowledgements

This report would not have been completed without contributions from a number of local scientists and water resource managers. Janicki Environmental, Inc. would like thank project managers Kelli Hammer Levy and Melissa Harrison of Pinellas County and Kris Kaufman of the Southwest Florida Water Management District for their oversight and insights into the successful completion of this report. The stakeholder group provided immeasurable contributions to the success of this project. The stakeholder group included representatives of the City of Tarpon Springs, City of Dunedin, City of Clearwater, City of Largo, Pinellas County, Florida Department of Environmental Protection, the United States Environmental Protection Agency, and the Southwest Florida Water Management District. Cooperative funding for this project was supplied by Pinellas County, the Southwest Florida Water Management District, and the United States Environmental Protection Agency. Janicki Environmental would also like to acknowledge the contributions of their sub-consultants on this project for their contributions. Specifically, Kathy Anamisis, Pam Latham, Doug Robison, and David Tomasko of Atkins Global are acknowledged for their contribution to the sections of the report detailing the state of the resources for land use, seagrass, and environmental lands. Additionally, Ann Hodgson and Ann Paul of the Audubon of Florida's, Florida Coastal Islands Sanctuaries program contributed Chapter 5.7 of the State of the Resource Report concerning birds.

Executive Summary

The Pinellas County Department of Environmental Management (PCDEM), in cooperation with the U.S. Environmental Protection Agency (EPA), the Southwest Florida Water Management District (SWFWMD), in partnership with the cities of Clearwater, Largo, Dunedin, and Tarpon Springs, is developing a ***Comprehensive Conservation and Management Plan for Clearwater Harbor and St. Joseph Sound***. This area includes the northernmost portion of Pinellas County's Gulf Coast shoreline and contains some of the most extensive natural areas and environmental preserves in southwest Florida. However, northwestern Pinellas County is also one of the most densely populated areas in all of Florida. The Comprehensive Conservation and Management Plan (CCMP) is being developed to provide a unique management strategy to protect and restore the valued natural systems that make this area so valuable and attractive to residents and visitors. By assessing existing data, integrating various existing management strategies, and identifying knowledge and information gaps, the CCMP will set forth a foundation and a path forward to integrate natural resource protection efforts and focus future work on those areas where the greatest yields can be gained. To that end, this document, the ***State of the Resource Report for Clearwater Harbor and St. Joseph Sound***, establishes the scientific foundation and rationale from which to proceed in developing the CCMP for Clearwater Harbor and St. Joseph Sound, collectively referred to as CHSJS. There are three watersheds within the CCMP area (Figure 1):

- St. Joseph Sound (SJS)
- Clearwater Harbor North (CHN)
- Clearwater Harbor South (CHS)

The northern boundary of the CHSJS Estuary is a line drawn from the northern end of Anclote Key perpendicular to the mainland (Figure 1). Other limits of the estuary are primarily defined by bridges including the Dunedin Causeway separating Clearwater Harbor North from St. Joseph Sound, and the Memorial Causeway separating Clearwater Harbor South from Clearwater Harbor North. The southern extent of Clearwater Harbor South is defined by the Indian Rocks Causeway bridge located at The Narrows.

The St. Joseph Sound watershed includes the Anclote River basin which extends north and east into Pasco County. The Pasco County portion of this watershed was only evaluated with respect to pollutant

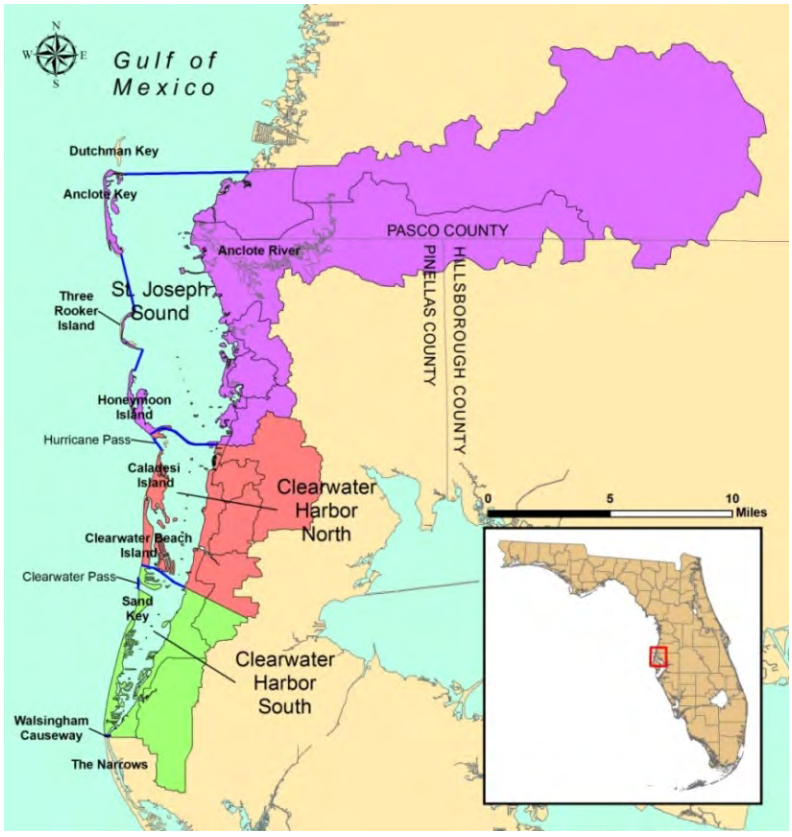

Figure 1. CHSJS CCMP area location map.

loading because of its influence on St. Joseph Sound. Data analysis and management recommendations for the Anclote River are restricted to those areas within Pinellas County. The remainder of the St. Joseph Sound watershed lies within the City of Tarpon Springs, the City of Dunedin, and unincorporated Pinellas County. The Clearwater Harbor North and Clearwater Harbor South watersheds encompass all or parts of the municipalities of Dunedin, Clearwater, Largo, Belleair, Belleair Bluffs, Belleair Beach, Belleair Shores, and Indian Rocks Beach as well as unincorporated Pinellas County.

A stakeholder group composed of representatives from state, regional, county, municipal, and public citizen groups has been formed as part of the development of the CCMP. Through regular meetings and workshops, the stakeholders have identified key resources of concern and management issues that have become the focus of the CCMP. These key resources and issues include:

- Watershed Hydrology and Estuarine Circulation
- Water Quality
- Seagrasses
- Fish, Birds, Turtles, and Marine Mammals
- Freshwater and Saltwater Wetlands and Native Uplands
- Managed Lands

For each of the key resources, data are identified, described and analyzed; and management goals and targets are identified. Goals and targets for the key resources provide an essential framework for the CCMP.

The State of the Resource Report is organized as follows:

- Chapter 1 summarizes the extent and history of the CCMP area.
- Chapter 2 characterizes the physical features of the CHSJS Estuary.
- Chapter 3 characterizes the physical features of the CHSJS watershed.
- Chapter 4 describes analysis of natural resources in the CHSJS watershed.
- Chapter 5 describes the critical natural resources in the CHSJS Estuary.

Estuaries are among the most highly productive biological systems on earth. The CHSJS Estuary is a major focus of the CCMP because of its natural resources and economic value to the region. Estuarine health and productivity is driven by the combination of nutrient delivery, sediment delivery, circulation, emergent vegetation, submerged aquatic vegetation, and the balance of benthic and pelagic food webs. Circulation prevents water stagnation and increases mixing, although it can also increase turbidity and therefore decrease water clarity. Long residence times of water in an estuary allow organic detritus to contribute nutrients to the food chain, but can also lead to reduced dissolved oxygen concentrations. Therefore, estuarine water quality and overall productivity relies on a delicate balance of inputs, nutrient uptake and cycling, and mediating influences such as residence times. In the sub-tropical estuaries of the CHSJS CCMP area, water quality conditions are partially related to the expression of phytoplankton which contribute to overall productivity, but can also contribute to deleterious conditions and harmful algal blooms if allowed to proliferate. Phytoplankton concentrations (as measured by chlorophyll *a* concentrations) are thought to be limited by nutrient concentrations or nutrient loads to the estuary from the

watershed. High phytoplankton concentrations can also reduce light availability and thus affect the health and success of seagrass in the study area. Currents, wind speed, and sediment type also play a role in the health and success of seagrass in the study area. The health of seagrass contributes to the area being highly prized for recreational fishing. Water quality also impacts the temporal and spatial extent of water column habitat availability for those organisms whose survival and reproductive strategies are dependent on specific water quality conditions (e.g., specific salinity ranges, dissolved oxygen requirements, and water clarity).

To provide context to the current state of the resources in the CCMP area, a brief history of the area is provided. In the early 20th century, the City of Clearwater was incorporated and was known principally as an agricultural port city. Tarpon Springs was also among the first urban centers in the area and was one of the largest sponge ports in the United States. The town of Dunedin was another early seaport and trading center, and at one time was home port to the largest commercial fleet of ships in the state. By 1920, the U.S. Army Corps of Engineers (Corps) had already finished major construction on Florida's Atlantic portion of the Intracoastal Waterway (ICW) and was developing plans for the Cross Florida Barge Canal. In 1910, Congress appropriated $29,000 to dredge and maintain a 7-by-100-foot channel from Tampa Bay into Boca Ciega Bay and a 5-by-50-foot channel on to Clearwater Harbor as part of the Gulf of Mexico ICW. The Corps completed this work in 1920, however enlargement of the channel that extended from Clearwater Harbor north through St. Joseph Sound to the Anclote River was not completed until 1962.

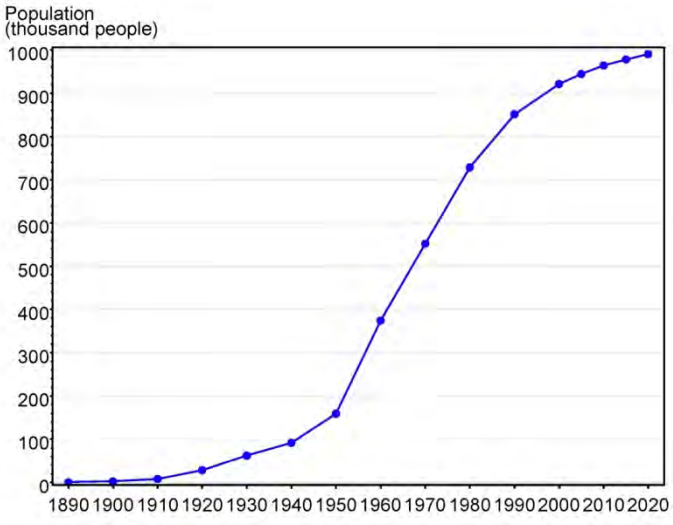

Figure 2. Pinellas County permanent population - historical, current and projected future. (Pinellas County Planning Department, 2010

Development of the watershed and exponetially increasing immigration and settlement in Pinellas County followed improvements to infrastructure, especially land-based transportation. A 135 % increase in the population in Pinellas County between 1950 and 1960 was the largest increase ever recorded in the County and was followed by commensurate increases in residential development in each of the next three decades (Figure 2). Environmental impacts due to land development activities led to the establishment of regulatory agencies in the early 1970s. During this same period, portions of northeastern Pinellas County and northwestern Hillsborough County were leased for wellfield development in response to saltwater intrusion into local water supplies. In 1975, the Local Government Comprehensive Planning Act was enacted by the Florida Legislature and in the late 1970s, Pinellas County began identifying environmentally-significant lands with the intent of ",,,adopting the necessary and appropriate regulatory land use designations to preserve their environmental significance."

To provide baseline information on the extent of natural resources in the study area such as wetlands, native uplands and seagrasses, historical aerial photographs circa 1940 were obtained from the National Archives and Records Administration in Washington D.C. These photographs are the earliest record available with complete coverage throughout the CHSJS area. The

photographs were digitized and geo-rectified so that the areal extent of local natural resources could be estimated. Comparisons were then made to more recent aerial surveys of land use and seagrasses conducted by SWFWMD.

Below is a summary of the natural resource value assessments conducted as part of the State of the Resource Report.

Land Use

Historically, the CHSJS watershed was dominated by pine flatwoods, dry prairie, forested and unforested freshwater wetlands, and near the coast, salt marsh and mangrove habitats. Based on an analysis of historical aerial photography it was determined that by 1942 about 65% of the watershed remained in one of these types of "native lands". Thirty four percent of the watershed in 1942 was classified as developed lands, dominated by agriculture. Other non-native land uses included residential, commercial and municipal development within the watershed. In many areas agricultural development had supplanted native uplands and wetlands, consequently altering the natural surface water and groundwater systems of the watershed. Since the 1940s, urban and residential development increased dramatically replacing historical agricultural areas and destroying more native uplands and wetlands. Today less than 20%, 10%, and 5% of historical native lands remain in St. Joseph Sound, Clearwater Harbor North, and Clearwater Harbor South, respectively. Natural areas in the CHSJS CCMP area are now limited primarily to the northeast portion of the St. Joseph Sound watershed and within public lands including the barrier island state parks. Increased urban and residential development has increased impervious land surface and other features that are associated with adverse stream impacts including reduced stream stability, habitat degradation, water quality degradation, and a loss of biological diversity. The dramatic losses to uplands and wetlands in the three watersheds of the CCMP area have also consequently reduced available habits for threatened and endangered species including the gopher tortoise, colonial waterbirds, Bald Eagle, and Red Cockaded Woodpecker.

Given the extensive loss of both native uplands and wetlands to urban and residential land uses, it was considered unreasonable to expect that the CCMP should set a goal of restoring land to the historical acreage circa 1942. Therefore, current acreages for uplands, forested wetlands, non-forested wetlands, mangroves, and salt marshes were documented and should be considered minimum acceptable acreages for each habitat type within the watershed. In the CCMP document, several strategies will be outlined and prioritized to increase the extent of these habitat types to the largest practical extent with a focus on restoring the balance of habitat types based on the historical balance of habitats estimated from the 1940s photographs. The current acreages for each habitat type in the mainland portion of the CCMP area are as follows:

	St. Joseph Sound	Clearwater Harbor North	Clearwater Harbor South	Total Acres
Uplands (acres)	1,500	517	241	2,258
Forested Wetlands (acres)	1,567	252	23	1,842
Non-Forested Wetlands (acres)	536	137	86	759
Mangroves (acres)	209	3	24	236
Saltwater Marshes (acres)	448	3	2	454

Coastal island wetland habitats (i.e., those not associated with the mainland) were historically and remain dominated by mangrove forests. While some salt marsh habitat remains, the current habitat ratios are similar to their historical proportions. The current acreages for mangrove, and saltwater marshes along coastal island habitats are:

	St. Joseph Sound	Clearwater Harbor North	Clearwater Harbor South	Total Acres
Mangroves (acres)	153	390	24	567
Saltwater Marshes (acres)	77	13	0	90

Seagrasses

Seagrass communities are keystone indicators of estuarine health in sub-tropical systems such as Clearwater Harbor and St. Joseph Sound. Seagrass health and success depends on good water quality and water clarity making seagrasses useful indicators of ecosystem health. Seagrasses support a complex trophic food web and a detritus-based food chain, as well as provide sediment and nutrient filtration, sediment stabilization, and breeding and nursery areas for finfish and shellfish. A vast array of estuarine and marine organisms relies upon seagrass habitats for a portion or all of their life cycles. The canopy structure of the seagrass bed provides protection and cover for fish in their fry and juvenile stages, essentially serving as a nursery ground. Primary production within seagrass beds also provides food for recreationally and commercially important fish species and serves as a trophic foundation for the ecosystem. Seagrass meadows are also a direct food source for the West Indian manatee (*Trichechus manatus*), green sea turtle (*Chelonia mydas*), and ecologically important invertebrates such as the variegated sea urchin, *Lytechinus variegates*. Therefore, seagrass meadows support a complex trophic food web and a detritus based food chain.

Sediment deposition can have either positive or negative consequences for seagrasses depending on the volume, timing and quality of the sediments. Since seagrasses live in the shallow, protected

coastal waters that are directly proximal to the shore and watershed, seagrasses are highly susceptible to nutrient and sediment inputs. Nutrient assimilation and recycling is another of the many ecosystem services that seagrass communities provide. Seagrasses filter nutrients and contaminants, which helps improve water quality and support adjacent habitats and fisheries. They allow for organic-matter accumulation and nutrient regeneration and recycling, which support primary production and sustain food webs. They can also serve as sinks for nitrogenous loads from watershed sources. Anthropogenic nitrogen loads can lead to excessive algae growth, which adversely affects light penetration to submerged seagrasses.

Historical aerial photography was used to develop a historical seagrass coverage for the open bay segments of the CCMP area using the same National Archive aerial photographs of 1942 that were used for the land use change analysis. Seagrass extent in the western portion of St. Joseph Sound, for which no 1942 National Archive photographs were available, was digitized from aerial photographs taken in 1957. These data were then used to estimate the historical areal extent of seagrasses within the open bay segments of the CCMP. These estimates were then compared to recent surveys conducted by the SWFWMD after adjusting for non-restorable areas, such as dredging of the Intracoastal Waterway and other dredge and fill projects.

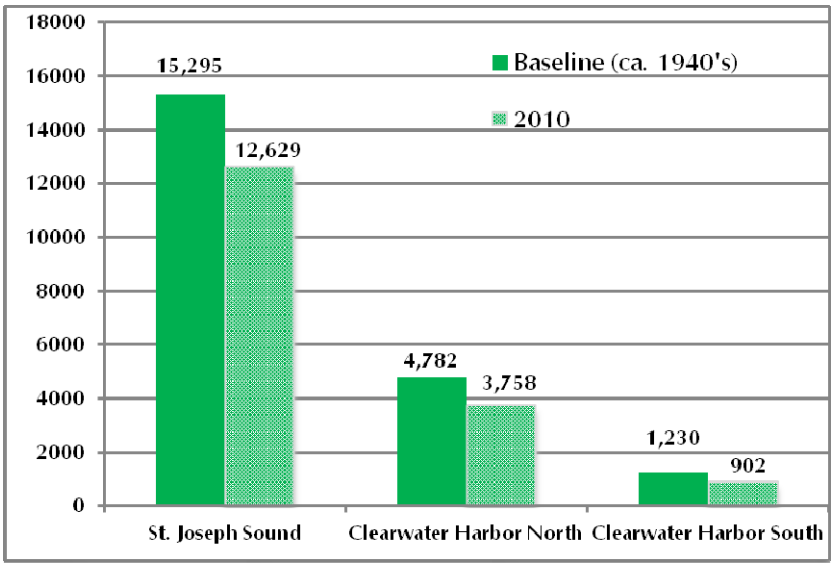

Figure 3. Comparison of historical and 2010 seagrass acreages for each CHSJS estuarine segment.

Current seagrass areal extents are 83%, 79% and 73% of historic estimates for St. Joseph Sound, Clearwater Harbor North and Clearwater Harbor South, respectively (Figure 3). Clearly Clearwater Harbor South has lost the largest proportion of seagrasses relative to historic estimates. However, St Joseph Sound lost more acreage than the other segments.

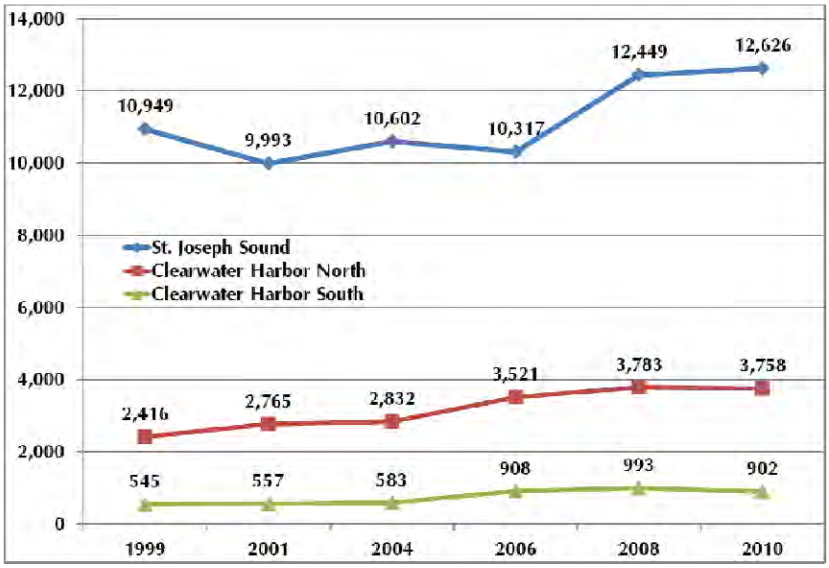

Figure 4. Change in seagrass areal extent between 1999 and 2010 for each CHSJS estuarine segment.

Despite these historical losses, seagrass acreage has been trending

upward since 1999 throughout Clearwater Harbor and there have been substantial recent gains in St. Joseph Sound. The most recent seagrass mapping efforts, completed in 2010, indicate that in St. Joseph Sound, seagrass cover in 2010 was 15% higher than in 1999, an increase of 1,680 acres (Figure 4; Table 1).

In Clearwater Harbor North, seagrass acreage increased 56%, from 2,416 acres in 1999 to 3,758 acres in 2010. Seagrass cover in Clearwater Harbor South increased 66%, from 545 acres to 902 acres between 1999 and 2010. These substantial increases in seagrass acreage are concurrent with improved water quality between 1999 and 2010 relative to conditions in the early 1990s.

Table 1. Seagrass acreage within each segment for all years.

Segment	Adjusted 1942 Baseline	1999	2001	2004	2006	2008	2010
St. Joseph Sound	15,295	10,949	9,993	10,602	10,317	12,449	12,629
Clearwater Harbor North	4,782	2,416	2,765	2,832	3,521	3,783	3,758
Clearwater Harbor South	1,230	545	557	583	908	993	902

In Clearwater Harbor North and South, historical seagrass estimates were used to develop seagrass areal extent targets. Given the recent trajectory in seagrass acreage in these segments, the historical acres were thought to be reasonable estimates of the potential gains. Large areas of seagrass loss in St. Joseph Sound appear to be due to physical disturbances such as barrier island migration, the dredging of the ICW and its associated impacts on current velocities, and depth and wave energy, as well as the potential effects of episodic biological perturbations and grazing events as described in Chapter 5. Given these considerations, it was deemed unrealistic to develop a target for St. Joseph sound that is based on historical conditions. Consequently, the seagrass areal target acreage for St. Joseph Sound is an average of the two most recent surveys.

Therefore, the segment-specific seagrass targets for the CHSJS Estuary are:

Segment	Acreage Target
St, Joseph Sound	12,539 acres
Clearwater Harbor North	4,782 acres
Clearwater Harbor South	1,230 acres

Water Quality

Hydrologic processes have a significant effect on the ecology of the estuary. Transport of nutrients and sediments to coastal waters of the CHSJS Estuary is largely determined by the amount of rainfall over monthly, seasonal, and annual time periods. Rainfall directly impacts surface water flows, is a significant source of directly deposited nitrogen and phosphorus from the atmosphere, and can increase the amount of suspended solids in adjacent waterbodies through sediment erosion and transport to surface waters.

The timing, volume, and distribution of freshwater inflows to Clearwater Harbor and St. Joseph Sound are affected by land use and hydrologic alterations that have occurred in the watershed, as well as by precipitation patterns. Extensive alteration to the watershed's hydrologic features has changed how freshwater is delivered to the receiving water. Channelization of coastal streams and destruction of coastal wetlands has increased peak flow rates and velocities, and reduced opportunities for pollutant removal and groundwater recharge. Higher peak flows and reduced attenuation has also increased the potential for channel and coastal erosion. The CHSJS watershed receives approximately 127 cm (i.e. 50 inches) of rainfall annually with nearly half of the total occurring over four months between June and September (Figure 5).

The largest source of freshwater inflow into the CHSJS Estuary is the Anclote River. Both natural and anthropogenic factors influence discharges in the Anclote River. Well fields for potable water supply have operated in the Anclote River watershed for decades, and significant pumping of groundwater for public supply has resulted in river flows that are estimated to have been reduced by 29%. Local resource managers recognized that existing levels of pumping were not sustainable, and developed the *Northern Tampa Bay New Water Supply and Ground Water Withdrawal Reduction Agreement*, which was implemented in 1998. Through the recovery plan regional groundwater withdrawals would be reduced from 158 million gallons per day (mgd) in 1998 to 90 mgd in 2009. Minimum flow criteria were developed for the river by the SWFWMD in 2007. Reductions in wellfield pumping resulted in a measureable increase in river flows. A 2009 re-evaluation of impacts on the Anclote River due to groundwater withdrawals suggested that if the 2008 pumping rates and well rotation schedule were continued, flow in the Anclote River would recover to the SWFWMD minimum flow thresholds.

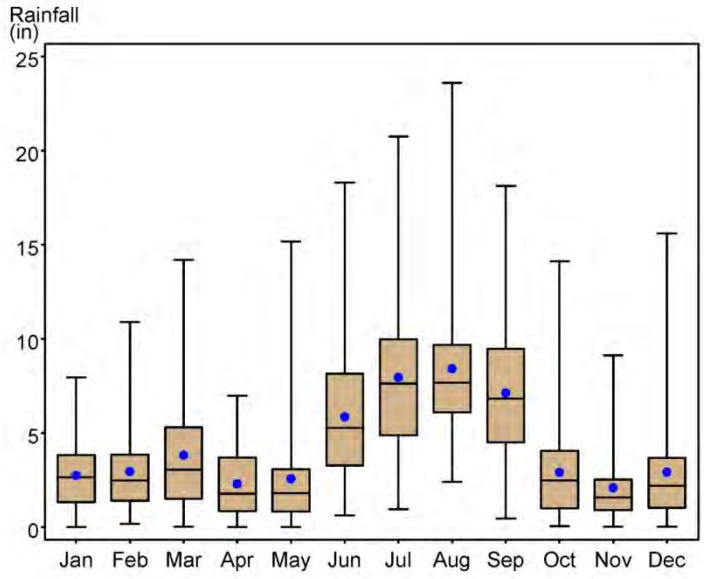

Figure 5. Distribution of monthly rainfall at City of Tarpon Springs rain gage over a 75 year period of record.

The remaining freshwater sources are smaller creeks and small magnitude coastal springs including Klosterman Creek, Curlew Creek, Cedar Creek, Spring Branch, Stevenson Creek, Smith Creek, McKay Creek and Wall Spring. While these tributaries deliver a much lower volume of freshwater than the Anclote River, they remain ecologically import and contribute significant amounts of freshwater, nutrients and sediments to the estuary. Direct runoff from coastal lands, direct precipitation to the estuary as well as direct discharge from stormwater outfalls also contribute freshwater and nutrients to the estuarine waters.

Hydrologic loadings often result in high nutrient loading to the estuary which drives primary production and may result in subsequent eutrophication. Increases in sediment loads are another consequence of heavy rainfall and may be associated with increased concentrations of heavy

metals and organic contaminants that bind to sediment particles. Suspended solids can also impact light attenuation in the water column and can negatively impact submerged aquatic vegetation as well as benthic invertebrates and fish species. Total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS) and biochemical oxygen demand (BOD) are four of many "pollutants" measured to evaluate water quality. These pollutants are measured in streams and estuarine waters throughout the CHSJS as concentration by the Pinellas County Department of Environmental Management. Pollutant concentrations are expressed as milligrams per liter of water (mg/L). Phytoplankton concentrations are an often used indicator of the system response to nutrient pollution. In freshwater, TP is commonly the nutrient that governs phytoplankton concentration while TN generally limits phytoplankton concentrations in the estuarine waters. The CHSJS soils are generally rich in phosphorus and TN is recognized as the limiting nutrient. Phytoplankton concentrations are typically estimated by measuring the concentration of chlorophyll *a* (the photosynthetic pigment in phytoplankton). Chlorophyll *a* concentrations are reported in micrograms per liter (μg/L). Chlorophyll *a* concentrations in the CHSJS Estuary have been improving (i.e. decreased concentration) since 1992. Also, nutrient concentration trends (both TN and TP) at many stations within the tributaries to the estuaries have been improving (i.e. decreasing concentration) over that time.

A pollutant loading model was developed for the State of the Resource Report to estimate the mass (load) of four principal "pollutants" delivered via freshwater inflow to the CHSJS Estuary. Pollutant loading estimates use the volume of water delivered to the estuary with either measured or estimated concentration of these pollutants in the watershed to derive a mass delivered via freshwater discharge. Pollutant loading estimates are an integral part of the Florida Department of Environmental Protection's (FDEP) Total Maximum Daily Loads (TMDL) program that attempts to define the assimilative capacity of waterbodies it deems impaired due to excessive nutrient pollution. While TMDL's have been expressed as both concentrations and loads, the calculation of loading estimates has played an integral role in assigning regulatory nutrient pollution thresholds in nearby Tampa Bay. Estuarine biological processes respond in system specific manner to both the concentration of nutrients in the water and to the mass of nutrients delivered. The differences in response to loads or concentrations include factors such as dilution, water residence times, and the complex interactions between the mass delivered and nutrient assimilation and recycling from biological processes.

Pollutant loading model estimates were generated for a 23 year period from 1985 through 2008 for each sub-basin of the CCMP study area. Since loads are a function of rainfall, higher rainfall years will generally have higher loads. Therefore loads can be more variable than concentrations across years because of the effects of rainfall. For example, the St Joseph Sound segment had much higher than typically loadings for the years of 1998 and 2003 when rainfall amounts and subsequent river flows from the Anclote River were much higher than typical. This variability was not observed to the same extent in Clearwater Harbor North or Clearwater Harbor South due to the lesser contribution of freshwater flows to these segments. Total loads are a combination of both point sources (e.g., wastewater treatment plants and industrial facilities) and non-point sources (e.g., stormwater runoff and agriculture or pasture lands). In the CCMP area, non-point source loads contributed the majority of the total loads delivered to the estuary when excluding direct deposition due to rainfall.

The calculation of loadings per acre (i.e. load/acre/year) was used to compare "unit area loads" or "yields" to identify sub-basins which contributed, on average, the highest yield of pollutants. Stevenson Creek in Clearwater Harbor North had among the highest unit area loads for hydrologic

load, TN load, TP load and BOD load. However, both Spring Branch and Smith Bayou sub-basins had higher yields of TSS than Stevenson Creek. Despite this finding, while the marine segment of the Stevenson Creek watershed is identified by FDEP as impaired for nutrients, the CHN estuary does not show signs of impairment. In fact, all of the open bay segments of the CHSJS are meeting their designated full aquatic life uses according to FDEP. In summary, while there are issues related to pollutant loadings and concentrations in many of the CHSJS tributaries, pollutant loadings to the CHSJS Estuary are not currently sufficient to cause impairment in the open estuary as evidenced by improving chlorophyll *a* concentrations and recent increases in seagrass areal extent in all estuarine segments.

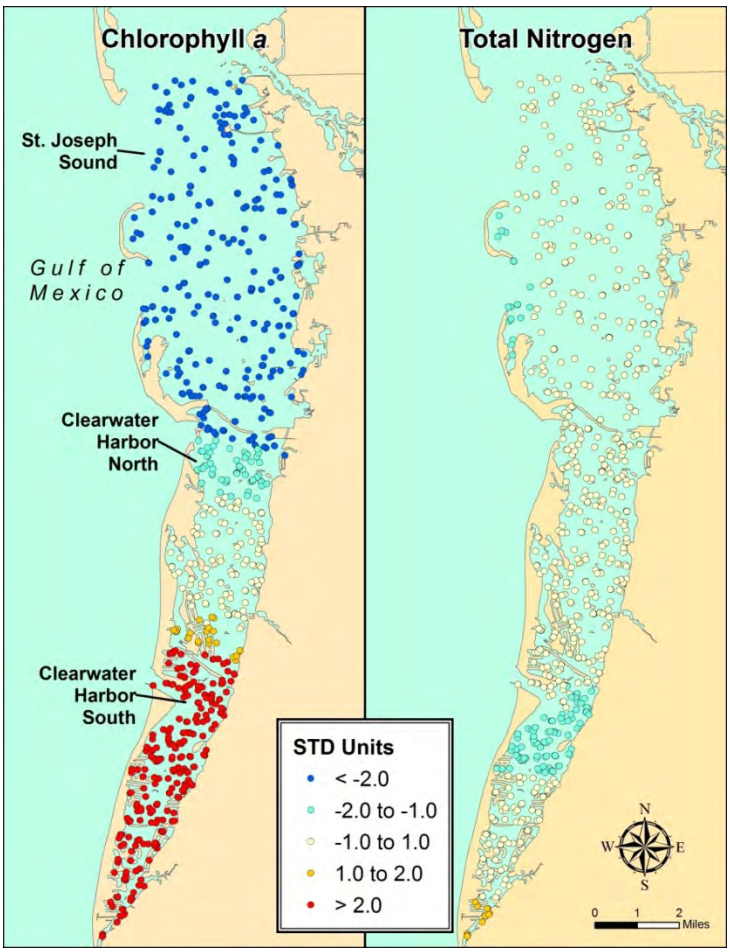

Figure 6. Spatial distribution of chlorophyll *a* *(left) and TN (right).* *Red* dots indicate significant clustering of higher than average values and blue dots indicate statistically lower than average values.

Descriptive and quantitative statistical analyses suggested that neither nutrient concentrations nor nutrient loadings alone were confident predictors of the chlorophyll *a* concentrations used as an indicator of estuarine health. While within segment analysis did not reveal a direct link between nutrients and phytoplankton concentrations, descriptive plots suggested a north/south gradient in chlorophyll *a* concentrations that appeared to be principally a function of residence times. The direct influence of tidal exchange with the Gulf of Mexico is most pronounced in St. Joseph Sound and least pronounced in Clearwater Harbor South. The increased residence time of water in the Clearwater Harbor South segment seemingly allows for a higher concentration of phytoplankton for a given level of nutrient concentration as shown in Figure 6. In this plot the chlorophyll *a* concentration and total nitrogen values are standardized to that they are on the same scale (i.e., units of standard deviation from their long term average). Therefore, blue filled circles represent lower than average concentrations and red filled circles indicate higher than average concentrations.

For the purposes of the CCMP, the estuary water quality goal was established to ensure that water quality conditions in the estuary are protective of two critical indicators of estuarine health – seagrasses and dissolved oxygen. Given the results of analysis described above, and the fact that seagrasses are currently stable or improving throughout the CHSJS Estuary it was concluded that recent water quality conditions are sufficient to maintain full aquatic life uses in the estuary. Therefore, a reference period approach was used to establish management targets and thresholds

used to monitor water quality in the estuarine open bay waters of the CCMP. The reference period was defined as the 2003-2009 time period.

Target chlorophyll *a* and water clarity (% transmissivity) values for each CHSJS estuarine segment were defined by the overall average of the annual geometric means for each constituent during the reference period. A threshold value for these constituents was defined as a value would indicate that water quality was significantly higher than that observed over the reference period. The threshold value was calculated based on statistical theory that if water quality in any year was not different from reference period conditions, its geometric mean value would be lower than the reference period mean +1.95 standard deviation with 95% confidence. Therefore, the threshold values can be used to test the sample geometric means for the three parameters for compliance with the established targets and thresholds. Any sample geometric mean higher than these values would then be considered an excursion for that water quality constituent.

The proposed chlorophyll *a* targets and thresholds are:

	Target	Threshold
• St. Joseph Sound	1.9 μg/L	3.1 μg/L
• Clearwater Harbor North	3.5 μg/L	5.4 μg/L
• Clearwater Harbor South	4.8 μg/L	7.6 μg/L

The proposed percent light transmittance targets and thresholds are:

	Target	Threshold
• St. Joseph Sound	90%	83%
• Clearwater Harbor North	82%	75%
• Clearwater Harbor South	74%	62%

Threshold values for TN concentrations and TP concentrations were calculated in a similar manner and are presented below. These targets and thresholds were developed as management criteria and are proposed to be used to evaluate water quality with respect to not allowing for degradation of water quality from that observed over recent time period (i.e. 2003-2009) when the open bay estuarine segments were fully meeting their designated uses. Within this context, an excursion is defined as an annual geometric average for a particular constituent that exceeded the threshold value. The annual geometric mean should be derived strictly from water quality sampling conducted according to Pinellas County's probabilistic water quality sampling design in designated strata "W1", "W2" , and "W3" corresponding to St. Joseph Sound, Clearwater Harbor North and Clearwater Harbor South, respectively. These thresholds are not to be considered as end of pipe criteria for point source discharges within the CCMP for regulatory purposes. Further, a single excursion of the threshold value does not necessarily mean that there has been significant degradation of water quality. The analyses of Chapter 5.2 of the State of the Resource Report suggests that there have been times when estuarine water quality values for chlorophyll *a*, TN, TP,

and transmittance have historically exceeded the proposed threshold values and yet the estuarine waters were meeting full aquatic life uses according to FDEP. However, in keeping with the spirit of EPA's anti-degradation policy given the special nature of these estuarine waters, the threshold values were chosen as the appropriate management level criteria for these segments.

With respect to pending numeric nutrient criteria proposed by the EPA, The CCMP nutrient thresholds may be considered as site specific criteria for these waterbodies under the constraints and assumptions described above. While EPA has stated that the numeric nutrient criteria must be expressed as concentrations others, including DEP, have argued that the estuarine numeric criteria can and should be expressed as loadings. Therefore, both concentration - and loading-based TN and TP criteria are proposed. Pollutant loading-based thresholds have also been derived using the same methods described above for concentrations, using the geometric averages from the reference period and the standard deviation associated with the estimate of the population of geometric mean values.

The proposed TN and TP concentration-based numeric criteria are:

	TN Criterion	TP Criterion
• St. Joseph Sound	0.66 mg/L	0.05 mg/L
• Clearwater Harbor North	0.61 mg/L	0.05 mg/L
• Clearwater Harbor South	0.58 mg/L	0.06 mg/L

The proposed TN and TP loading-based criteria are:

	TN Criterion	TP Criterion
• St. Joseph Sound	493 tons/yr	85 tons/yr
• Clearwater Harbor North	124 tons/yr	17 tons/yr
• Clearwater Harbor South	58 tons/yr	7 tons/yr

In addition to the quantitative targets and thresholds described above, there were several natural resource components identified where qualitative goals were developed due to a lack of information necessary to develop numerical targets. These resource components include: sediment quality, benthos, fishes, dolphin, turtles, manatee and birds. For these resource components, descriptive analyses were conducted to describe available information and qualitative goals were developed to guide management activities associated with the natural resources of concern. Many of these value natural resources rely heavily on wetland habitats, sea gasses and water quality for which quantitative targets have been developed as described above.

Benthos

There was a paucity of information on sediment quality in the study area so a baseline characterization of sediment quality was performed as part of this study. While collecting

information on sediment quality, macroinvertebrate collections were also performed to provide a baseline characterization of benthic macroinvertebrates in the CHSJS Estuary. The location of the samples characterized by their sediment grain size categories are provided in Figure 7. The benthic macroinvertebrate samples contained between 10 and nearly 100 taxa with abundances from 10 to 1,100 individuals per sample. Relative abundances in St. Joseph Sound were frequently higher than those observed in both Clearwater Harbor North and South and the lowest abundances tended to occur in Clearwater Harbor South.

The limited availability of data for the CHSJS Estuary precludes establishing quantitative goals or targets for either benthic community integrity or sediment quality. Therefore, the proposed goals for benthic community integrity or sediment quality were to minimize the extent of contaminated and/or hypoxic benthic sediments; to develop a benthic sampling program designed to provide a baseline characterization of sediment quality and the benthic invertebrate community, and to establish sediment quality targets, similar to those developed for the Tampa Bay estuary, that maintain the sediment quality necessary for a diverse benthic community.

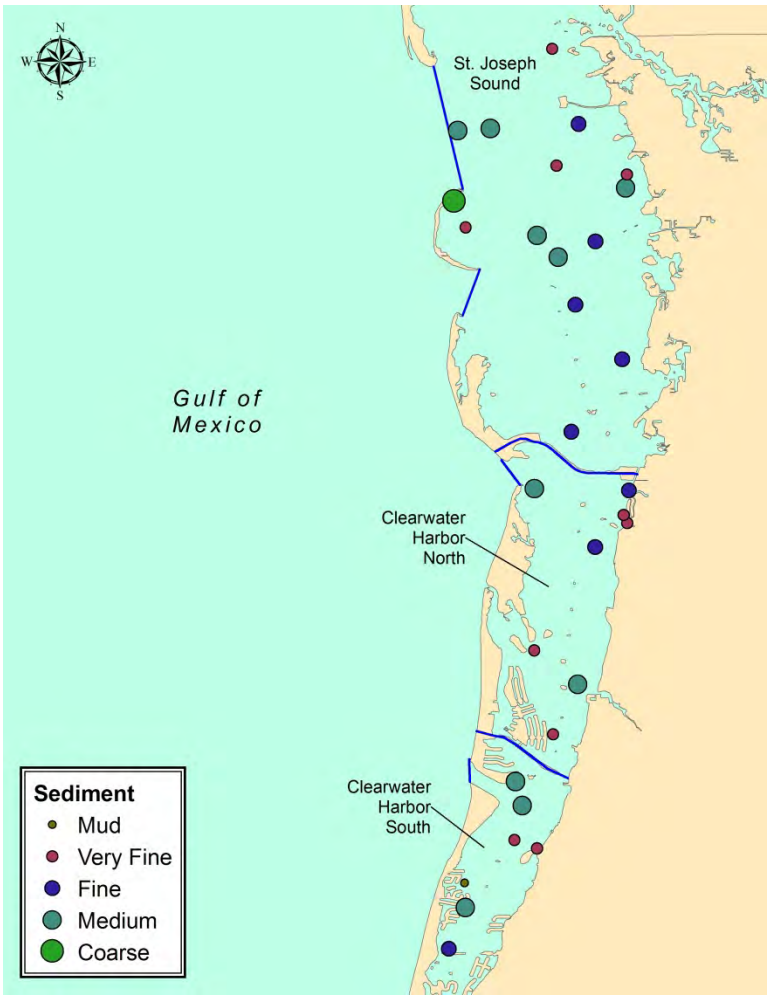

Figure 7. Distribution of sediment grain size from benthic samples collected in September 2009.

Fishes

The CHSJS Estuary supports a diverse assemblage of fishes and invertebrates occupying a mosaic of seagrass, mangrove and hard bottom habitats. The close proximity of the Gulf of Mexico to the west and a significant freshwater source, the Anclote River, to the east contribute to a dynamic and productive estuarine system. Several large barrier islands, Anclote Key, Three Rooker, Honeymoon and Caladesi Islands, and Sand Key provide a buffer from the Gulf and create calm, shallow waters behind them. Strong tidal currents flow through the passes between these islands scouring the bottom and creating deeper areas through which large fishes, sea turtles and marine mammals move between the Gulf and the estuary. The passes also transport into the estuary, planktonic fish and invertebrate larvae that are spawned offshore and along the beaches. Since the early 1970s, numerous studies have characterized the fish and invertebrate community of the study area including several masters' theses on Anclote River estuarine fish assemblages and more recent surveys by the Florida Wildlife Research Institute (FWRI). Based on these studies as well as other information, stressors to fish populations with the

CHSJS Estuary were identified as: impacts to nursery areas (e.g., prop scarring of seagrasses, mangrove losses); fishing pressure; water quality degradation, red tide events, and cold stress.

The FWRI collects information on fishing pressure using creel surveys. There were 3 different types of anglers recorded in this data; charter anglers, private boat anglers, and shore anglers. Clearwater Municipal Marina experienced the highest amount of charter boat pressure while private vessel anglers exhibited greater pressure at sites within St. Joseph Sound, and Clearwater Harbor. Areas that experienced a higher than average number of shore anglers were near, or on, passes or channels and also at the Clearwater Pier/Big Pier 60.

FWRI's Molluscan Fisheries Program has monitored the status of the Bay Scallop population in St. Joseph Sound since 1994 and has tracked recruitment by scallop spat since 1997. From 1994-2006, adult scallop abundances ranged from 0.2 to 47.4 scallops per $600m^2$, but from 2007-2009 abundances more than tripled to 138-174 scallops per $600m^2$ (Stephenson and Geiger, 2010). Scallop population restoration efforts involving the rearing and release of scallop spat collected between 1999 and 2006 may have contributed to the increased scallop abundance observed in more recent years.

The limited availability of fisheries data for the CHSJS Estuary precludes establishing quantitative targets. However, the proposed goals for the preservation and protection of fish stocks include: maintaining the current extent of seagrasses and shoreline habitat (i.e., fisheries habitat) in the estuary; leveraging existing fish research efforts to provide a more quantitative estimate of the relative abundance of fishes over various habitat types within the study area; encourage participation in existing creel surveys to obtain accurate information on angler pressure; facilitating research into the utilization of the estuarine segments by the bay scallop, and public education to reduce anthropogenic stressors on fish habitat such as prop scarring.

Megafauna

Bottlenose dolphins, Florida manatees, and five species of sea turtles utilize the CHSJS area; all of which are federally protected under the Endangered Species Act. These species are often referred to as "charismatic megafauna" due to their large size and common appeal among humans which tends to invoke a connection with nature and the marine environment. As a result of this connection, these species have been successfully used to promote public awareness and conservation of coastal resources. While there are limited data available for analysis, a characterization of the ecology of these species, natural and anthropogenic stressors and management issues is an important part of the CCMP. Much of the existing information on marine mammals and sea turtles in the CHSJS system comes from research programs at the Florida Fish and Wildlife Conservation Commission (FWC), Mote Marine Laboratory, and the National Marine Fisheries Service (NMFS), though collaborative efforts between these and various other agencies have provided information as well. Florida has state-wide programs exist to monitor and assess the status of marine mammal and sea turtle populations and to conduct research on the biology and ecology of these species. This information is useful for the management of these natural resources and can be applied to populations that use the estuarine and coastal habitats of Clearwater Harbor and St. Joseph Sound.

The Florida manatee, *Trichechus manatus latirostris*, is another common marine mammal species found in the shallow, coastal waters of Clearwater Harbor and St. Joseph Sound. Manatee are especially abundant near warm waters at power plants and springs during the winter.

Sea turtles utilize the western shorelines of the barrier islands as nesting sites and deposit eggs above the high tide line, westward of the primary dunes. Sea turtles have high site fidelity, returning to the same beaches year after year to nest and the barrier islands associated with the project area have management plans aimed at protecting the nesting sea turtles and their eggs from harm. Three species, the green (*Chelonia mydas*), loggerhead (*Caretta caretta*) and leatherback sea turtle (*Dermochelys coriacea*) use the beaches to nest; however, loggerhead sea turtles are the most common species utilizing the barrier islands of the CHSJS.

Management goals for these species should focus on the protection of the habitat, including water quality, seagrass, and shorelines and sustainable fish populations for bottlenose dolphins. Public education regarding the human interactions with these animals among the boating and fishing community will continue to be an important part of the management strategy for these species and should be emphasized in the future. Facilitating future research into causes of sea turtles and manatee strandings, protecting crucial habitats within the estuaries, and continued monitoring are recommended.

Birds

A unique assemblage of colonial waterbirds (pelicans, wading birds, gulls, terns, and skimmers) and shorebirds use the Clearwater Harbor and St. Joseph Sound (CHSJS) region of peninsular Florida. Located on the Atlantic Flyway, these waterways, beaches, and shorelines are extremely important stopover and over-wintering sites for birds that nest further north, some as far as the Arctic tundra, but retreat south in the winter to find their fish, shellfish, insect, and invertebrate prey. At least twenty-five bird species, including several taxonomic groups of colonial waterbirds and territorial birds (oystercatchers, plovers, and willets), breed in CHSJS coastal habitats (Table 5-21). Eleven of these species are federally or state-listed as "endangered", "threatened", or as "species of special concern" and many birds that occur in the region are listed on non-regulatory management lists. In 2009, 5,331 pairs (all species combined) nested on islands in the system. This count did not include colonies of Least Terns and Black Skimmers that nested on scattered beaches and rooftops in this region of Pinellas County. Because of the species richness and abundance of the region's avifauna, BirdLife International and the National Audubon Society Audubon of Florida have recognized the CHSJS area as highly valuable for its avifauna by inclusion of two of its regions, "Clearwater Harbor-St. Joseph Sound" and the "Gulf Islands GEOPark", in the Important Bird Areas (IBAs) of Florida.

Additionally, thousands of ducks, hundreds of Common Loons and grebes, and thousands of shorebirds also use CHSJS waters and shores as overwintering habitats. A small group of songbird species nest uniquely in the CHSJS mangroves, coastal hammocks, and shorelines, while many others over-winter here or stop during their fall and spring migrations. Several raptor species (Bald Eagles, Osprey, owls), commonly called "birds of prey", nest regionally, while others follow migrating flocks of shorebirds and ducks seasonally.

Bird habitats in CHSJS include forested areas (patches of mangroves, coastal hammocks, or pine flatwoods remaining on barrier islands, some natural mangrove islands, and mangroves and coastal

hammock communities on some islands created when the Intracoastal Waterway (ICW) was dredged); beaches on barrier islands and dredged spoil material islands; and coastal marshes. The dominant types of nesting habitats within the CHSJS study area include arboreal (tree), beach, and coastal marshes. Many species of colonial waterbirds use arboreal habitats for nesting including: Brown Pelican, Double-crested Cormorant, the herons and egrets, White Ibis, and Roseate Spoonbill. Colonies of birds nesting in trees generally occur only on small islands that have no resident mammalian predators and are off-shore, separated by open water and deep channels with tidal currents that discourage mammals from swimming to them. Colonial waterbirds will not nest on islands if mammalian predators are present. Three of the larger barrier islands (Honeymoon Island, Caladesi Island, and the northern section of Clearwater Beach) still have relatively undisturbed mangrove forests, coastal hammock communities, salt marshes, beaches, and pine flatwoods. Conversely, most of Clearwater Beach and Sand Key are highly developed and the beach-front communities of condominiums, hotels, and residences on Clearwater Beach, Belleair Shores, Belleair Beach, and Indian Rocks Beach have displaced most native vegetation and shallow water shorelines.

Management and conservation activities conducted by Audubon's Florida's Coastal Islands Sanctuaries (FCIS) program, the Florida Park Service, Florida Department of Environmental Protection Pinellas Aquatic Preserves, Pinellas County, and the cities of Clearwater, Belleair Beach, and Indian Rocks Beach, other cooperating agencies, and regional volunteers (Tampa Bay Regional Planning Council's Agency on Bay Management, Clearwater Audubon Society, Suncoast Chapter of the Florida Native Plant Society, Keep Pinellas Beautiful, and boating groups, among others) are addressing some management needs but more work needs to be undertaken.

The following actions which should be continued or added to on-going activities for the protection of the birds of the CHSJS Estuary include population estimation, colony protection, public education, predator control, cooperation among law enforcement agencies, habitat management, taking measures for climate change, fishing line accumulation, coordination with public agencies, and protecting nesting islands from erosion.

The information contained in this State of the Resource report includes a comprehensive summary of the key natural resource elements that will be used to guide development of a Comprehensive Conservation and Management Plan for Clearwater Harbor and St. Joseph Sound. The CCMP document will establish a process for achieving the goals and objectives developed from the analysis presented in the State of the Resource report and outline specific management actions to conserve, protect and monitor the ecological integrity of this incredible environmental asset that is Clearwater Harbor and St. Joseph Sound.