CONSERVANCY of Southwest Florida

OUR WATER, LAND, WILDLIFE, FUTURE.

Estuaries REPORT Card

A guide to understanding the health of Southwest Florida's rivers, estuaries and bays

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2 List of Common Acronyms

EBABM – Estero Bay Agency on Bay Management

BMAP – Basin Management Action Plan

BMP – Best Management Practices

cfs – cubic feet per second

CHNEP – Charlotte Harbor National Estuary Program

CERP – Comprehensive Everglades Restoration Project

CREW – Corkscrew Regional Ecosystem Watershed

CWA – Clean Water Act

EPA – Environmental Protection Agency

ERC – Estuaries Report Card

FDEP – Florida Department of Environmental Protection

FLUCCS – Florida Land Use and Cover Classification System

FNAI – Florida Natural Areas Inventory

FWC – Florida Fish and Wildlife Conservation Commission

FWS- US Fish and Wildlife Service

GGE – Golden Gate Estates

HABs - Harmful Algal Blooms

ICW – Intracoastal Waterway

IWR – Impaired Waters Rule

MFLs – Minimum Flows and Levels

NERR – National Estuarine Research Reserve

OFW – Outstanding Florida Water

SAV – Submerged Aquatic Vegetation

SFWMD – South Florida Water Management District

STORET – derived from STOrage and RETreival- a water quality database administered by the Environmental Protection Agency

SWFCWP – Southwest Florida Comprehensive Watershed Plan (formerly referred to as Southwest Florida Feasibility Study)

SWIM – Surface Water Improvement and Management

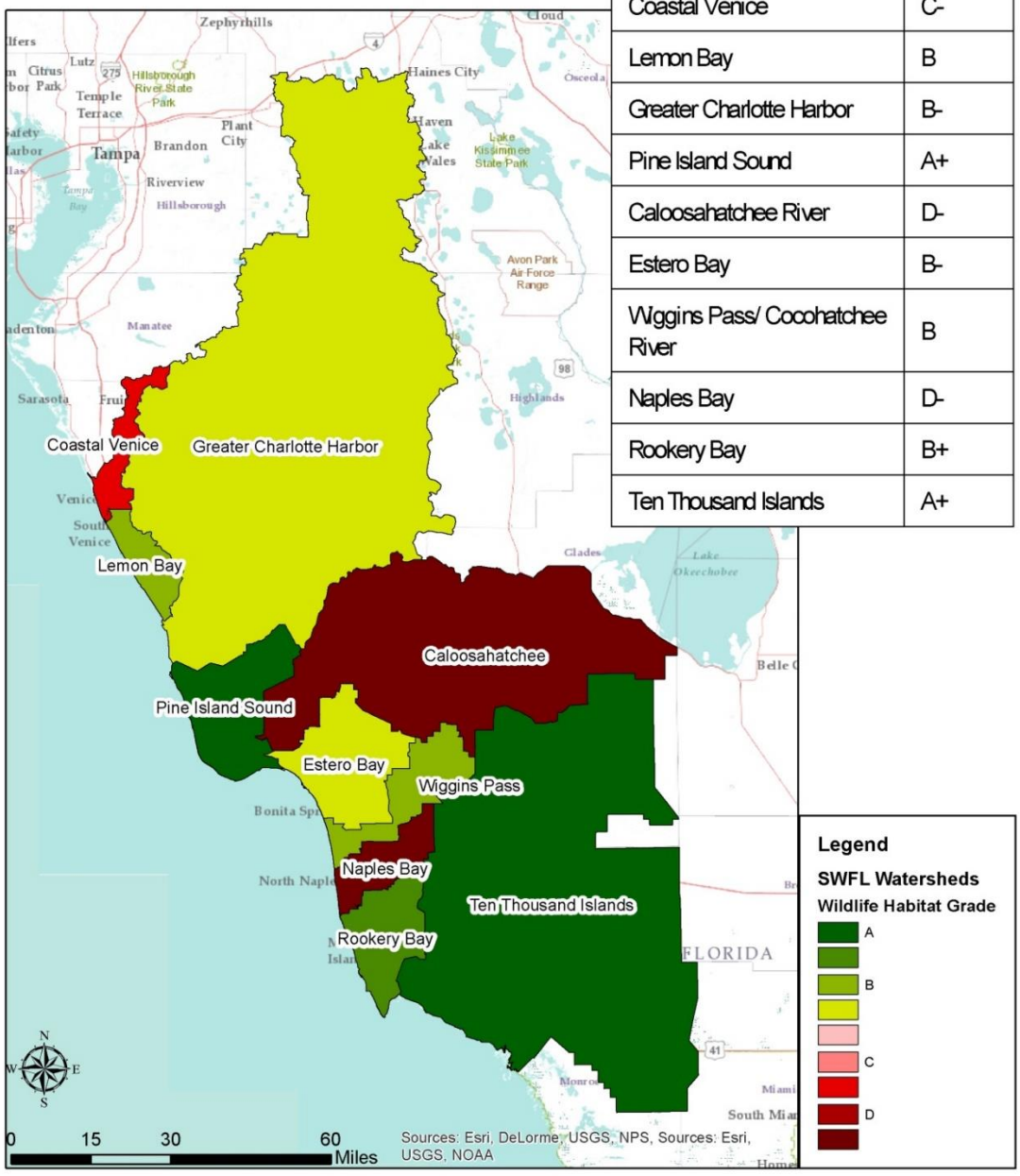
SWFWMD – Southwest Florida Water Management District

TMDL – Total Maximum Daily Load

USACE – US Army Corps of Engineers

WBID – Waterbody Identification Number

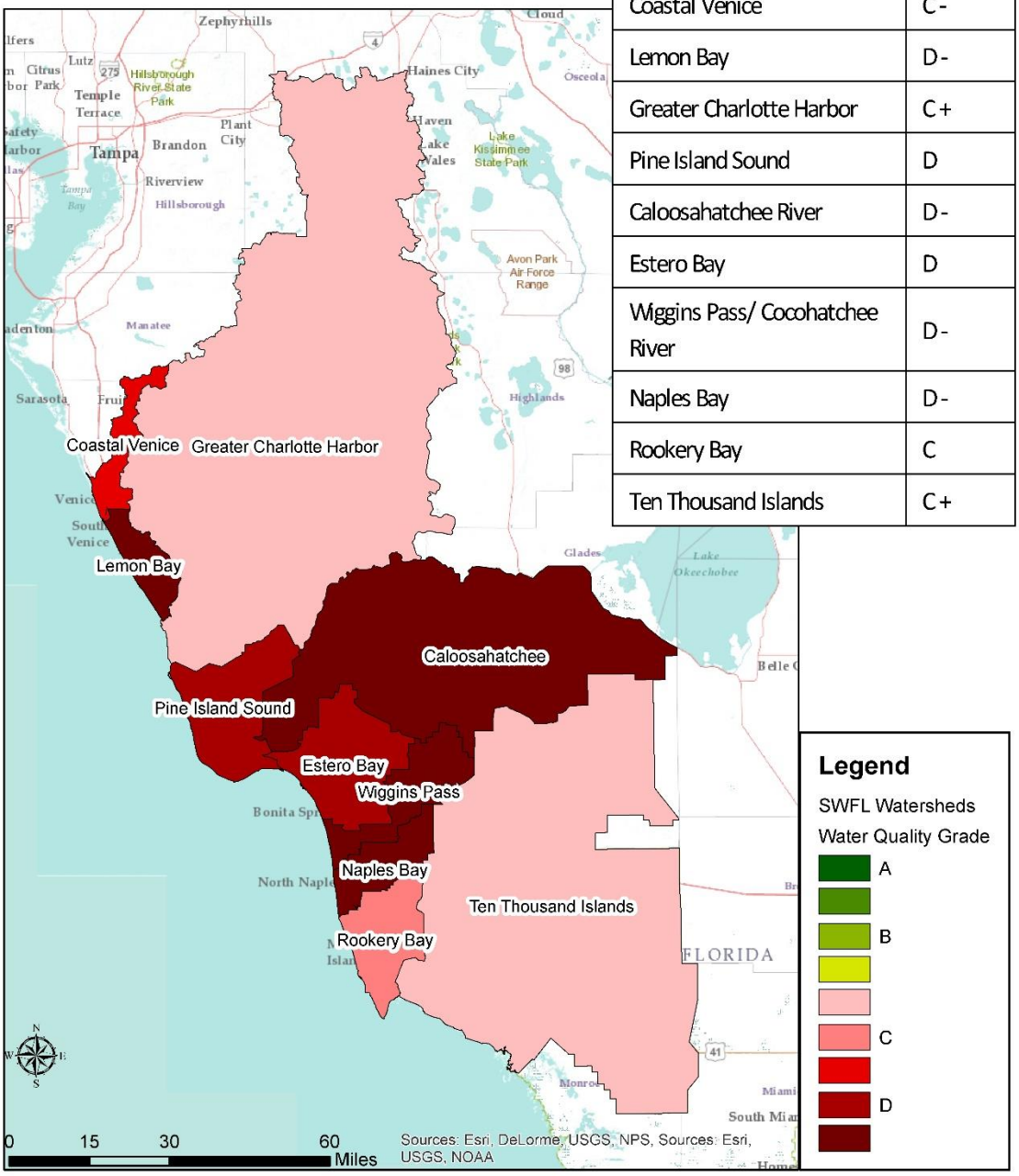
3 Grade Summary



Watershed	Wildlife Habitat Grade
Coastal Venice	C-
Lemon Bay	B
Greater Charlotte Harbor	B-
Pine Island Sound	A+
Caloosahatchee River	D-
Estero Bay	B-
Wiggins Pass/ Cocohatchee River	B
Naples Bay	D-
Rookery Bay	B+
Ten Thousand Islands	A+

Water Quality

Watershed	Water Quality Grade
Coastal Venice	C-
Lemon Bay	D-
Greater Charlotte Harbor	C+
Pine Island Sound	D
Caloosahatchee River	D-
Estero Bay	D
Wiggins Pass/ Cocohatchee River	D-
Naples Bay	D-
Rookery Bay	C
Ten Thousand Islands	C+



4 REPORT CARD

4.1 Background

Southwest Florida is home to some of the most unique habitats and natural resources in America, making it a top destination for ecotourism, scientific research, and recreational enjoyment. The Gulf coast is also host to some of the most productive estuaries, and more than 70 percent of Florida's recreationally and commercially important fishes, crustaceans, and shellfish rely on this area where freshwater meets salt water.[1] A mosaic of mangroves, freshwater marshes, saltwater marshes, rivers, and streams intertwine with canals, coastal development, agriculture and other human-influenced environments to create an interrelated and challenging system to manage and preserve. Each estuary in southwest Florida lies downstream of a larger watershed that encompasses freshwater lakes, streams, rivers, canals, wetlands, and sloughs. For this reason, it is vital to examine the entire watershed to identity the factors impacting the estuary.

The beauty and productivity of Florida's coastal ecosystems are also driving forces in the state's economic growth. The recreational saltwater fishing industry contributes over 109,000 jobs and over $7.6 billion to the state economy, while the commercial fishing industry is the second largest in the nation, generating $12 million in in-state sales.[2] In addition, Florida's beaches have a $50 billion recreational value, and tourism is the #1 job provider in the state.[3] With these values, it is no wonder that more and more emphasis is being placed on conserving, protecting, and restoring our estuaries for future generations.

The importance of estuarine and watershed health is ever more pressing as Florida continues to experience the booming population growth and associated development seen over the past several decades. Thirty-five of Florida's counties border the Atlantic Ocean or Gulf of Mexico, and approximately 75% of Florida's population lived along the coast in 2016.[4] The population along the coast increased by approximately 977,000 residents between 2010 and 2016, with Lee County as one of the top five counties with the largest influx of residents.[4] The trend is likely to continue, as current models project a 37% increase in the state's population by 2045.[5]

In order to accommodate new residents, more infrastructure is being built along the coast, including developments and roads, often at the expense of the environment. Destruction of filtering wetlands, increases in impervious surfaces and stormwater runoff, addition of upstream pollution sources, failing septic systems, continued disturbance of hydrology, and many other factors can influence the health of estuaries and place the natural resources Floridian's depend on at risk.

In Florida, 2016 was a crisis year for water. January 2016 was the wettest January on record for a number of areas in the state,[6] triggering a ripple effect with impacts felt across southwest Florida. The unseasonal rainfall resulted in damaging discharges of freshwater to the Caloosahatchee and St. Lucie estuaries, and algae blooms that lasted for months. Four Florida counties, including Lee County on the west coast were under a state of emergency for 242 days as a result of the algae blooms and discharges. The disaster focused public attention on the fragile nature of the region's coastal ecosystems and the economies that depend on pristine beaches, fisheries, and clean water. The Estuaries Report Card is a

policy tool to continue highlighting these types of critical issues for the region's waterways and to explore what the public and policy-makers can do to help address southwest Florida's water challenges.

The Conservancy of Southwest Florida is committed to protecting and conserving the natural environment of the region, and one of our core goals is to prevent further degradation of our estuaries, nearshore marine waters, bays, rivers and freshwater resources. To achieve this goal, a three-pronged approach is used through strategic policy and advocacy, scientific research, and action-oriented public education. To create a sustained public resolve to protect and restore our estuaries, it is imperative that the public have access to information on the health of local estuaries to better understand the function and condition of estuarine watersheds and the associated challenges for management and restoration.

For this purpose, the Conservancy created the Estuaries Report Card as a method to summarize the best available information about the health of the region's estuaries. The Report Card compiles information from many sources, using consistent indicators of estuarine health, and converts this information into grades that represent southwest Florida's estuarine health.

The 2017 Report Card utilizes the original four indicators from the 2005 Report – extent of wetlands, conservation lands, water quality assessment data and hydrology information – and also includes the 2011 addition of mangrove coverage and the 2017 addition of impervious surface cover. The 2017 Report Card is most applicable as a representation of wildlife habitat and water quality status. Some conclusions can be drawn through comparisons to the prior Reports; however, variables such as changes in watershed boundaries and the availability of data prevent specific trend analyses or direct comparison.

Providing southwest Florida's public and decision-makers periodic snapshots on the environmental health of the region will hopefully lead to further grassroots and governmental initiatives to protect southwest Florida's estuaries and other exceptional natural resources for future generations.

4.2 Indicators of Estuarine Health

The general indicators of estuarine health fit into three categories: (1) wildlife habitat, (2) water quality, and (3) species abundance and diversity (indicator species). Many of the indicators are directly or indirectly connected with water quality, which in turn influences habitat and/or species abundance and diversity. Alternately, some species (such as oysters) can affect both water quality and habitat. Ultimately, the selection of indicators for an assessment of current estuarine health depends on access to data representative of baseline or optimum conditions and the existence of current comprehensive data on existing conditions throughout the region in order to characterize Florida's environment before and after human (anthropogenic) influence.

The wildlife habitat grade for this Report Card uses three categories: (1) extent of wetlands remaining, (2) extent of mangroves remaining, and (3) extent of conservation lands. The water quality grade was determined by combining the scores for water pollution, hydrologic alteration, and extent of impervious surface.

Table 4.2-a Final Indicators Used in 2017 Report Card

Wildlife Habitat	Water Quality
Extent of Wetlands Remaining	Water Pollution
Extent of Mangroves Remaining	Hydrology
Extent of Conservation Lands	Extent of Impervious Surface

The Conservancy also reviewed indicators used by the Charlotte Harbor National Estuary Program (CHNEP), the Estero Bay Agency for Bay Management (EBABM), and other estuary program reports to compile a list of potential estuarine health indicators (Appendix E).

However, information does not exist for all of the potential indicators. For example, although current estimates for seagrass coverage are available, there is no baseline (historic) data for estuaries outside the CHNEP region. Therefore, indicators used for the 2017 Report Card were selected both for dependability as indicators of estuarine health and based on availability of data across the entire study area.

The following is a summary of each indicator and its relevance in representing estuarine health.

Wildlife Habitat

A healthy ecosystem provides habitat for numerous animal and plant species. Coastal wetlands, mangrove forests, oyster reefs, and seagrass meadows provide homes for many important species and may continue to provide habitat even after the organisms, such as oysters, that created the habitat are no longer alive. Wildlife habitat loss is a major contributing factor to population decline among coastal

species. As habitats disappear, organisms depending on the habitat are also lost. CHNEP's Management Plan identified fish and wildlife habitat loss as one of four "priority problems" for the region.[7]

The habitat indicators discussed below are critical for many species of crabs, fishes, and sea birds, as well as for smaller organisms that provide food for these larger creatures.

Extent of Wetlands Remaining

Wetlands are "areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season."[8] Wetlands have hydric soils and a unique vegetation community adapted to the particular nutrient cycling and hydrologic characteristics of wetlands.[8] Wetland plant species can consist of a combination of grasses and rushes, brackish or salt water species of red, black, and white mangroves, or typical freshwater marsh plants such as pickerel weed, cattail, and marsh grasses.[9]

Wetlands are important for improving coastal water quality by filtering stormwater runoff and removing contaminants and sediments.[10] Wetlands also play a critical role in regulating the flow of water into a watershed. Excavation of drainage canals and the addition of impervious surfaces short-circuits surface water flow upstream and moves it rapidly down the coastal water basin, while passage of water through natural wetlands extends the purification process. This ensures the delivery of freshwater to the estuary at natural rates and volumes. During times of high precipitation, wetlands may also act as storage for floodwater, reducing the rate of runoff and replenishing groundwater.[10] One acre of wetland can store over a million gallons of floodwater.[11]

In addition, wetlands provide habitat for a variety of coastal birds, mammals, and fisheries species. Wetland loss and degradation reduce the amount of habitat available to support healthy populations of wildlife and marine organisms and decrease the natural ability of the land to deal with seasonal flooding.[12] The extent of wetlands remaining is an indicator of estuarine health and is typically determined by evaluating the extent of current wetlands relative to their historic coverage.

Extent of Mangroves Remaining

Mangrove forests are important to coastal environments for several reasons. First, mangrove leaf litter, trunks, branches, and seeds add organic material to coastal waters, providing the basis of an elaborate food chain. Second, mangroves provide habitat, breeding grounds, and nursery areas to over 1,300 marine and terrestrial animals, such as birds, mammals, crustaceans, and fishes.[13,14] Third, mangroves

act as an effective buffer against storms, disperse wave energy, inhibit erosion, and absorb floodwaters.[15]

Mangroves have also been proposed as a means to monitor change in coastal environments by acting as indicators of climate change, storm effects, sea level change, pollution, and changes in sedimentation. Mangroves are sensitive to oil and air pollution, as well as to alterations in the frequency of marine or freshwater inundation.[16] Therefore, the extent of mangroves remaining is another indicator of estuarine health, evaluated by comparing the current coverage of mangroves in each estuary to the historic extent of mangrove coverage. Growth rates and seedling health may also be important aspects to consider; however, these indicators were not included in the analysis due to inadequate data across the region.

Extent of Conservation Lands

With the rapid development of coastal watersheds in southwest Florida, pavement and lawns are rapidly replacing wetlands and other natural areas. The most effective way to preserve the ecological value and function of wetlands and natural areas is by permanent conservation, either through public ownership or conservation easements. Conservation lands are critical to the protection of estuaries and coastal watersheds. Conversely, development can reduce the capability of the land to store and regulate the release of rainwater from the watershed and to cleanse it of particulates, nutrients, and contaminants. Covering the land with impervious surfaces and installing drainage systems create an imbalance in the timing and delivery of surface water. These activities also prevent the recharge of groundwater and adversely impact water clarity and quality.[17]

Florida Forever is the state's current conservation land acquisition program, and many Florida Forever projects are located within Report Card watersheds. Local conservation land acquisition programs exist in Sarasota, Charlotte, Lee and Collier Counties. Private land trusts and non-profits also participate in fee simple acquisitions or in purchasing conservation easements.

Unfortunately, starting in 2009, funding for Florida Forever was significantly reduced from $300 million annually to less than $20 million annually. In response, a coalition of environmental groups, spearheaded by the Florida's Water and Land Legacy campaign, successfully gathered enough signatures to place a constitutional amendment (Amendment 1) on the 2014 ballot to dedicate 33% of existing real estate documentary stamp taxes to land and water protection. Amendment 1 passed by an overwhelming 75%.[18] In 2017, $0 was allocated by the legislature for Florida Forever. Efforts are underway to ensure that the legislature allocates the collected funds as directed by the amendment language. A bill was passed by the Florida legislature in 2016 that will dedicate 25% or $200 million (whichever is less) of Amendment 1 dollars to Everglades restoration projects, with priority given to projects which reduce harmful discharges to the St. Lucie and Caloosahatchee estuaries.

Local conservation land acquisition programs have also experienced reduced acquisition activity over the past several years, either through sunset of bonded funding or through increased political pressure. Conservation Charlotte has run out of funding for acquisitions and has transitioned to management mode. Conservation Collier also transitioned to a management focused program between 2011 and 2013, although the program still considered bargain sales and donations. In January 2017, the Board of County Commissioner's voted to reinitiate the acquisition component of the program, and new property nominations are now being evaluated. Sarasota and Lee County programs remain well funded. Lee County's Conservation 20/20 program's continuation was on the 2016 general election ballot and passed with an overwhelming 84% of the vote.[19] The Conservancy of Southwest Florida, along with other groups and individuals, spearheaded the Yes On Conservation 20/20 campaign to support the continuation of the program. The resounding vote of confidence by Lee County citizens demonstrates that southwest Floridians place a high value on the conservation of environmentally-sensitive lands and the protection of water resources and wildlife habitat.

Moving forward, highlighting the economic benefits derived from natural landscapes to the public and decision-makers, and emphasizing why it is vital to support and revitalize public land acquisition programs for continued environmental and economic sustainability, remains critical. A number of studies have showcased the many ecosystem services and economic benefits provided by natural landscapes.

Extent of conservation lands is a useful indicator of estuarine watershed health that can be evaluated by comparing the extent of protected or conserved areas to the total land area.

Water Quality

Water Pollution

The health of estuarine systems largely depends upon water quality. Coastal water quality is affected by both natural and anthropogenic factors, such as rainfall, tidal action, coastal development and alterations in water flow patterns. Changes in these factors may lead to detrimental impacts including extreme fluctuations in salinity, increases in harmful bacteria or other pollution, and hypoxia (not enough oxygen in the water). These situations severely compromise estuarine health, which in turn endangers coastal species such as seagrasses, manatees, and even humans that rely on the water.[20] The following are important water quality criteria grouped into six major parameter categories and used as indicators of estuarine health in southwest Florida. The list of specific water quality standards used by FDEP to assess these parameters can be found in Appendix 7.1.

1) Nutrients:

Total Nitrogen and Total Phosphorous

Nutrients that have been dissolved in the water, such as nitrogen compounds (nitrites, nitrates, and ammonia) and phosphorus, provide nourishment to plants. A continuous biochemical storage-release-cycling system supplies these nutrients to the ecosystem. Without these sources of nutrient replacement, the ecosystem would gradually become impoverished; however, high loads of these compounds (eutrophication) may throw off estuarine balance and cause unnaturally large algal blooms or other adverse ecological effects.[21, 22]

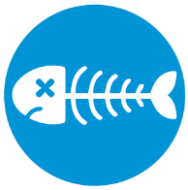
Eutrophication is a natural process associated with some lakes and estuaries, but human activities can also trigger or greatly accelerate eutrophication by increasing the rate at which nutrients and organic substances enter aquatic ecosystems from the surrounding watersheds. Agricultural runoff, urban runoff, leaking septic systems, sewage discharges, and eroded stream banks can all increase the flow of nutrients and organic substances into aquatic systems. When high nutrient concentrations stimulate algal blooms, the water may be affected in two ways. First, algal blooms can decrease light penetration, negatively impacting Submerged Aquatic Vegetation (SAV) such as seagrasses and resulting in the loss of the food and shelter for many estuarine species. Second, the amount of dissolved oxygen can be severely depleted during the decomposition of the algae.[21] In some cases, such as that of red tide or blue-green algae blooms with microcystins, algal blooms may even cause direct toxicity to other organisms (as discussed in further detail in Appendix 8.3).

Numeric nutrient standards were recently adopted by Florida as new water quality standards. However, the water quality assessment information used in this Report Card was evaluated under the prior narrative nutrient standard that included response parameters such as Chlorophyll-a (chl-a) and Tropic State Index (TSI) to determine attainment.

Chlorophyll-a allows plants to convert sunlight into energy and is used to measure the amount of algae biomass in a waterbody. Since algal blooms are associated with nutrient excess, chl-a is used as an indicator for nutrient impairment.[23]

Trophic State Index is a classification system of biological productivity on a rating scale of 1 to 100 and is derived from Total Nitrogen, Total Phosphorus, and chl-a measurements. It is usually measured in lakes. Lakes with a TSI of less than 30 lack in nutrients and biological productivity, while TSI values greater than 70 usually indicate an overabundance of nutrients that can harm wildlife.[24]

Unionized Ammonia was also included in the nutrient parameter category since ammonia is a nitrogen waste released by aquatic animals, affecting the nutrient cycle.



2) **Oxygen Depletion:**

Biological Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen used by microorganisms to assimilate organic wastes. BOD is the most commonly used parameter for determining the oxygen demand on the receiving water of a municipal or industrial discharge. The greater the BOD, the more rapidly oxygen is being depleted.[25]

The rate of oxygen consumption in an estuary is affected by a number of factors, including temperature, the presence of certain kinds of microorganisms, and the types of organic and inorganic material in the water. A high BOD indicates a large presence of organic matter in the water. Increases in organic matter may be caused by natural sources, such as leaf litter, or by anthropogenic sources. Major anthropogenic sources contributing to high levels of BOD in this region are wastewater treatment facilities, septic tanks, and agricultural and urban runoff.[25]

Dissolved Oxygen Concentration (DO) is an important indicator of estuarine health because fish, shellfish and other marine animals are negatively affected by anoxia (no oxygen) and hypoxia (very low oxygen). DO is the measure of the amount of gaseous oxygen dissolved in the water column. Oxygen is dissolved into water from the atmosphere and is a product of photosynthesis.

Reduction in DO may result from natural processes and/or human pollution. Human sources of nutrients can lead to low DO because the nutrients stimulate algal growth; when the algae die, oxygen is required by the bacteria responsible for decomposing the dead algae. Current and accurate data on concentrations of DO in water are essential for documenting changes to the environment caused by natural phenomena and human activities. Time of day and long-term information on the condition of the system is important as well, due to fluctuations in DO levels based on temperature, salinity, and available light. [25]

3) **Pathogens (e.g., Bacteria, Protozoans):**

Pathogens act as infectious agents of disease, spreading illnesses such as cholera, salmonella, typhoid fever, and dysentery. High levels of pathogenic organisms in the water column are a human health concern. Coliform bacteria “are a collection of relatively harmless

microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals."[26, 27] They originate from soils, plants, and human and animal wastes. Fecal coliform bacteria (including *Escherichia coli*), a subgroup of total coliforms, generally do not pose a danger to people or animals, but they may indicate the presence of other disease-causing bacteria such as those causing typhoid, dysentery, hepatitis A, and cholera. Stormwater runoff and leaching from septic systems and animal feedlots are common sources of fecal contamination.[27]

Bacterial contamination in shellfish, primarily fecal coliform, can pose a problem for human health if contaminated shellfish are consumed. Sources of contamination include sewage treatment plants, on-site sewage systems, farm animals, boater waste, pets, and wildlife.[21] The Florida Department of Health (FDOH) monitors contamination levels in shellfish harvesting areas and determines whether the areas should be open, closed, or restricted to harvesting. Currently, the FDEP determination for impairment is based on a degradation of harvesting status as opposed to the current harvesting status. This means that some areas with prohibited harvesting status are not listed as impaired due to their consistent status as prohibited; this also means that some conditional status locations are impaired, having been downgraded from permitted to conditional during the monitoring period.[28, 29]

4) **Metals/Toxins:**

The levels of contaminants and toxins have increased in estuaries as a result of industrial activities and discharges, spurred by industrialization in the 1940s and 1950s. These contaminants include pesticides, fungicides, herbicides, oils, greases, and heavy metals such as copper, mercury, and zinc. Toxins are introduced to estuaries through industrial discharges; runoff from lawns, streets, and agriculture; urban development; and boating. In addition, the estuary's own sediment may serve as a source of contaminants due to the buildup of toxic compounds deposited over the years.[30]

Monitoring for the presence of toxins can provide information about possible effects on estuarine community structure. Toxins in an estuary can directly affect even top predators through the process of bioaccumulation and biomagnification, whereby the concentrations of toxins accumulate in the flesh and increase every level up the food chain.[30] Because there are limited water quality standards and sampling for toxins other than metals in southwest Florida, metals were the only parameters included in the analysis of this category.

Waters containing high concentrations of metals may become toxic, adversely affecting drinking water and disrupting growth and reproduction of aquatic organisms. Heavy metals like mercury and lead may enter an estuary through rain or as dry particulate matter and then build up in

sediment and, when absorbed by plants, can enter the food chain. For some metals, long-term exposure in even relatively small concentrations may lead to serious health effects.[21] The metals focused on for this Report Card are cadmium, copper, iron, lead, and mercury.

Cadmium may be airborne or carried by water and has many sources. Incineration of rubber and some plastics, plating from old cars and airplanes, some fungicides, and galvanized pipes, roofs, and cisterns are all potential sources of cadmium contamination.[31] In humans, cadmium can lead to flu-like symptoms and lung damage. Trace levels of cadmium ingested over a long period of time can result in kidney damage, fragile bones, lung disease, and cancer.[32] Cadmium also stunts growth and causes a variety of internal damages to wildlife, and can be lethal if the concentration is high enough.[33]

Copper may be released into waterways due to its common use as an algaecide/pesticide or from tar on rooftops. In humans, copper is predominantly toxic in infants or adults with specific metabolic disorders. Less severe implications are unpleasant odor and taste associated with contaminated waters. Copper can also be toxic for aquatic life at high enough concentrations.[34] Uptake of this metal is also related to cadmium presence.[34]

Iron, although an essential nutrient and detoxifying agent in small concentrations, can form precipitates on fish gills and other body parts in high concentrations, inhibiting their function or smothering them. Iron has also been found to degenerate cells and decrease light penetration into the water.[34] This metal occurs naturally in groundwater, but can also be present in wastewater and stormwater, due to corrosion, and in fertilizer.[35]

Lead accumulates in the body and affects the central nervous system, with pregnant women and children most at risk.[36] Symptoms may be flu-like, and continued exposure may cause kidney, nerve, and brain damage. Lead poisoning can also occur in wildlife, resulting in damage to the nervous, immune, and reproductive systems, and can lead to paralysis and death.[37] Although small levels occur naturally, industry, pipes, fittings, and the service connections of some household plumbing systems are common sources.[34]

Mercury is an airborne pollutant released by incineration and fossil fuel combustion that is converted to methyl mercury when it reaches the water. High concentrations may cause neurological problems and death in wildlife and humans. Even after emissions have stopped, sediments in polluted waters may continue to pose a threat. In addition, accumulation in fish tissue can be dangerous to those who eat fish.[38]

5) Physical Parameters:

Physical parameters can provide valuable data in relation to water quality and estuarine health and can include pH (waterbody acidity or alkalinity), salinity (salt content), and concentrations of dissolved or suspended substances. They can also be used to determine the source of impairment; for example, constant high turbidity can indicate that excessive amounts of stormwater are entering a receiving water body. [39]

pH is a measure of acidity or alkalinity of water on a log scale from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral and most estuarine organisms prefer a pH in the range of 7.0-8.5, neutral to slightly alkaline. pH is generally relatively stable in estuarine and marine waters because of carbonate buffering. However, significant changes in pH may occur due to disturbance of acid sulfate soils from mine drainage or chemical pollution. An altered pH that is higher or lower than normally found in estuaries can cause tissue damage to aquatic organisms, leading to death. Changes in pH can also affect the availability of metals and the solubility of calcium carbonate, an important component of shell-forming organisms. Changes in pH of more than 0.5 units from the seasonal maxima or minima could cause significant harm to organisms inhabiting the estuary.[39] above[39]

Dissolved Solids include a variety of substances that can dissolve in water including salts, metals, and organic compounds. Total dissolved solids is not a measure of water quality per se but an indicator of the presence of other substances and is only measured in Class I potable waters. Elevated total dissolved solids can result in incrustations, films, or precipitates on fixtures; corrosion of fixtures; and reduced efficiency of water filters and equipment. [40]

Salinity/Chloride is the concentration of salts in water. FDEP uses chloride as one of the measures of salinity for watershed assessments. In estuaries, salinity tells us how much freshwater has been mixed with seawater. There is a gradient in salt content that starts with high values in Gulf waters, decreases inward through the estuary, and drops at some distance up the tidal tributaries. Many aquatic organisms function optimally within a narrow range of salinity. Changes in salinity, above or below this range, may weaken organisms and cause them to succumb to biotic pressures such as predation, competition, disease, or parasitism. [41]

Specific Conductance is the measure of the water's ability to carry an electrical current and is used as an indirect measure of salinity. Conductivity is based on the concentration of solids dissolved, mostly salts: the greater the concentration of dissolved solids, the higher the conductivity. Specific conductance is the measure used by FDEP to determine impairment, which is the conductivity normalized to a temperature of 25 °C.[42]

Turbidity/Total Suspended Solids is another important physical pollutant because it reduces water clarity, thereby limiting the amount of sunlight that reaches submerged aquatic vegetation (SAV), such as seagrasses and phytoplankton. Turbid water results from the delivery or resuspension of sediments and other materials caused by natural or anthropogenic activities. Activities that disturb sediments, such as dredging or boat wakes, can increase murkiness and the measured turbidity. Flooding or regulatory releases of water can also increase turbidity, and reduce light penetration. If light penetration is reduced significantly and for a sufficient period of time, plant growth may decrease, thus impacting the organisms dependent upon SAV for food and cover.[43]

As particles of silt, clay, and organic materials settle to the bottom, non-mobile organisms can suffocate and sediment can blanket hard bottom, decreasing its habitat value.

6) **Biology:**

FDEP measures the biological health of waterbodies based on an aquatic community-based evaluation consisting of one of the following procedures: Stream Condition Index (SCI), BioRecon (used only for planning list assessments), Lake Vegetation Index (LVI), or Shannon-Weaver Diversity Index. The state water quality standard is technically for "biological health," although FDEP refers to this parameter in the listing process as biology, and it is based on a pass-fail analysis of the aforementioned procedures. For example, SCI assesses benthic macroinvertebrate health in streams, and LVI assesses aquatic plants (macrophytes) in lakes. [44]

The collection of biology data is generally sparse throughout the region, although FDEP has started prioritizing collection of SCI's for nutrient and dissolved oxygen assessments, for example. Moreover, the Florida Impaired Waters Rule (IWR) requires a causative pollutant in order to list a waterbody as impaired for biology. If a causative pollutant is not identified, then the waterbody is placed in category 4d (Study List).

Waterbodies categorized as 4d's are considered impaired and included on the 303(d) list submitted to EPA. However, 4d's are not prioritized for TMDL development until a causative pollutant is identified per the procedures outlined in 62-303.430. As a result, there are no current TMDLs for biology in the region, and all waterbodies that have failed biological assessments and meet the IWR thresholds for impairment in the Report Card watersheds are listed in category 4d, not category 5. Please see Appendix 7.2 for more details on the IWR, the listing process, and category 4d.

Hydrology

One of the most prominent stressors of an estuarine ecosystem is altered hydrology. Excessive freshwater withdrawals and over-drainage or dramatic increases of freshwater flowing into an estuary are examples of alterations that take place as a result of anthropogenic activities. These hydrological changes can decrease water quality by increasing turbidity and nutrient loading, changing the residence time of water in the estuary, and altering the natural salinity regime.

Restoration of historic hydrology helps return the balance of estuarine systems and their nursery grounds. Reestablishing slower and more natural flow rates reduces the level of suspended particulates, thereby increasing light penetration and photosynthesis. This indicator is evaluated through a measurement of impervious surface cover (ISC) and a qualitative assessment of the hydrologic changes in the estuary watersheds.

Extent of Impervious Surface

The percentage of impervious surface cover (ISC) across an estuary's watershed is a new addition to the Report Card to provide an additional estimate of hydrologic function. Impervious surfaces are any anthropogenic structure including surfaces paved with asphalt or concrete, parking lots, sidewalks, roads, and rooftops that inhibits water from infiltrating the soil.[45] ISC harms the physical, chemical, and, ultimately, the biological quality of streams and estuaries. Because these artificial surfaces prevent water from passing through, they result in higher volumes of stormwater runoff and more frequent and severe peak flow events.[46] The higher discharges worsen water quality by transporting and concentrating pollutants and sediment from urban areas into local and downstream water bodies.[47] Stormwater runoff also alters stream channel morphology and hydraulics and increases surface water temperatures. Studies over time have shown that ISC as low as 5% is associated with declines in macroinvertebrate and fish diversity and density, and that increases in ISC further damage wildlife populations.[48]

4.3 Grading Methodology

This report assesses the health of each estuarine watershed based on two categories: Wildlife Habitat and Water Quality. A Wildlife Habitat grade was assigned based on the averaged percentage of wetlands and mangroves remaining for each watershed. The Wildlife Habitat grade was weighted by the percentage of conservation lands within the same watershed. Water pollution assessment lists were used to calculate the water quality grade for each watershed, and those grades were then weighted based on the watershed's qualitative hydrologic conditions and percentage of ISC.

Wildlife Habitat

Three measures of Wildlife Habitat were used for this Report Card: (1) Extent of Wetlands Remaining, (2) Extent of Mangroves Remaining, and (3) Extent of Conservation Lands. The baseline for the extent of wetlands remaining is the "predevelopment" conditions of each watershed. Wildlife Habitat was graded based on the percentage of remaining wetlands averaged with percentage of mangroves remaining, qualified with a plus (+) or minus (-) derived from the percentage of conservation lands.

In order to calculate the Extent of Wetlands Remaining, the current wetland acreage was divided by the pre-development wetland acreage and multiplied by 100 to obtain a percentage. The percentage of the Extent of Wetlands Remaining was assigned a letter grade according to the following scale. The same method was used for Extent of Mangroves Remaining.

Grade	Percentage
A	80-100%
B	60-79%
C	40-59%
D	20-39%
F	19% or less

The letter grade was assigned a qualifying value based on the percentage of acres within the watershed that are in permanent conservation. The Conservation Lands percentage was assigned a value on a scale of 36% and above (+), no qualifier for 24-35%, and 23% or less (-).

Extent of Wetlands Remaining

The most current estimate of wetlands is calculated using the Florida Land Use and Cover Classification System, commonly known as FLUCCS, published by Florida's Water Management Districts. Because the Report Card area falls within the boundaries of the South Florida Water Management District (SFWMD) and the Southwest Florida Water Management District (SWFWMD), both FLUCCS data layers were used (see Table 4.3-a below for corresponding water management districts and watershed). The most recent FLUCCS shapefile available from the SFWMD at the time this analysis was completed was titled "LU-12", with data representing land use data published in 2012. The most recent FLUCCS shapefile available from the SWFWMD was titled "LU-11," representing land use data published in 2011. The 6000 series of

FLUCCS codes denote different wetland types and were selected from the FLUCCS data layer to represent existing wetlands. The Greater Charlotte Harbor, Pine Island, and Caloosahatchee watersheds are split between water management districts. For these watersheds, the most recent (2012 SFWMD) data were used where available, while the older (2011 SWFWMD) data were applied to the remaining area.

In areas where neither "LU-12" nor "LU-11" data were available, the "LU-08" FLUCCS shapefile from the SFWMD, representing land use data published in 2008, was used.

Table 4.3-a Water Management Districts that oversee each watershed

Watershed	Corresponding Water Management District
Coastal Venice	SWFWMD
Lemon Bay	SWFWMD
Charlotte Harbor	SFWMD / SWFWMD
Pine Island Sound	SFWMD / SWFWMD
Caloosahatchee River	SFWMD / SWFWMD
Estero Bay	SFWMD
Wiggins Pass/Cocohatchee	SFWMD
Naples Bay	SFWMD
Rookery Bay	SFWMD
Ten Thousand Islands	SFWMD

The pre-development wetlands are also provided by both water management districts in a "pre-development wetlands" data layer. The following categories of wetlands were extrapolated from the SFWMD data layer: Cypress, Hydric Flatwood, Hydric Hammock, Mangrove, Marsh, Scrub Cypress, Swamp Forest, Tidal Marsh, and Wet Prairie. The following categories of wetlands were extrapolated from the SWFWMD: Cypress Swamp, Hardwood Swamp, Herbaceous Wetlands, Mangrove Swamps, and Salt Marsh. All other categories were considered uplands and not included in the calculation for predevelopment wetlands. Since both datasets reflect pre-development conditions, they were merged.

Acreages of each habitat were calculated using the calculate geometry tool in ArcGIS 10.3. Acreages were summed using the statistics tool in the attribute table. Details of the wetlands acreage for each watershed are found in Appendix 6.1.

Extent of Mangroves Remaining

Current coverage of mangroves for all watersheds was determined from a GIS shapefile provided by the Florida Fish and Wildlife Conservation Commission (FWC) titled "Florida Mangroves 2014."

The merged pre-development wetlands shapefile was also employed to determine historic mangrove coverage. The categories "Mangroves" and "Mangrove Swamps" were selected from the wetlands shapefile.

The extent of mangroves remaining was calculated in the same manner as wetlands. Details of the mangroves acreage for each watershed are found in Appendix 6.3.

Extent of Conservation Lands

Federal, state, and local public conservation lands, as well as private lands with conservation easements, were identified for each watershed based on information provided by the Florida Natural Areas Inventory (FNAI) "Managed Lands" data layer dated December 2014. Aquatic Preserves were also included in the Extent of Conservation Lands acreage by utilizing the "Aquatic Preserves" data layer dated December 2011. The Managed Lands and Aquatic Preserve shapefiles were clipped to each watershed's boundary and acreages were calculated using the calculate geometry tool. Where Managed Lands and Aquatic Preserves overlapped, the overlap between the layers was subtracted out of the Aquatic Preserves acreage, in order to avoid double-counting the overlapping areas. The individual conservation areas and the acreages used to attain the aggregated percentages are provided in Appendix 6.5.

Water Quality

The calculation of the water pollution score for each watershed has two parts: (1) the acres of spatial impairment – how many total acres do not meet water quality standards for one or more parameter categories, and (2), the severity of the impairment - when one waterbody is impaired for multiple parameter categories.

The watershed assessment lists from the Florida Department of Environmental Protection are the basis for the water quality grades. Please see Appendix D for more information on the water quality data and the watershed assessment process.

Spatial Impairment Score:

1. The total acreage for each of the 10 watersheds was determined by calculating the acres of each Waterbody Identification Number (WBID) within the watershed boundary using the calculate geometry tool in GIS.
2. The acreages for impaired WBIDs – waterbodies in Categories 4d, 4e and 5 - was summed to identify the total number of impaired acres within the watersheds, also using the calculate geometry tool.
3. The remaining unimpaired WBIDs acreages within the watersheds were then used to calculate the percentage of unimpaired acres.
4. Finally, the percentage of unimpaired acres within each watershed was assigned a spatial impairment GPA score (Table 4.3-b). Each rank is based on the following percentage scale to correlate the unimpaired acreage percentage with GPA score – the higher the unimpaired percentage, the better the grade:

Table 4.3-b GPA Scale for Spatial Impairment/Percentage Unimpaired

GPA Score	Percentage Unimpaired
4.00	93-100%
3.67	85-92%
3.33	77-84%
3.00	69-76%
2.67	61-68%
2.33	53-60%
2.00	45-52%
1.67	37-44%
1.33	29-36%
1.00	21-28%
0.67	13-20%
0.33	0-13%

$$\text{Percentage of Watershed Unimpaired} = \left(1 - \frac{\text{Sum of Acreage for Impaired WBIDs}}{\text{Total Acreage of Watershed}}\right) \text{x } 100$$

Impairment Severity Score:

1. To determine the severity of impairment within the impaired portions of the watershed, the impairment parameters were divided into six categories commonly associated with water pollutants: (1) Biology, (2) Metals, (3) Nutrients, (4) Oxygen-depleting wastes, (5) Pathogens, (6) Physical Parameters.
2. Each impaired WBID's acreage was multiplied by the number of categories for which it was impaired, i.e., if it was impaired for Pathogens and Nutrients, the acreage was multiplied by 2.
3. The multiplied acreages were summed for each watershed.
4. The sums were divided by the total impaired acres (see #2 under spatial impairment) for the watershed multiplied by 6—the number of possible categories of impairment.
    - This method does count multiple categories of impairment as more severe than a single one. However, it does not account for the differences in toxicity levels of certain pollutants.
    - Moreover, the method normalizes the denominator to represent that all WBIDs could have 6 possible types of impairment, even though not every WBID was sampled for all 6 categories. One solution is to utilize a weighted mean in the denominator, which would represent the actual number of categories measured. However, normalizing the denominator is a more conservative approach because it avoids underscoring the watersheds. Normalizing the denominator also maintains consistency with the 2005 and 2011 Report Card methodology.

- In actuality, the severity of impairment score is a relative degree of unimpairment in the watershed. The inverse of the severity is assigned a GPA grade to ensure the overall water quality grade is consistent with a high score – and equals a higher letter grade.

$$\text{Severity Acreage} = \text{Acreage of WBID X Number of Pollutant Categories Impaired}$$

$$\text{Severity of Impairment Score} = 1 - \left(\frac{\text{Summed Severity Acreage of Impaired WBIDs}}{\text{Total Acres in Watershed} * 6}\right)$$

Combined Water Quality Spatial and Severity Grade

1. The final water pollution score weights the spatial impairment more heavily than the severity of impairment - a weight of 2/3 to 1/3, equation included below. The weighting gives a greater degree of significance to how many acres within a watershed are impaired as opposed to how many types of impairments occur within the impaired area.

2. The spatial and severity impairment scores using the 4.0 grade point scale were inserted into the below equation to calculate the final GPA between 0.00 and 4.00.

$$\left(\frac{(\text{Spatial Impairment x } 2) + \text{Severity of Impairment}}{3}\right)$$

3. This GPA was then assigned a letter grade, based on the 4.0 grade scale:

Grade	Combined GPA
A	3.67- 4.00
B	2.67- 3.66
C	1.67- 2.66
D	0.67- 1.66
F	0.00- 0.66

Narrative Hydrologic Restoration Qualifier

The 2005 and 2011 Report Cards documented alterations in hydrology for the ten watersheds. The 2017 Report Card relied on interviewing local experts and reviewing recent hydrologic restoration plans to update the current hydrologic status and assess any positive or negative changes due to either restoration activities or new development since 2011.

Impervious Surface Cover Qualifier

The percentage of ISC in each watershed was added to provide an additional estimate of hydrologic impacts. The data was obtained from the National Land Cover Database 2011 Percent Developed Imperviousness shapefile. Average percentages were calculated across each watershed and then associated with estuarine hydrologic quality. Schueler et al. (2009) outlined a modified Impervious Cover Model to determine stream health and quality, which several studies have supported.[48] The National Oceanic and Atmospheric Administration (NOAA) also uses this model in its Coastal Change Analysis Program (Figure 4.3-a).[49] Given the model's usage by NOAA and others, the Conservancy decided to apply the model ranges to help update and provide the basis for the hydrologic qualifier. Percentages that demonstrated a general support of physical quality were given a positive qualifier, percentages that started to show signs of stress were given no qualifier, while percentages that showed significant declines were given a minus qualifier.

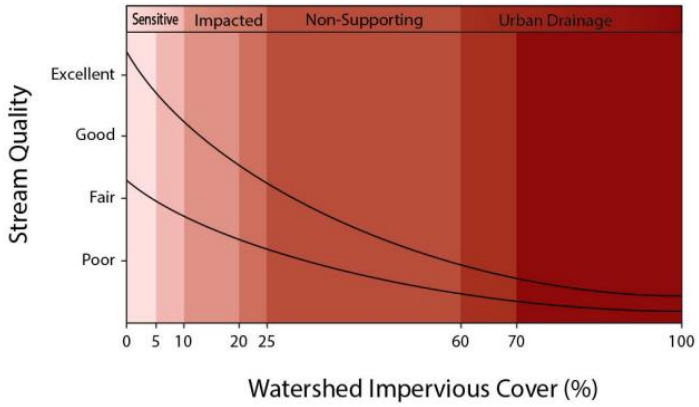


Figure 4.3-a Impervious Cover Percentages with Corresponding Water Quality, taken from NOAA

According to NOAA, "The model acknowledges that there is additional variability beyond impervious cover, some of which can be attributed to other watershed metrics such as forest cover, road density, riparian composition, and land use practices. The wide range of possible stream quality scenarios associated with low impervious cover indicates that these other metrics should be explored when evaluating multiple management practices aimed at improving water quality."[49] Evaluating the additional metrics recommended by NOAA for the ISC cover is outside the scope of this report. However, the general ranges identified in Table 4.3-c provide guidelines for assigning the hydrologic qualifier.

Table 4.3-c Impervious Surface Cover Impacts and Report Card Qualifiers

Percent Imperviousness	Impact	Description	Report Card Qualifier
0-1%	Unstressed	Can maintain hydrologic function and supports aquatic life	Positive (+)
1.1-5%	Slightly Sensitive		

5.1-10%	Sensitive	Can maintain hydrologic function, but signs of degradation begin to show	None
10.1-25%	Impacted	Hydrologic functions and water quality become compromised, significant decline of aquatic populations	Negative (-)
25.1-60%	Non-supporting		
61.1-100%	Urban Drainage	Only functions as a conduit of floodwaters	

Combined Hydrologic Qualifier

The hydrologic qualifier was assigned based on a review of both the ISC percentage and the narrative hydrologic alteration section. The ISC qualifier was treated as the base modifier and adjusted to take into account watershed specific information. For example, if a watershed had a high ISC percentage, but recently completed or ongoing restoration projects were reasonably expected to improve hydrologic function, the qualifier was adjusted in a positive manner. Conversely, a low ISC percentage could be adjusted based on hydrologic alterations such as channelization and control structures that negatively impact the hydrology of the watershed to a demonstrated greater extent than impervious surface cover.

Statewide Mercry TMDL Impacts

Due to delays in FDEP's watershed assessment process, comprehensive new water quality data was only available for half of the watersheds in the Report Card at the time the Water Quality grades were calculated - those contained in Group 1 Cycle 3: Estero Bay, Cocohatchee/Wiggins Pass, Naples Bay, Rookery Bay, and Ten Thousand Islands. During the Group 1 Cycle 3 assessment, FDEP began applying the statewide mercury Total Maximum Daily Load (TMDL) that was adopted in 2013. Once a waterbody has an adopted TMDL, it is moved from category 5 (impaired) to category 4a (TMDL adopted) on FDEP's watershed assessment lists, regardless of whether the waterbody is meeting the restoration targets defined in the TMDL document.

The results of this are evident in the watersheds contained in Group 1 Cycle 3, where mercury is no longer listed in category 5 and is not captured as a pollutant in the Report Card methodology. The other watersheds still contain the mercury impairments in category 5. To illustrate how the statewide mercury TMDL and similar changes in assessment process or standards can potentially impact the Water Quality grades, the grades for Coastal Venice, Lemon Bay, Greater Charlotte Harbor, Pine Island Sound and the Caloosahachee River watersheds were calculated without the mercury impairments (Table 4.3-d). These are only for illustrative purposes and should not be considered as a definitive interpretation of what the grades would be should all the assessment data be available. More information on the watershed assessment delay and the statewide mercury TMDL is in Appendix 5.1 and Appendix 7.5, respectively.

Table 4.3-d Water Quality Grade Calculated with and without Mercury Impairment for the five Northern Watersheds

Watershed	Grade with mercury impairment	Grade without mercury impairment
Coastal Venice	C-	C-
Lemon Bay	D-	B-
Greater Charlotte Harbor	C+	B+
Pine Island Sound	D	B
Caloosahatchee River	D-	D-

4.4 The Ten Estuaries of Southwest Florida

Southwest Florida is a complex interconnected system of mangrove swamps, marshes, sloughs, ponds, lakes, rivers, canals, and estuaries that encompasses over 11 million acres in its entirety. The region ranges from north of Lake Okeechobee south toward the Florida Everglades and includes southern Sarasota, Charlotte, Glades, Hendry, Lee, and Collier counties. The 2017 Estuaries Report Card focuses on ten estuary watersheds including Coastal Venice, Lemon Bay, Greater Charlotte Harbor, Pine Island Sound, Caloosahatchee River, Estero Bay, Wiggins Pass/Cocohatchee River, Naples Bay, Rookery Bay, and the Ten Thousand Islands (Figure 4.4-a).

The boundaries for each of the estuaries and their watersheds are based on the Florida Department of Environmental Protection's (FDEP) waterbody identification numbers (WBIDs), each of which depicts a particular sub basin or drainage unit within a watershed. Multiple WBIDs comprise a basin, and one or more basins are within a watershed. WBID boundaries are updated periodically to better reflect water flow patterns. Therefore, several of the watersheds and WBIDs depicted in the 2017 Report Card are different from the 2011 and 2005 Report Cards both visually and in acreage.

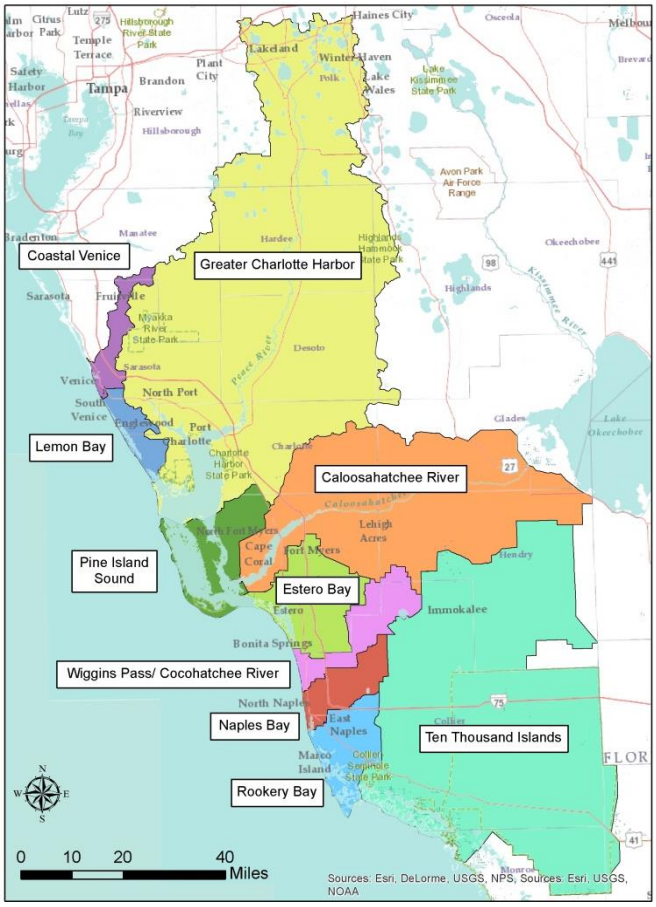


Figure 4.4-a Watersheds of Southwest Florida

Coastal Venice

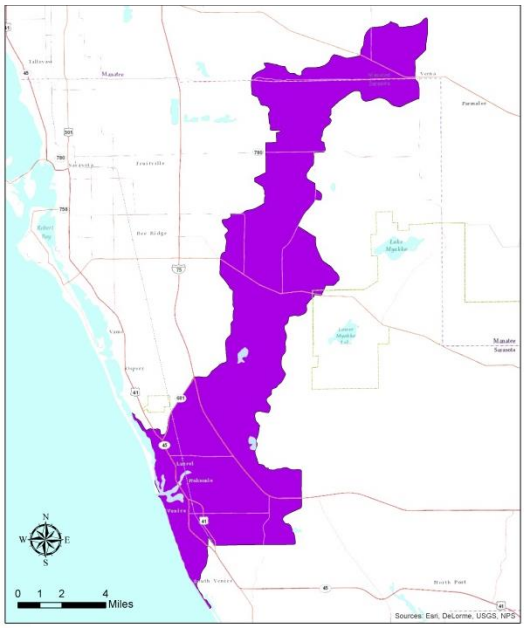


Figure 4.4-b Coastal Venice

Coastal Venice is a 62,961-acre watershed that extends from the north of Manasota Key bridge to the Venice inlet and stretches northeast, above the Myakka River, all the way into Manatee County (Figure 4.4-b). The watershed comprises three interconnected shallow bays – Lyons, Dona and Roberts – separated from the Gulf of Mexico by a barrier island. Dona and Roberts Bay are fed by Shackett and Curry Creeks, respectively, while Lyons Bay is not connected to a freshwater system.[50] The Coastal Venice watershed is part of the Charlotte Harbor National Estuary Program's study area.

Historically, the Coastal Venice watershed was characterized by slough-like and meandering freshwater systems that flowed through seasonal wet depressions before draining to the bays.[50] The Calusa Indians, who controlled the region when the Spaniards arrived in the early 16th Century, were the first of many to alter the natural environment by creating basic canal systems and artificial islands built from shells.[51] Such early alteration of the land was a sign of what was to come, as the current Venice coastline is representative of intense alteration as a result of coastal development. In 1948, the coast was mostly intact with only a few homes or farms along the waterfront. However, by the 1950s and 1960s mangroves were removed to build seawalls and manmade structures; marshes were replaced by residential canals and waterfront home sites; and shallow estuarine areas were dredged to supply landfill for waterfront properties.[50] The Intracoastal Waterway (ICW) was also constructed in the 1960s to allow commercial shipping vessels to navigate between Hatchett Creek and Alligator Creek.[52,53] The presence of the ICW and urban runoff along the coastline add further challenges for watershed management.

Recognized as the shark tooth capital of the world, Venice has become a popular tourist destination, in large part because of its famous public beaches that are littered with fossilized shark teeth. Collecting these prehistoric shark's teeth that vary in size and color has become a favorite pastime of both visitors and residents of the area.[54] Further recreational opportunities exist for sportsmen and wildlife enthusiasts. Fishermen can expect to find a wide variety of fish including mackerel, black sea bass, and snook, while birders can find great blue herons, and the threatened wood stork and Florida scrub jay.[55,56] Birds and other wildlife can be found in the watershed's prominent habitats including pine flatwoods, freshwater marshes and swamps, as well as shrub and brushland.

Twelve percent (7,725 acres) of the Coastal Venice watershed is conserved. The watershed contains most of the 6,113-acre Pinelands Reserve (4,332 acres), followed by a majority of the 1,691-acre Heritage Ranch Conservation Easement at (1,636 acres).

Land Use

The dominant type of land use in the Coastal Venice watershed is urban at 34%, followed by agriculture at 22% (Figure 4.4-c).

Population Estimates

The Coastal Venice watershed is located in Sarasota and Manatee Counties. Communities within Coastal Venice include Venice, Laurel, and Nokomis.[57] Population estimates for the communities are included in Table 4.4-a.

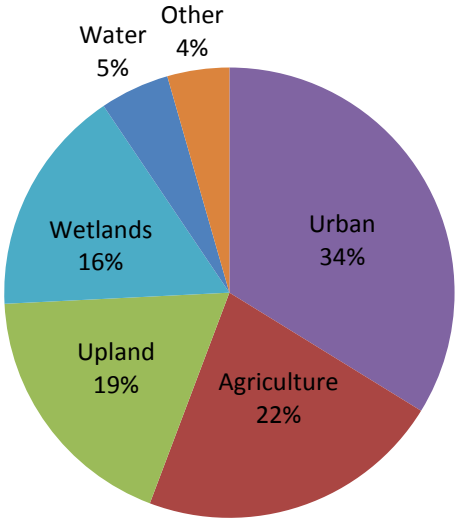


Figure 4.4-c Coastal Venice Land Uses

Table 4.4-a Coastal Venice Population Estimates

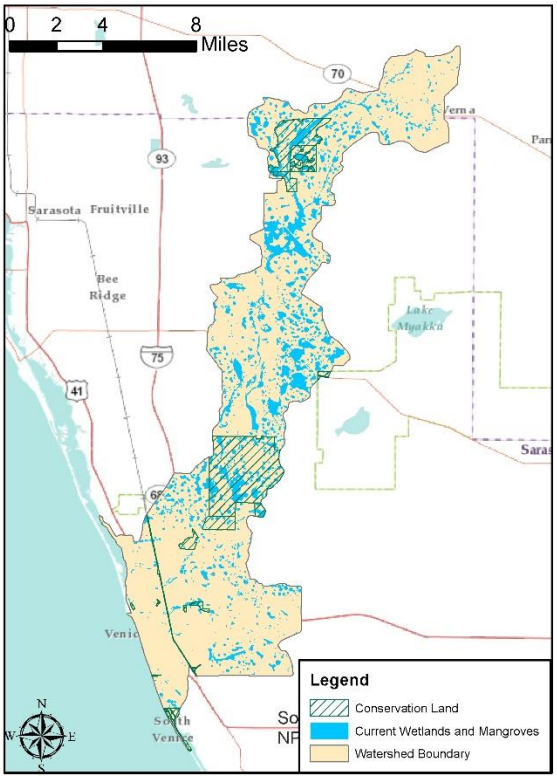
City	Population (2016)	Population Change (2010-2016)
Venice	21,849	5.3%
Laurel	8,174 (2014)[58]	0%[59]
Nokomis	3,478 (2014) [60]	9.8%[61]

Coastal Venice

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	10,293	49%
Mangroves Remaining	71	47%
Combined Percent		**48%**
Percent Conservation Lands	12%	Minus
Overall Grade		**C-**

Total Acreage: 62,961 Total WBIDs: 14

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	29%	1.33
Severity of Impairment	79%	3.33
Combined GPA		**2.00**
Percent Impervious Surface	10.9%	Minus
Hydrology (Descriptive)		Minus
Overall Grade		**C-**



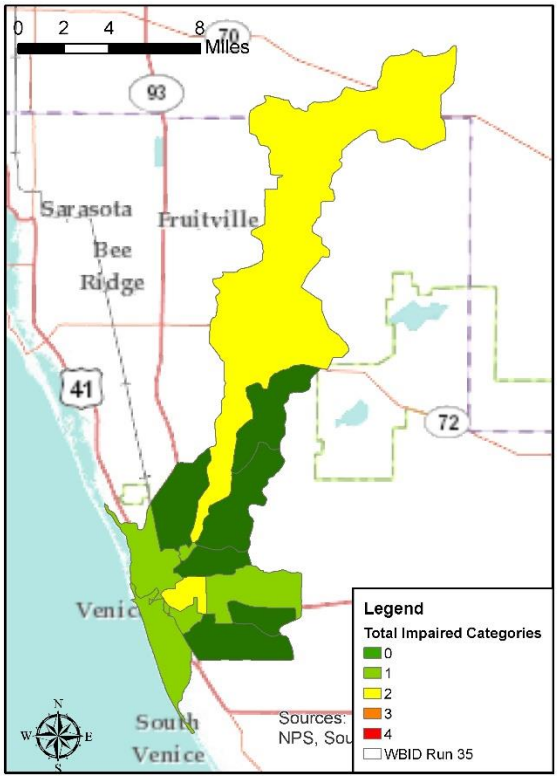


Figure 4.4-d Coastal Venice Report Card

Wildlife Habitat:

The Coastal Venice watershed has lost more than 50% of the area's historic wetlands and mangroves and is the third most urbanized watershed evaluated in the 2017 Report Card. In addition, only 12% of the watershed is designated conservation land, resulting in a minus qualifier. As a result, the Coastal Venice Wildlife Habitat grade is C -.

The largest land holding in preservation is a majority of the Pinelands Reserve, a combination nature park and mitigation area surrounding a landfill owned by Sarasota County,[62] followed by the privately held Heritage Ranch Conservation Easement. Most of the watershed falls within Sarasota County, which has a two-prong local land acquisition program—the Environmentally Sensitive Lands Protection Program (ESLPP) and Neighborhood Parkland Acquisition Program[63]—that could contribute to future improvements to and protection of wildlife habitat. Although seagrass is not used as a grading indicator, seagrass beds have rebounded in the Dona and Roberts Bay area above the restoration target, indicating improvements in submerged habitat conditions.[64] Preventing further loss of wetlands and mangroves, protecting additional conservation areas, and restoring historic wetland areas are strategies that can help enhance wildlife habitat in the Coastal Venice watershed.

Water Quality:

Coastal Venice has poor to mid-range water quality, with 71% of the watershed impaired for at least one parameter category (Table 4.4-b). Moreover, due to the urbanized nature of the watershed, hydrology in the area has been severely altered. There are a few planned hydrologic restoration projects in the Coastal Venice area, but they have not been completed. The impervious surface cover in this highly developed watershed is 11.2%, and the qualitative assessment of hydrologic alteration is poor; therefore, the Coastal Venice Water Quality grade is C -.

Table 4.4-b List of Category Impairments in Coastal Venice

Coastal Venice

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	6	8,160.92
Nutrients	1	33,566.28
Oxygen	3	38,329.37
All	8	44,538.91

Spatial Impairment:	44,539 acres
Severity of Impairment:	80,056 acres

The most pervasive water quality problems in this watershed fall into the metals category, specifically mercury, and the oxygen category. Six waterbodies are listed with mercury impairments in fish tissue. However, these impairments will likely be moved from Category 5 (impaired) to Category 4a (Total Maximum Daily Load (TMDL) adopted) due to the statewide mercury TMDL in place (see Appendix 7.5). Of the three waterbodies with DO impairments, one indicates nutrients (chl-a) as the causative pollutant, one indicates biological oxygen demand, and one has yet to have a causative pollutant identified. To date, no parameter-specific TMDLs have been developed for the Coastal Venice watershed.

Lemon Bay

Figure 4.4-e Lemon Bay

Extending from South Venice to the Gasparilla Island Causeway, the Lemon Bay watershed is a 62,320-acre watershed that has six basins discharging into the Bay: Alligator Creek, Woodmere Creek, Forked Creek, Gottfried Creek, Ainger Creek, and Lemon Bay Coastal (Figure 4.4-e). The Bay is separated from the Gulf by several barrier islands, including Manasota Key, Don Pedro Island, and Knight's Island.[65]

Similar to the other estuaries in the region, the land was first used by the Calusa Indians until the 1700s.[66] Since then, its location along the coast has made it an attractive place to live and visit. Due to the relatively high percentage of urban land use, the watershed has been impacted by stormwater runoff, channelization of natural streams, increase of impervious surfaces, and conversion of natural habitat to other land uses. The tributaries to the estuary have also been transformed by ditching for mosquito control and development activities.[67]

Fortunately, Lemon Bay's natural resources have also received beneficial recognition. The estuary has been designated as part of the Charlotte Harbor National Estuary Program (CHNEP), an aquatic preserve established by the Florida Legislature, and as an Outstanding Florida Water (OFW) by the Florida Department of Environmental Protection (FDEP).[68] The major types of wildlife habitat in Lemon Bay are pine flatwoods, freshwater marshes, and shrub and brushland, where one can find significant wildlife, including wood storks, sea turtles, manatees, and eagles.[68]

Twenty-six percent of the Lemon Bay watershed (16,178 acres) is set aside for conservation. The Lemon Bay Aquatic Preserve (6,994 acres) is a network of mangroves, marsh grass, and large expanses of seagrass meadows that are valuable habitats to over 150 species of birds, 100 species of invertebrates, and 200 species of fishes.[69] Portions of the 8,232-acre Myakka State Forest (3,345 acres) and the 44,560-acre Charlotte Harbor Preserve State Park (2,610 acres) are also within the watershed.

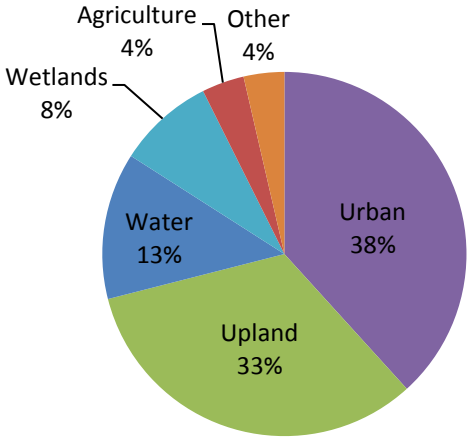


Figure 4.4-f Lemon Bay Land Use

Land Use

The dominant type of land use in Lemon Bay is urban at 38%, followed by upland at 33% (Figure 4.4-f).

Population Estimates

Lemon Bay is a part of Sarasota and Charlotte counties. Communities in the Lemon Bay watershed include Englewood, South Venice, Rotonda West, Placida, Grove City, Manasota Key, and Venice Gardens. Table 4.4-c depicts population estimates for the three largest municipalities.[70]

Table 4.4-c Lemon Bay Population Estimates

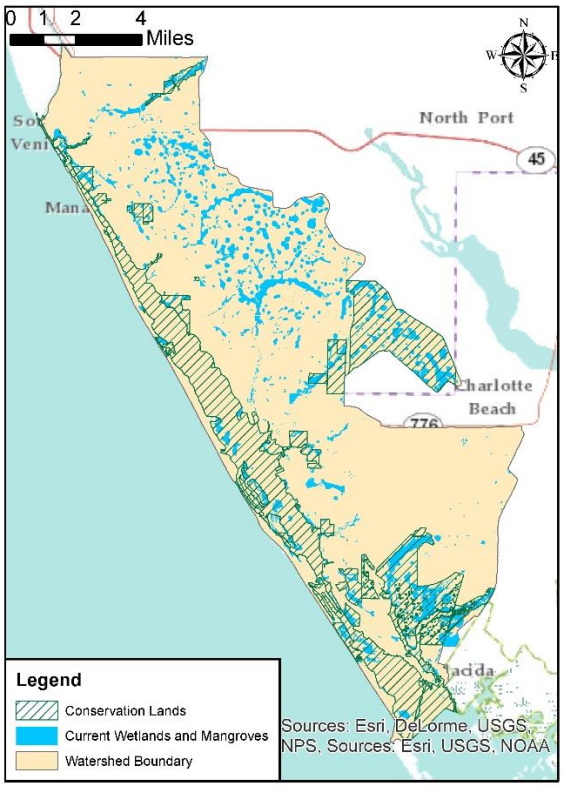
City	Population Estimate (2014)	Population Growth (2010-2014)
Englewood	14,929[71]	0.4%[72]
South Venice	13,976[73]	0.2%[74]
Rotonda West	8,466[75]	-0.3%[76]

Lemon Bay

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	6,667	69%
Mangroves Remaining	1,172	60%
Combined Percent		**65%**
Percent Conservation Lands	26%	None
Overall Grade		**B**

Total Acreage: 62,320 Total WBIDs: 23

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	5%	0.33
Severity of Impairment	64%	2.67
Combined GPA		**1.11**
Percent Impervious Surface	16.1%	Minus
Hydrology (Descriptive)		Minus
Overall Grade		**D-**



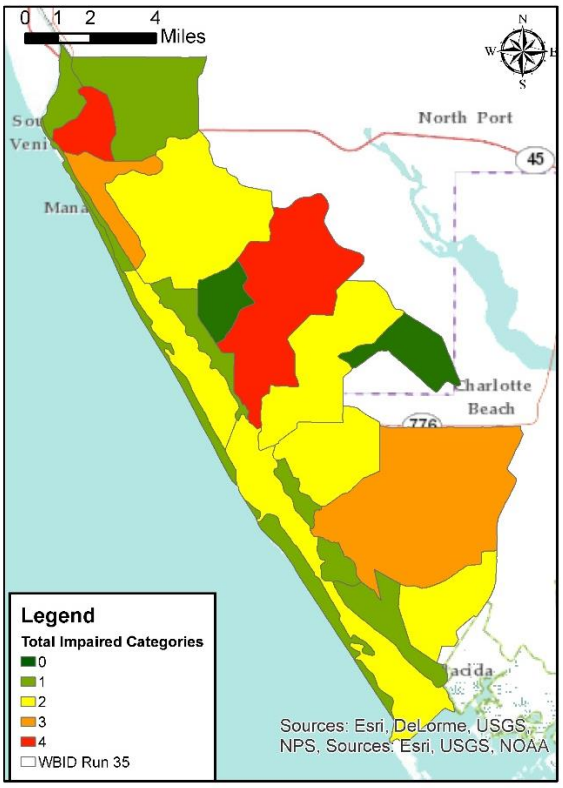


Figure 4.4-g Lemon Bay Report Card

Wildlife Habitat:

The Lemon Bay watershed has about 70% of the area's historic wetlands and about 60% of historic mangrove coverage remaining yet also exhibits the second highest percentage of urban land use of the watersheds evaluated in the Report Card, at 38%. About 26% of the watershed is in preservation, a percentage which receives no qualifier. Despite the high rate of urbanization in the Lemon Bay watershed, the location of development in the region and the preservation of key wetland and mangrove coastal areas have resulted in a Wildlife Habitat Grade of **B**.

The majority of the watershed's conservation areas are located within the Lemon Bay Aquatic Preserve, Myakka State Forest, and Charlotte Harbor Preserve State Park. Although seagrass is not used as a grading indicator, seagrass beds have rebounded in the Lemon Bay watershed to levels above the restoration target, indicating improvements in submerged habitat conditions.[77]

Water Quality:

Lemon Bay has degraded water quality with 95% of the watershed impaired for at least one parameter category (Table 4.4-d). The hydrology of the watershed has been severely altered, although several restoration projects have been completed since 2011. The impervious surface cover in this highly developed watershed is 15.9% and the qualitative assessment for hydrology is poor; therefore, the Lemon Bay watershed Water Quality Grade is **D-**.

Table 4.4-d List of Category Impairments in Lemon Bay

Lemon Bay

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	19	54,290.99
Nutrients	6	31,906.03
Oxygen	7	32,151.43
Pathogens	5	17,731.79
All	21	59,152.98
	Spatial Impairment:	59,153 acres
	Severity of Impairment:	136,080 acres

The most pervasive water quality problems in this watershed fall into the metals category, specifically mercury, followed by the oxygen and nutrients categories. Nineteen waterbodies are listed for mercury impairment based on mercury levels found in fish tissues. However, these impairments will likely be moved from Category 5 (impaired) to Category 4a (Total Maximum Daily Load (TMDL) adopted) due to the statewide mercury TMDL in place (see Appendix 7.5). The nutrient impairments are likely caused by

septic tank leaching and stormwater runoff in the Lemon Bay watershed, and are closely associated with the DO impairments, according to the Charlotte Harbor National Estuary Program.[7] Land development has contributed to the overall degradation of water quality in the Lemon Bay watershed. The watershed has experienced over-pumping of groundwater and the channelization of the majority of the region's coastal creeks. To date, two TMDLs have been adopted within the Lemon Bay watershed: Coral Creek-East (Dissolved Oxygen) and Gottfried Creek (Bacteria).

Greater Charlotte Harbor

The Greater Charlotte Harbor watershed extends from the northern headwaters of the Peace River to the coast of Charlotte Harbor (Figure 4.4-h). This 2,054,195-acre region is comprised of three basins—the Peace River, Myakka River, and Charlotte Harbor Proper—each with unique hydrological, ecological, and management characteristics.[7] The Peace River's major tributaries include Shell Creek, Horse Creek, Paynes Creek, Joshua Creek, and Charlie Creek. The Myakka River's tributaries include Curry Creek, Deer Prairie Creek, and Howard Creek. The large size of the watershed of Charlotte Harbor Proper compared to the size of the estuary itself results in approximately 10,880 acres draining into 640 acres - a 17:1 ratio. The high watershed-to-estuary ratio underscores the importance of the watershed in determining the health of the estuary.[78]

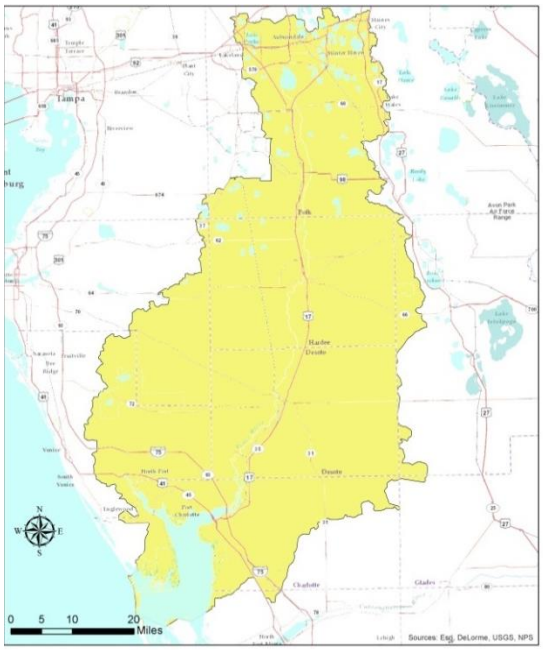


Figure 4.4-h Greater Charlotte Harbor

Charlotte Harbor Proper was once part of the center of the Calusa Kingdom that reigned in Florida between 400 B.C. and the 1700s.[66] Subsequently, the Peace River basin was used for phosphate mining and agriculture, including citrus, cattle ranching, and row crop farming. Since the 1880s, this basin has been the home of the largest phosphate mining industry in the state—producing yields to satisfy 25 percent of world demand and 75 percent of U.S. demand for phosphate fertilizer.[79, 80] The impacts from mining resulted in the 2004 listing of the Peace River as one of the 10 most endangered rivers in the United States.[81] The Myakka River basin has historically been used for cattle ranching and agriculture, which continue today alongside the expanding urban development in the area.[7] To the south lies the basin of Charlotte Harbor Proper, where the coastline continues to attract rapid urban development. Tourism is the third largest industry in the region and occurs in all three basins.[7] Along with land degradation, dissolved oxygen and salinity levels in the Harbor are significantly affected by both natural seasonal fluctuations in river discharges, and also fluctuations that arise from development and agricultural water use.[7]

Unlike many of the estuaries in southwest Florida that are heavily influenced by the Gulf of Mexico, Greater Charlotte Harbor is mainly influenced by the two large freshwater rivers that feed into it—the Peace and Myakka Rivers. The watershed's natural habitats include freshwater swamps and marshes, shrub and brushland, and pine flatwoods. The estuarine parts of the watershed contain extensive seagrass meadows, mangrove swamps, and salt marshes, all of which serve as nurseries for shrimp, crabs, and fish. The estuary supports 86 [82] of the state's endangered and threatened species, including the Florida manatee, Florida grasshopper sparrow, and several species of sea turtles, and is critical habitat for the smalltooth sawfish.[83] The Harbor also supports important commercial and recreational fishing and shellfishing industries and is recognized internationally as a hot spot for sport fishing.[84]

The State and Federal governments have conserved land in Greater Charlotte Harbor over the past several decades. In 1987, recognition of the immense natural resource value of the watershed led to the inclusion of the Charlotte Harbor as a National Estuary in the Clean Water Act that sought to identify, restore, and protect estuaries of national importance. The Charlotte Harbor National Estuary Program (CHNEP) published its first management plan in 2000 and most recently updated the plan in 2013.[7] The estuary has also been recognized as an Outstanding Florida Water (OFW) and as a Southwest Florida Water Management District (SWFWMD) Surface Water Improvement and Management (SWIM) priority waterbody, which provides further resources to the region to support protection and restoration efforts.

Nineteen percent (389,649 acres) of the Charlotte Harbor has been conserved. The Myakka River Basin is home to the Myakka River State Park (37,134 acres) and the Peace River Basin contains the Bright Hour watershed conservation easement (32,241 acres). The 34-mile section of Myakka River in Sarasota County is designated a Florida Wild and Scenic River.[7] The Charlotte Harbor Proper basin is home to several significant tracts of conservation lands, such as a portion of the 67,570-acre Fred C. Babcock / Cecil M. Webb Wildlife Management Area (47,906 acres), the Gasparilla Sound-Charlotte Harbor Aquatic Preserve (81,484 acres), and a portion of the 44,560-acre Charlotte Harbor Preserve State Park (27,843 acres).

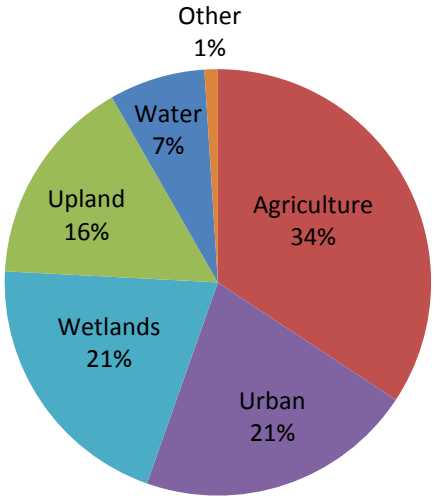


Figure 4.4-i Greater Charlotte Harbor Land Use

Land Use

The dominant land use in the Greater Charlotte Harbor watershed is agriculture at 34%, followed by urban and wetlands at 21% each (Figure 4.4-i).

Population Estimates

The Greater Charlotte Harbor watershed comprises portions of Polk, Lee, Sarasota, Hardee, DeSoto, and Charlotte counties. Communities include Lakeland, North Port, Port Charlotte, Winter Haven, Arcadia, Punta Gorda, Wauchula, and Bowling Green. Table 4.4-e depicts the top four municipalities' population estimates.[57]

Table 4.4-e Greater Charlotte Harbor Population Estimates

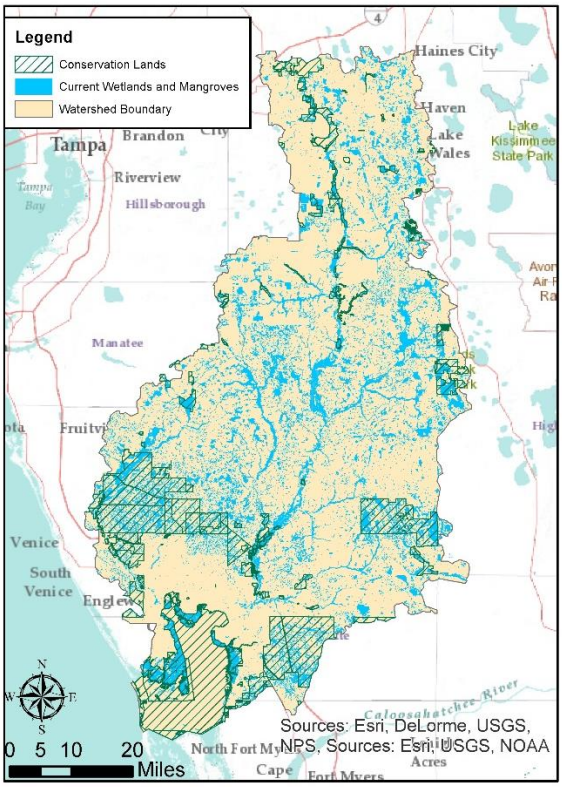
City	Population (2016)	Population Change (2010-2016)
Lakeland	102,507	5.2%
North Port	64,472	12.4%
Port Charlotte	55,942 (2014)[85]	1.8%[86]
Winter Haven	39,524	16.7%

Greater Charlotte Harbor

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	419,793	73%
Mangroves Remaining	20,194	62%
Combined Percent		**68%**
Percent Conservation Lands	19%	Minus
Overall Grade		**B-**

Total Acreage: 2,075,832 Total WBIDs: 430

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	46%	2.00
Severity of Impairment	85%	3.67
Combined GPA		**2.56**
Percent Impervious Surface	2.8%	Plus
Hydrology (Descriptive)		Plus
Overall Grade		**C+**



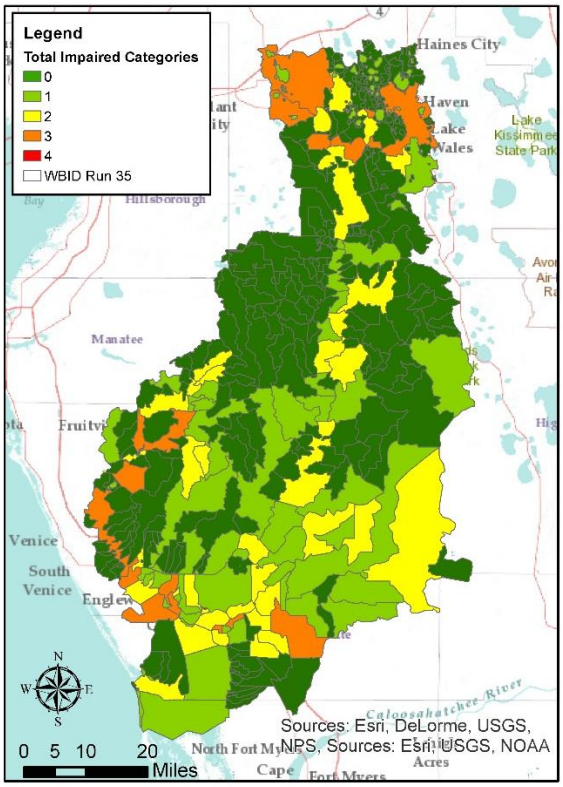


Figure 4.4-j Greater Charlotte Harbor Report Card

Wildlife Habitat:

The Greater Charlotte Harbor watershed has about 73% of the region's historic wetlands and about 62% of historic mangrove coverage remaining. Despite nearly 390,000 acres protected, due to the vast size of the watershed, this represents only 19% of the watershed, resulting in a minus qualifier. Therefore, the Greater Charlotte Harbor Wildlife Habitat Grade is **B-**.

Based on the most recent land use data from the Water Management Districts, Charlotte Harbor has had many acres of wetlands converted to forested uplands, mining, and urban development land uses. Many of the conservation areas surrounding Charlotte Harbor Proper are in public ownership but are interspersed with development that has displaced natural areas and agriculture.[7] The acquisition of the Peaceful Horse Ranch in the Peace River basin by the State in 2014 as part of a settlement agreement between environmental groups and the Mosaic phosphate mining company added over 4,000 acres to preserved lands in the watershed. The Conservancy of Southwest Florida played a role in facilitating the transfer to State ownership, and Peaceful Horse Ranch is one of the largest additions to publicly conserved land in recent years. Conservation Charlotte, the Charlotte County land acquisition and management program, no longer has acquisition funds and is only managing existing preserves. However, there are several Florida Forever projects within the watershed, including the Charlotte Harbor Estuary and Peace River Refuge, that include properties that will hopefully be added to existing conserved land and aid in restoring wetlands and other habitats in the future.

Water Quality:

Greater Charlotte Harbor's water quality is in the mid-range, with 54% of the watershed impaired for at least one parameter category (Table 4.4-f). The hydrology of the watershed has been altered in many areas but, there are a number of completed, ongoing, and planned restoration projects. The impervious surface cover in the watershed is 2.8%; therefore, the Greater Charlotte Harbor Water Quality Grade is **C+**.

Table 4.4-f List of Category Impairments in Greater Charlotte Harbor

Greater Charlotte Harbor

Parameter Category	WBIDS Impaired	Acres Impaired
Biology	3	121,569.51
Metals	50	373,490.52
Nutrients	69	248,047.91
Oxygen	61	398,047.01
Pathogens	26	276,477.50
Physical	1	5,810.68
All	142	1,113,950.11

Spatial Impairment:	1,113,950 acres
Severity of Impairment:	1,817,073 acres

The most pervasive water quality problems are oxygen (DO), nutrients, and metals. Many of the DO impairments are associated with areas with nutrient impairment,[7] and nutrients are considered the "causative pollutant" in a number of the DO listings. Part of Charlotte County's multi-year implementation plan for RESTORE Act funding is a project aimed to eliminate septic tank systems in the coastal areas of the County that will reduce future potential nutrient loading once implemented.[87] Mercury is the predominant metal impairment, although there are also some listings for iron. However, these impairments will likely be moved from Category 5 (impaired) to Category 4a (Total Maximum Daily Load (TMDL) adopted) due to the statewide mercury TMDL in place (see Appendix 7.5). Notably, 27% of the Greater Charlotte Harbor watershed is not measured for any parameter category and no water quality monitoring data was available for those particular waterbodies in the assessments available at the time the Report Card was compiled. There are twelve TMDLs approved in the Greater Charlotte Harbor watershed for either nutrients or bacteria.

Pine Island Sound

The Pine Island Sound watershed is a 187,111-acre region immediately south of the Greater Charlotte Harbor watershed and encompasses Matlacha Pass, Pine Island Sound, and San Carlos Bay, as well as Pine Island and the barrier islands of Cayo Costa, Captiva, and Sanibel Island (Figure 4.4-k). The Pine Island Sound watershed is part of the Charlotte Harbor National Estuary Program's study area.

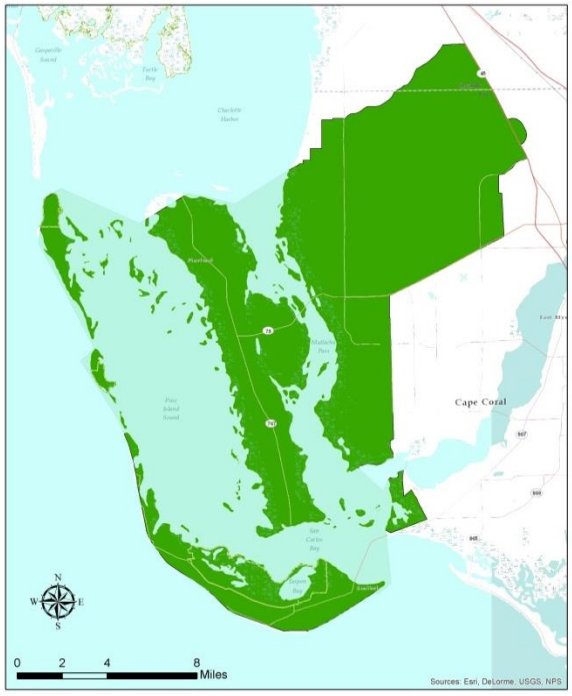


Figure 4.4-k Pine Island Sound

Pine Island Sound estuary was historically known for shellfish fisheries. However, the scallop fishery disappeared in the early 1960s, and the shellfish population has been on the decline. Much of the ecological degradation in the Sound has been attributed to expanding urban development, water pollution from agricultural and residential runoff, and water mismanagement of the Caloosahatchee River system. Direct runoff and rainfall from the heavily channelized and hydrologically altered City of Cape Coral provides the majority of freshwater to Pine Island Sound, influencing the quantity and quality of freshwater flow into Matlacha Pass and San Carlos Bay.[88] During large releases from the Caloosahatchee River, part of the outflow moves through San Carlos Bay into southern Pine Island Sound. Dredging and altered timing and volumes of freshwater discharges from the river system can harm the valuable seagrasses of the Sound along with the other plants and animals sensitive to salinity fluctuations.[7]

Despite the impacts to this watershed, Pine Island Sound is a unique spot for wildlife. Known for its extensive seagrass beds, the estuary provides essential habitat for young fish and is home to over 100 invertebrate, 200 fish, and over 150 bird species.[89] Tarpon and snook swim in its waters, and egrets, ospreys, herons, pelicans, ibis, wood storks, bald eagles and other coastal birds soar in its skies. The area serves as habitat for eight known federally-listed endangered species, including the Atlantic green turtle, leatherback turtle, Atlantic hawksbill turtle, Kemps ridley turtle, wood stork, Everglades kite, and Florida manatee.[90] It is also designated as critical habitat for the smalltooth sawfish by the National Oceanic and Atmospheric Administration (NOAA).[91]

Of the ten watersheds in this report, Pine Island Sound has the second highest percentage of conservation lands/aquatic preserves, with more than fifty-five percent (105,193 acres) of its watershed in public conservation. These protected areas serve to preserve wildlife, aquatic life, and native plant communities, and act as estuarine buffers. The major preserves include the majority of the 53,934-acre Pine Island Sound Aquatic Preserve (51,838 acres), a portion of the 44,560-acre Charlotte Harbor Preserve State Park, (14,051 acres), the Matlacha Pass Aquatic Preserve (12,497 acres), and the J.N. Ding Darling National Wildlife Refuge (6,359 acres).

Land Use

The dominant form of land use in the Pine Island Sound watershed is open water at 45%, followed by wetlands and urban at 21% each (Figure 4.4-l).

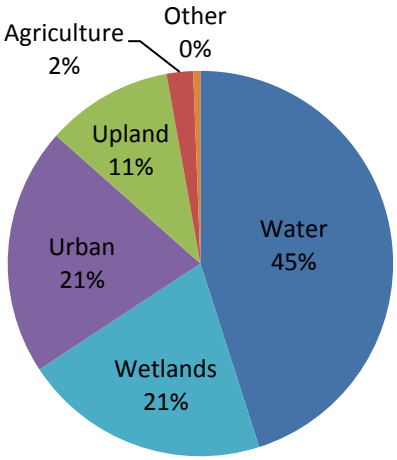


Figure 4.4-l Pine Island Sound Land Uses

Population Estimates

The Pine Island Sound watershed is located in Lee County. Communities in the watershed include Sanibel, Captiva, Saint James City, and a portion of Cape Coral.[57] Table 4.4-g depicts population estimates for the communities.

Table 4.4-g Pine Island Sound Population Estimates

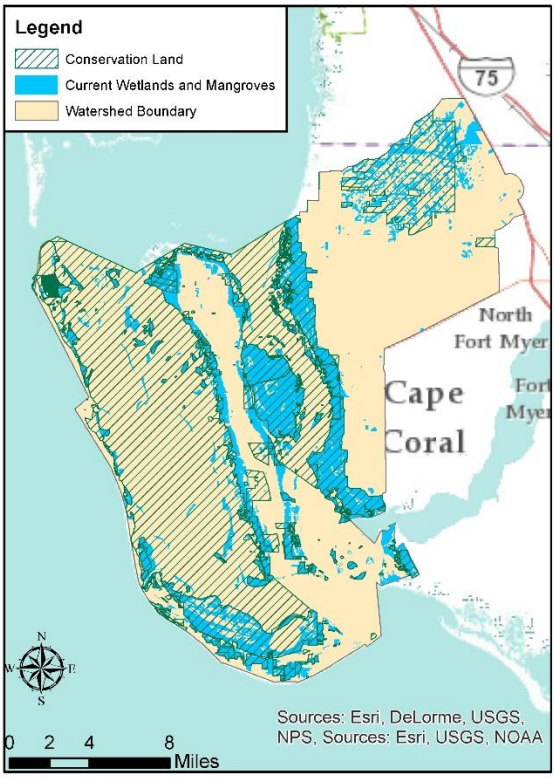
City	Population Estimate (2016)	Population Growth (2010-2016)
Cape Coral	170,474	10.5%
Sanibel	6,591	1.9%
Saint James City	3,784 (2010)[92]	N/A

Pine Island Sound

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	38,685	69%
Mangroves Remaining	26353	103%
Combined Percent		**86%**
Percent Conservation Lands	56%	Plus
Overall Grade		**A+**

Total Acreage: 187,111 Total WBIDs: 17

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	5%	0.33
Severity of Impairment	75%	3.33
Combined GPA		**1.33**
Percent Impervious Surface	9.0%	None
Hydrology (Descriptive)		None
Overall Grade		**D**



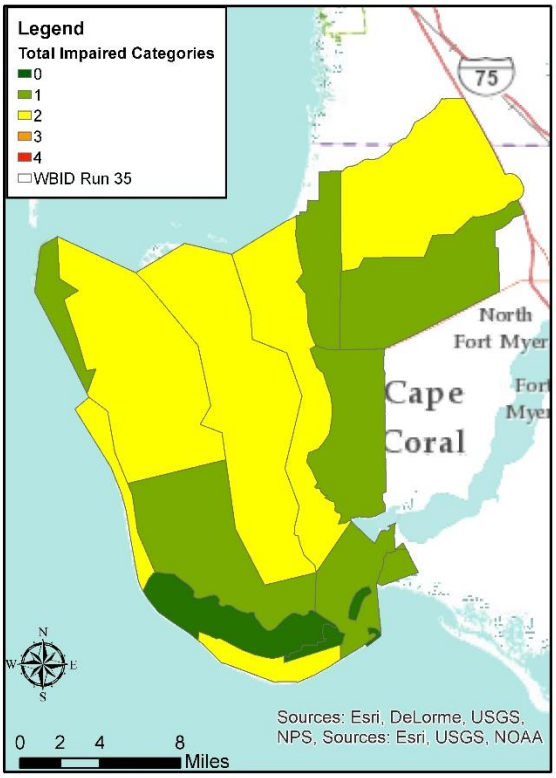


Figure 4.4-m Pine Island Sound Report Card

Wildlife Habitat:

The Pine Island Sound watershed has 69% of the region's historic wetlands remaining, and remarkably, shows a 3% increase in total mangrove coverage compared to historic acreage. Although portions of the watershed are highly developed, 56% of the area is in conservation, the second highest percentage in the Report Card. Therefore, the Pine Island Sound Wildlife Habitat Grade is **A+**.

Pine Island Sound Aquatic Preserve is the most significant preservation area in terms of size. Charlotte Harbor Preserve State Park and Matlacha Aquatic Preserve also contribute to the strong conservation presence in the watershed, among other state and federal landholdings. The Lee County Conservation 20/20 land acquisition and management program has several preserves in the watershed, as do private entities like the Sanibel-Captiva Conservation Foundation and the Calusa Land Trust. Pine Island Sound has met seagrass acreage targets, and some progress has been made in shellfish recovery since the disappearance of the scallop population in the 1960s.[7] Additionally, there has been significant work to restore oyster reef habitat through the Oyster Habitat Restoration Plan - a collaborative partnership between the CHNEP, The Nature Conservancy, and numerous other partners.[93] The goal of this plan is to enhance and restore self-sustaining oyster habitat and related ecosystem services throughout the estuaries and tidal rivers and creeks.[93]

Water Quality:

Pine Island Sound watershed has degraded water quality with 95% of the watershed impaired for at least one parameter category (Table 4.4-h). Although its hydrology has been moderately altered, there are several restoration activities planned or ongoing to alleviate some of the excessive freshwater discharges. The impervious surface cover is 9.3%, and the qualitative assessment of hydrologic alteration is poor to fair. Therefore, the Pine Island Sound Water Quality Grade is **D**.

Table 4.4-h List of Category Impairments in Pine Island Sound

Pine Island Sound

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	9	125,064.32
Nutrients	3	34,706.53
Oxygen	4	47,540.14
Pathogens	3	77,013.28
All	13	177,089.25
	Spatial Impairment:	177,089 acres
	Severity of Impairment:	284,324 acres

The most pervasive water quality impairments in the Pine Island Sound watershed are metals and oxygen (DO), with nutrients and pathogens tied for third. Nine waterbodies are impaired for mercury; however, those impairments will likely be moved to Category 4a for Total Maximum Daily Load (TMDL) adopted due to the statewide mercury TMDL adoption in 2013 (see Appendix 7.5). Nutrients in the watershed are of increasing concern, as the draft watershed assessment lists indicate that Matlacha Pass is newly impaired for nutrients, likely as a result of stormwater and sewage/septic runoff. The same runoff is also most likely the source of the pathogen category impairments, specifically for fecal coliform. Currently, no TMDLs have been adopted in the Pine Island Sound watershed.

Caloosahatchee River

The Caloosahatchee River watershed spans 880,954 acres from the river's artificial headwaters at Lake Okeechobee to its outflow in San Carlos Bay (Figure 4.4-n). The watershed is comprised of four basins: the Tidal Caloosahatchee (westward of gate S-79), West Caloosahatchee (between gates S-78 and S-79), East Caloosahatchee (between S-78 and Lake Hicpochee), and S-4 (between Lake Hicpochee and Lake Okeechobee).[94] Major tributaries in the Tidal Caloosahatchee basin include Telegraph Creek, Orange River, Jacks Branch, Billy's Creek, Popash Creek, and several others. The Caloosahatchee River watershed is part of the Charlotte Harbor National Estuary Program's study area.

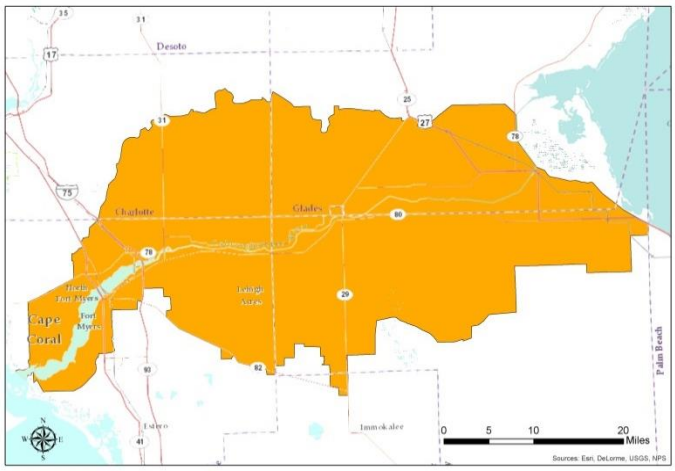


Figure 4.4-n Caloosahatchee River

Over the past 150 years, the historically shallow and meandering river has been deepened, straightened, and widened into a highly managed waterway. The Calusa Indians were the first to connect the Caloosahatchee to Lake Okeechobee for trade purposes.[95] In the 1880s, a canal was constructed to directly link the Caloosahatchee River to Lake Okeechobee, opening the region to navigation and development.[96] In 1948, the federally-authorized Central and Southern Florida Flood Control Project created another 1,000 acres of levees, 720 miles of canals, and 200 additional water control structures that redirected and changed the quantity, timing and distribution of flows entering the Caloosahatchee watershed.[97] Since then, three additional water control structures have been built in the Caloosahatchee: S-77, S-78 and S-79.[98] The W.P. Franklin Lock and Dam (S-79) is the westernmost water control structure and acts as a salinity barrier, constraining the movement of tidal inflow.[99] Additionally, the Caloosahatchee River watershed has experienced significant land impacts. The cities of Ft. Myers and Cape Coral are centers of urban development in the west, while agriculture is prevalent in the east.[100]

Due to the intense hydrologic alteration and development, the watershed's ecosystems are significantly degraded. Pollution from watershed runoff and discharges from Lake Okeechobee have impacted the water quality and salinity regime in the estuary. The watershed experiences more frequent red tides and blue-green algae blooms due to elevated nutrient loads.[101] FDEP estimates that over 60% of the nitrogen loading reaching the estuary originates in Lake Okeechobee.[102] The eutrophic conditions from such events create low dissolved oxygen levels, resulting in occasional fish kills.[103]

The Caloosahatchee experiences both dry and wet season impacts. Typically, during the dry season, the river and estuary receive too little water and the salinity spikes. During the wet season, the estuary receives too much freshwater inflow from Lake Okeechobee and the watershed, causing the salinity to drop precipitously. The extreme swings in salinity can contribute to mortality of organisms such as

oysters and bay scallops, and submerged aquatic vegetation.[104] In 2006, the river was listed the 7th Most Endangered River in the U.S. by American Rivers.[105]

Despite the ecological degradation, the river continues to serve as important habitat for several wildlife species, including manatees, oysters, birds, and fishes. Beds of seagrass still have the potential to thrive when river conditions are in the correct range of salinity, light availability and water quality. [7, 106] Portions of the Caloosahatchee have been designated critical habitat for the endangered small tooth sawfish, as well as Florida Panther Primary and Secondary Zones.[107,108] Wildlife habitat found here includes pine flatwoods, coniferous forests, freshwater marshes, and cypress wetlands.

Sixteen percent of the total land (144,783 acres) has been set aside for conservation. The most significant tract is the Babcock Ranch Preserve (71,113 acres), a large expanse of pinelands and cypress recognized for its historic value as a working ranch and an area of timber harvesting, and for its ecotourism value.[109] The watershed also contains the Fred C. Babcock / Cecil M. Webb Wildlife Management Area (19,665 acres), the Spirit of the Wild Wildlife Management Area, and a small portion of the 32,347-acre Okaloacoochee Slough State Forest (5,876 acres).[110]

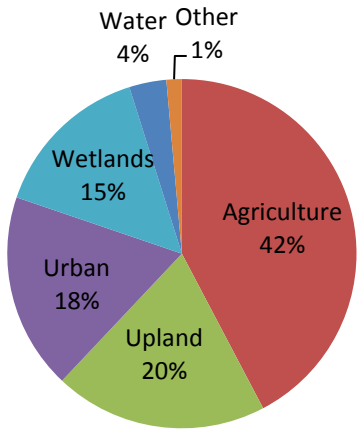


Figure 4.4-o Caloosahatchee River Land Uses

Land Use

The most significant land use in the Caloosahatchee River watershed is agriculture at 42%, followed by upland habitat at 20% (Figure 4.4-o).

Population Estimates

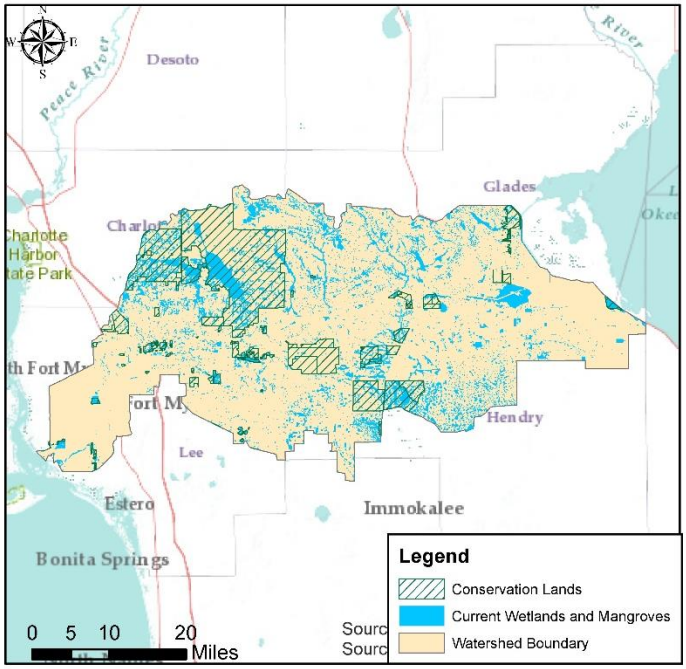
The Caloosahatchee River watershed includes portions of Charlotte, Lee, Collier, Hendry, and Glades Counties. Cities in the western portion of the watershed include the City of Fort Myers, Cape Coral, Lehigh Acres, and North Fort Myers.[57] Population estimates for the communities are listed in Table 4.4-i.

Table 4.4-i Caloosahatchee River Population Estimates

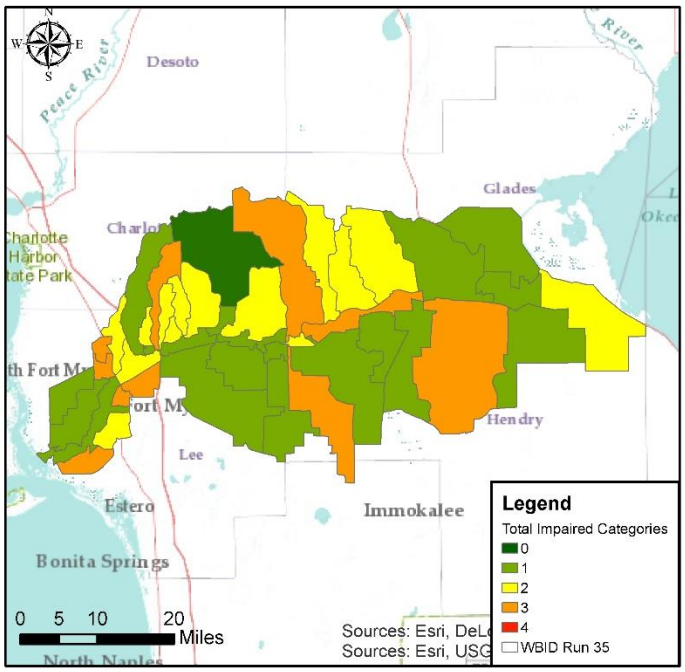
City	Population Estimate (2016)	Population Change (2010-2016)
Cape Coral	170,474	10.5%
Lehigh Acres	95,767 (2014)[111]	10.3%[112]
Fort Myers	76,108	22.2%
North Fort Myers	39,453 (2014)[113]	0.1%[114]

Caloosahatchee River

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	132,022	37%
Mangroves Remaining	2,716	37%
Combined Percent		**37%**
Percent Conservation Lands	16%	Minus
Overall Grade		**D-**



WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	6%	0.33
Severity of Impairment	71%	3.00
Combined GPA		**1.22**
Percent Impervious Surface	4.3%	Plus
Hydrology (Descriptive)		Minus
Overall Grade		**D-**



Total Acreage: 880,879 Total WBIDs: 45

Figure 4.4-p Caloosahatchee River Report Card

Wildlife Habitat:

The Caloosahatchee River watershed has only 37% of the region's historic wetland and mangrove coverage remaining, and only 16% of the watershed is designated conservation, resulting in a minus qualifier. Therefore, the Caloosahatchee River Wildlife Grade is **D-**.

The most significant conservation holdings in the Caloosahatchee watershed are the Babcock Ranch Preserve and the Fred C. Babcock Wildlife Management Area. The local land acquisition program for Lee County, Conservation 20/20, is still actively acquiring land in the watershed. However, the drastic loss of mangroves and wetlands throughout the western part of the watershed remains a significant factor impacting wildlife habitat. Loss of oysters, submerged aquatic vegetation, and other aquatic life due to dredging, hydrologic alteration and pollution, have also degraded wildlife habitat for other species. Preventing further loss of wetlands and mangroves, restoration of priority wetland areas, and continued conservation land acquisition are key strategies to improve wildlife habitat in the Caloosahatchee watershed.

Water Quality:

The Caloosahatchee River's water quality is degraded with 94% of the watershed impaired for at least one parameter category (Table 4.4-j). The watershed's hydrology has also been severely altered by the connection to Lake Okeechobee, the associated control structures, and the dredging and widening of the channel. The impervious surface percentage is relatively low, at 4.2%; however, the extreme degree of hydrologic alteration has resulted in a hydrology qualifier of minus. Therefore, the Caloosahatchee River Water Quality Grade is **D-**.

Table 4.4-j List of Category Impairments in Caloosahatchee River

Caloosahatchee River

Parameter Category	WBIDS Impaired	Acres Impaired
Biology	5	161,515.00
Metals	10	98,294.69
Nutrients	8	257,956.45
Oxygen	36	773,581.12
Pathogens	20	235,908.37
All	43	831,659.07
	Spatial Impairment:	831,659 acres
	Severity of Impairment:	1,527,256 acres

The most prevalent water quality impairment listings in the Caloosahatchee watershed are oxygen (DO) and pathogens. Notably, the majority of the DO impairments in the Caloosahatchee are listed as a category 4d, which means that no causative pollutant was identified. This can result from inadequate sampling or the absence of elevated levels of TN, TP, or BOD in the sampling areas. Fecal coliform impairments are likely due to leaking septics, inadequately treated sewage, and cattle operations. Nutrients and metals are also well-documented areas of concern. Due to the nutrient-rich discharges from Lake Okeechobee, combined with runoff from the watershed, blue-green algae blooms occur frequently. Most recently, the bloom in 2016 caused the closure of the Olga Water Treatment Plant that utilizes water from the river, and samples indicated the presence of the toxin microcystin.[115] Nine waterbodies are impaired for mercury. However, these impairments will likely be moved from Category 5 (impaired) to Category 4a (Total Maximum Daily Load (TMDL) adopted) due to the statewide mercury TMDL in place (see Appendix 7.5).

There are three TMDLs adopted in the watershed: Caloosahatchee Estuary (nutrients), Nine Mile Canal (bacteria), and Trout Creek (bacteria). There are several more currently under development for the upstream portion of the Caloosahatchee and the river's tributaries. The Caloosahatchee Estuary Basin Management Action Plan (BMAP) was adopted in 2012 to address the nutrient TMDL load reduction requirements, and some progress has been made implementing projects to reduce the nitrogen nutrient loading to the estuary.[116] However, this is only a small portion of the total nutrient pollution impacting the estuary, and adopting and implementing upstream TMDLs and BMAPs are necessary to achieve restoration goals. Moreover, the TMDL and BMAP for Lake Okeechobee does not directly address reductions in nitrogen, which is the nutrient of concern for the estuary. A nitrogen TMDL and BMAP for Lake Okeechobee (in addition to the existing phosphorus TMDL and BMAP) is necessary in order to fully address the pollutant loading to the Caloosahatchee estuary. The Caloosahatchee River's hydrology has been dramatically altered; water management operations result in high flows of freshwater into the river during the wet season and severely restricted flows during the dry season, leading to violations of the Minimum Flow and Level (MFL) established for the Caloosahatchee. Water storage, treatment, and conveyance throughout the Caloosahatchee watershed and in areas south and north of Lake Okeechobee are also necessary to alleviate the hydrologic impacts on the Caloosahatchee River and Estuary.

Estero Bay

Figure 4.4-q Estero Bay

The 198,144-acre Estero Bay watershed is located just south of the Caloosahatchee River estuary and is bordered by a line of barrier islands including Estero Island, Lovers Key, Long Key, Black Island, Big Hickory Island, and Little Hickory Island (Figure 4.4-q). Water is supplied by its main tributaries: Hendry Creek, Mullock Creek, Estero River, Spring Creek, and Imperial River.[117] The Coastal Venice watershed is part of the Charlotte Harbor National Estuary Program's study area.

The area was at the center of the Kingdom of the Calusa, which spanned from 400 BC to the 1700s. When the Spaniards sailed by the area in the 1500s, they named the bay "Estero", the Spanish word for estuary. The Bay area was comprised of agricultural and fishing settlements into the 1960s, even after the construction of the Tamiami Trail and the 10-mile canal in the 1920s. However, development quickly took off during the post-World War II boom in Bonita Springs and Ft. Myers Beach and continues to this day (e.g., Southwest Florida International Airport, Florida Gulf Coast University).[66]

Historically, a lack of substantial freshwater input and weak tidal exchange led to the formation of the lagoon-type estuary found in Estero. The reduced tidal exchanges due to the naturally restricted size of the inlets have been further constrained by the construction of bridges and causeways.[118] Because the bay is supplied with freshwater from a number of small creeks and rivers rather than one major source, it is extremely sensitive to runoff and upland discharge. Runoff, containing fertilizers, nutrients, pesticides and other contaminants, continues to increase as a result of increased percent impervious surface and development.[119] The problem will continue to worsen as both the already highly-populated coastal and the more sparsely populated inland areas are experiencing an increasing influx of new residents.[120] Lastly, boating along the coastline has caused significant damage to the estuary. The Bay has lost historic seagrass and oyster bed coverage due to propeller scarring, altered hydrology, and dredging activity. Approximately 107 acres of seagrasses are considered irrevocably lost due to the severe damage.[119]

Recognized for its value as a habitat for aquatic life, nearly 10,000 acres of Estero Bay were designated by the state as Florida's first Aquatic Preserve in 1966, and the tributaries have also been designated as Outstanding Florida Waters (OFWs).[119] Mangrove and cypress swamps are the main wildlife habitats within the bay. These inhabit the shorelines and inland areas, supporting a diverse array of bird rookeries among the various islands. One of the most productive estuaries in the state, approximately 40% of the state's endangered and threatened species live in the area, including the wood stork, piping

plover, sea turtles, mangrove fox squirrel, and Florida manatee.[118,126] The area is also critical habitat for the federally-listed smalltooth sawfish.[91] Extensive seagrass beds, tidal flats, and oyster beds are also found within the shallow bays and sounds, providing important habitat to support young fishes and crabs.[121] The eastern portion of the watershed also overlaps with Florida Panther Primary and Secondary zones—critical areas for the survival of the species.[108]

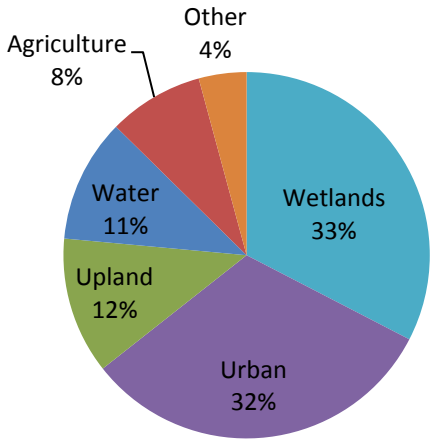


Figure 4.4-r Estero Bay Land Uses

The Estero Bay watershed has 45,726 acres of conserved land, with 10,728 acres located within a portion of the Corkscrew Regional Ecosystem Watershed (CREW). On the eastern edge of the watershed, CREW and its network have over 60,000 acres of protected marshes, pinelands, oak hammocks, and cypress swamps that are home to animals such as the swallow-tailed kite, black bear and Florida panther.[122] Other protected areas include the Estero Bay Aquatic Preserve (10,414 acres) and the majority of the 11,380-acre Estero Bay Preserve State Park (10,945 acres).

Land Use

The major types of land use in Estero Bay are wetlands at 33% and urban at 32% (Figure 4.4-r).

Population Estimates

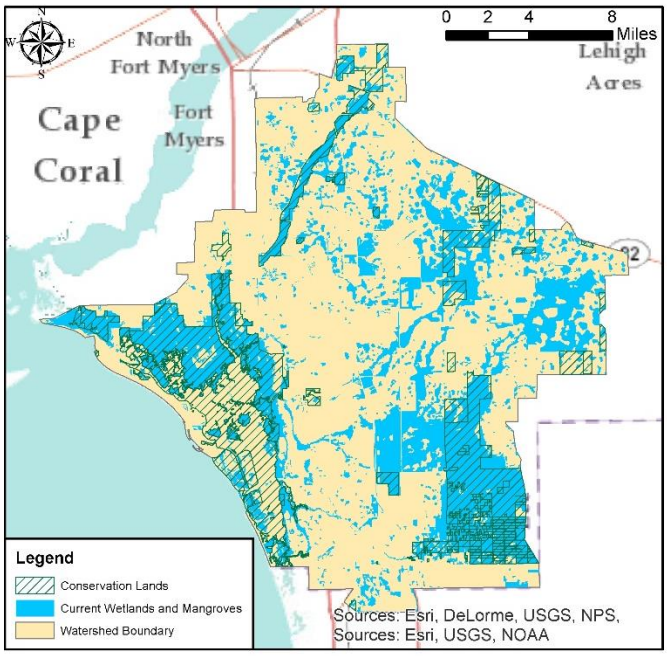
Estero Bay is a part of Lee County. Communities within the Estero Bay watershed include Bonita Springs, Fort Myers Beach, and the Village of Estero.[57] Population estimates are included in Table 4.4-k.

Table 4.4-k Estero Bay Population Estimates

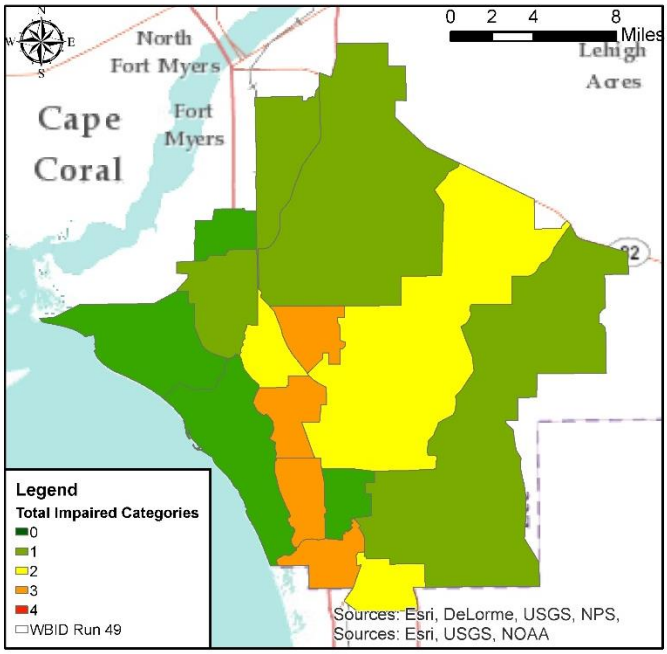
City	Population (2016)	Population Change (2010-2016)
Bonita Springs	48,388	10.3%
Estero	30,565	35.2%[123]
Fort Myers Beach	6,267	0.0%

Estero Bay

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	64,581	57%
Mangroves Remaining	11,394	86%
Combined Percent		**72%**
Percent Conservation Lands	23%	Minus
Overall Grade		**B-**



WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	16%	0.67
Severity of Impairment	79%	3.33
Combined GPA		**1.56**
Percent Impervious Surface	12.4%	Minus
Hydrology (Descriptive)		None
Overall Grade		**D**



Total Acreage: 198,144 Total WBIDs: 19

Figure 4.4-s Estero Bay Report Card

Wildlife Habitat:

The Estero Bay watershed has about 57% of the area's historic wetlands and about 86% of historic mangroves remaining. Portions of the watershed are highly developed, but the coastal mangrove fringe has been substantially preserved. About 23% of the watershed is in conservation, which results in a minus qualifier. Therefore, the Estero Bay Wildlife Habitat Grade is **B-**.

The Estero Bay Aquatic Preserve and Estero Bay State Park have preserved much of the Bay and surrounding areas. However, development has continued to increase both in the coastal region of the watershed and inland, impacting the Bay's tributaries, wetlands, and wildlife habitat. According to the South Florida Water Management District's (SFWMD) updated land use data, approximately 5,000 acres of wetlands in Estero Bay have changed from urban use and forested uplands since 2004, according to the most recent land use data (2012). Most of the headwaters of Estero Bay are in the Density Reduction/Groundwater Resource (DR/GR) area of Lee County, a land use designation created to protect water supply (aquifer recharge areas) and decrease density. Nonetheless, several large scale developments and mining operations are proposed in the DR/GR (see map in Appendix 9.2). If approved, additional wetlands, flowways, and wildlife habitat could be at risk. The Lee County Conservation 20/20 land acquisition and management program will hopefully play a crucial role in protecting additional lands in the Estero Bay watershed and the DR/GR, including the 4,000-acre Edison Farms property that encompasses three of the headwaters of Estero Bay. Preventing further loss of wetlands and flowways, wetland and flowway restoration, and protection of additional conservation lands are key strategies to help improve wildlife habitat in the Estero Bay watershed.

Water Quality:

The Estero Bay watershed's water quality is poor, with 84% of the watershed impaired for at least one parameter category (Table 4.4-l). The impervious surface cover in Estero Bay watershed is 12.4%, and significant hydrologic alterations have occurred. However, there are a number of completed, ongoing, and planned restoration projects to improve hydrologic function; thus, a neutral no qualifier was assigned for hydrology. The Estero Bay Water Quality Grade is **D**.

Table 4.4-l List of Category Impairments in Estero Bay

Estero Bay

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	7	68,795.27
Oxygen	9	112,369.59
Pathogens	6	67,580.47
All	11	166,994.68

Spatial Impairment:	166,995 acres
Severity of Impairment:	248,745 acres

Metals (iron), oxygen (DO), and pathogens (fecal coliform) are the most prevalent impairments listed. The DO impairments are a mixture of category 5 and category 4d (no causative pollutant identified). Since the 2011 Report Card, the mercury impairments in the Estero Bay watershed have been delisted from category 5 to category 4a (TMDL complete – see Appendix 7.5). Several other TMDLs have been adopted in the Estero Bay watershed: Hendry Creek (fecal coliform), and Hendry Creek and Imperial River (DO, causative pollutant Total Nitrogen). The Hendry Creek and Imperial River TMDLs for DO are also covered under a Basin Management Action Plan (BMAP) adopted in 2012, collectively referred to as the Everglades West Coast BMAP. As part of the BMAP, FDEP is conducting water monitoring studies in order to identify sources of nutrients in the Hendry and Imperial basins, including "(1) residential septic tanks; (2) residential lawn and ornamental fertilizer; (3) golf course fertilizer; (4) reclaimed water used on golf courses; and (5) agriculture."[124] Sources of fecal coliform are also likely related to septics, agriculture and/or pet waste, and wastewater facilities.[125] The Estero Bay Agency on Bay Management's 2014 State of the Bay Report concludes that some improvement in nutrient loading has been seen since the adoption of Lee County's fertilizer ordinance in 2009; however, "continuing urban development has led to flashier hydrology" and overall improvement of the water quality, hydrology and wildlife habitat of Estero Bay must happen at the landscape/watershed scale.[126]

Wiggins Pass/Cocohatchee River

The Wiggins Pass/Cocohatchee River watershed covers 119,610 acres in a long, narrow strip between Estero Bay to the north and Naples Bay to the south (Figure 4.4-t).[127] The Cocohatchee River and canal is the major tributary to the watershed. The headwaters to the watershed also overlap with the eastern part of the Estero Bay watershed, and the hydrologic connection to the Cocohatchee River and canal typically occurs during high water events, such as tropical storms.[128]

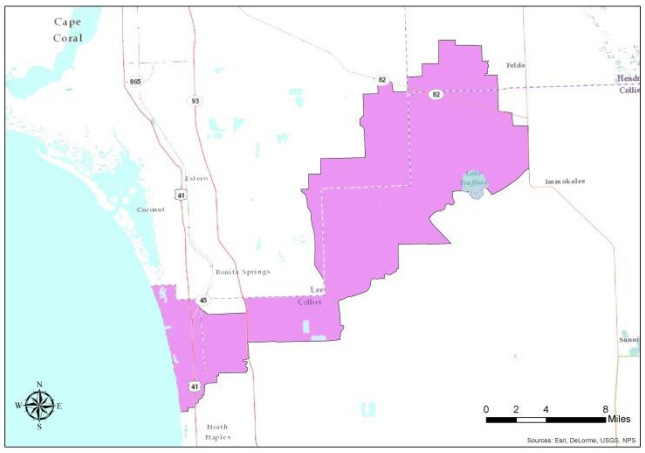


Figure 4.4-t Wiggins Pass/Cocohatchee River

Wiggins Pass has been called home by various groups throughout its history, including the Calusa Indians in the 1600s and the Seminole Indians and early European settlers in the 1800s.[127] Wiggins Pass has been dredged since the 1950s to allow navigation into the estuary and the Cocohatchee River. In the western portion of the watershed, increased urban development in North Naples and Bonita Springs has led to the destruction of mangroves and wetlands and the alteration of the watershed's hydrology.[129] The extensive conservation lands in the Corkscrew Regional Ecosystem Watershed (CREW) to the east attract nature enthusiasts and eco-tourists from the coastal areas.

A variety of wildlife continues to live in the sanctuaries of remaining natural habitat. Several Florida panther sightings have occurred in the eastern portion of the watershed that overlaps with the Panther's primary and secondary zones.[108,130] The nation's largest nesting area of the wood stork, a federally-listed threatened species, is located in Corkscrew Swamp. Other Federal and State listed species in the watershed include the gopher tortoise, Florida sandhill crane, limpkin, and Big Cypress fox squirrel. Several rare plants are also found in the Corkscrew Swamp, most notably the ghost orchid.[131] Florida manatees also travel inland from the coast during the winter months.[132]

Twenty-seven percent (32,348 acres) of conservation areas exists in the watershed to protect wildlife and natural communities. The watershed's largest undeveloped area is in the CREW conservation network, including a portion of the 27,696-acre CREW (16,493 acres), the Corkscrew Swamp Sanctuary (11,679 acres) and the Pepper Ranch Preserve (2,460 acres). The CREW Land and Water Trust, Lee County, and the South Florida Water Management District are often partners in CREW acquisitions in order to maintain aquifer recharge, natural flood protection, water purification, and preservation of wildlife habitat.[133] Delnor-Wiggins State Park (174 acres), located along the coast, was designated as an Outstanding Florida Water in 1996.[129]

Land Use

The most prominent forms of land use in the watershed are wetlands at 41% and agriculture at 29% (Figure 4.4-u).

Population Estimates

The Wiggins Pass/Cocohatchee River watershed is located in Collier, Lee, and Hendry counties. The watershed has a small overlap with communities of North Naples and Bonita Springs. Their entire populations are listed in Table 4.4-m.[57]

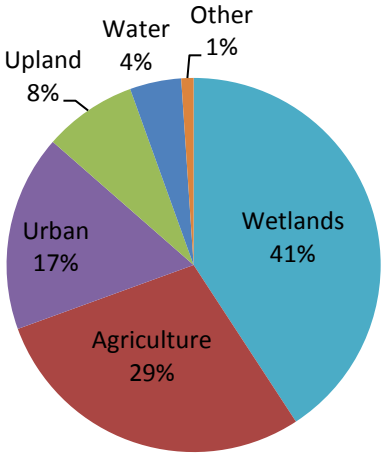


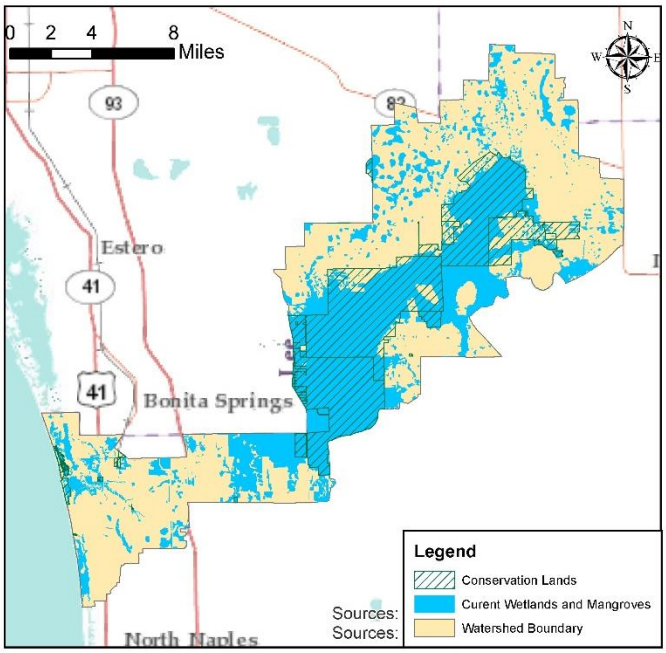
Figure 4.4-u Wiggins Pass/Cocohatchee River Land Uses

Table 4.4-m Wiggins Pass/ Cocohatchee River Population Estimates

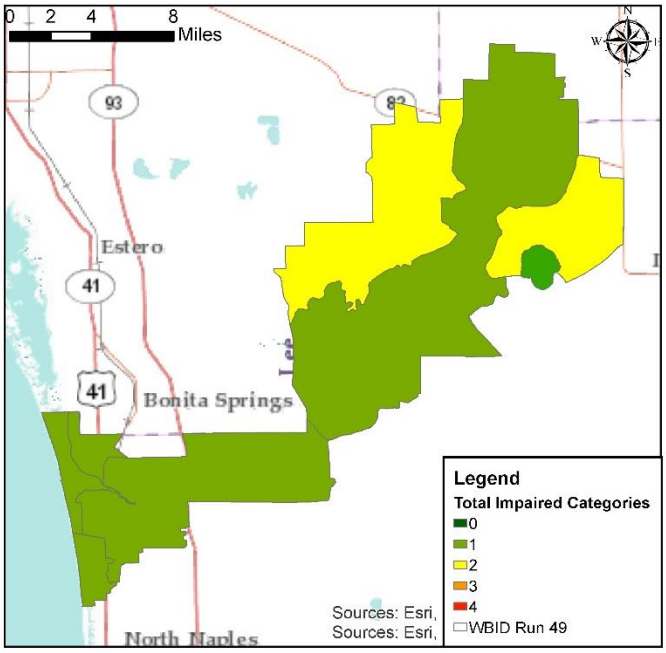
City	Population (2015)	Population Change (2010-2015)
Naples Park	7,195 (2014)[134]	20.5%[135]
North Naples	56,362	2.4%
Bonita Springs	48,388	10.3%

Wiggins Pass/ Cocohatchee River

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	48,772	70%
Mangroves Remaining	1,534	66%
Combined Percent		**68%**
Percent Conservation Lands	27%	None
Overall Grade		**B**



WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	1%	0.33
Severity of Impairment	79%	3.33
Combined GPA		**1.33**
Percent Impervious Surface	5.3%	None
Hydrology (Descriptive)		Minus
Overall Grade		**D-**



Total Acreage: 119,610 Total WBIDs: 8

Figure 4.4-v Wiggins Pass/ Cocohatchee River Report Card

Wildlife Habitat:

The Wiggins Pass/Cocohatchee River watershed has about 70% of historic wetlands remaining and about 66% of historic mangrove coverage remaining. The watershed near the coast is densely developed; however, the interior includes several thousand acres of conservation lands (27%) resulting in a neutral qualifier. The Wiggins Pass/Cocohatchee River Wildlife Grade is **B**.

The Corkscrew Regional Ecosystem Watershed and Audubon's Corkscrew Swamp Sanctuary contribute to the interior preservation lands and Delnor-Wiggins Pass State Park to the preservation of coastal mangrove areas. However, the only significant acquisition since the 2011 timeframe was the 600-acre Gargiulo property, which was bought by the State through the Florida Forever program as an addition to the CREW project.[136]

Water Quality:

The Wiggins Pass/Cocohatchee watershed is degraded with 99% impaired for at least one parameter category. The impervious surface cover in the Wiggins Pass/Cocohatchee watershed is 5.3%, which would receive no qualifier. However, due to the significant hydrologic alterations and minimal restoration activities, the hydrology qualifier has been modified to minus. The final Wiggins Pass/Cocohatchee River Water Quality Grade is **D-**.

Table 4.4-n List of Category Impairments in Wiggins Pass/Cocohatchee River

Wiggins Pass/ Cocohatchee River

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	3	28,033.83
Oxygen	5	112,670.71
Pathogens	1	11,777.56
All	7	118,119.69
	Spatial Impairment:	118,120 acres
	Severity of Impairment:	152,482 acres

The water quality impairments are oxygen (DO), metals (copper and iron), and pathogens (fecal coliform). The DO impairment listings are a combination of category 5 and category 4d (no causative pollutant identified). The copper impairment is likely associated with the application of copper sulfates as an algaecide on stormwater ponds, a longstanding practice in the area. In addition to the fecal coliform impairment inland in Cow Slough, there is an adopted TMDL for fecal coliform for the Cocohatchee River Estuary. Potential sources identified in the TMDL include "loadings from surface

runoff, wildlife, pets, leaking or overflowing sewage lines, and leaking septic tanks."[137] Currently, no Basin Management Action Plan (BMAP) is under development for the Cocohatchee fecal coliform TMDL. Inland, in the far northeast portion of the watershed, the Lake Trafford TMDLs for nutrients, un-ionized ammonia and dissolved oxygen also lack an official BMAP. However, restoration and management activities have improved the water quality of the lake.[138]

Prior to development, the Cocohatchee Flowway was 20 miles wide, allowing sheet flow of freshwater from the Corkscrew Swamp to reach the Imperial and Cocohatchee Rivers. Agriculture, land development, and the building of roads narrowed the flowway first to 2 miles where it crosses the Lee County line and then to 2,000 feet where it enters the Cocohatchee Canal. As the region continues to grow, more emphasis will need to be placed on hydrologic restoration and mitigating current stormwater runoff in order to address the hydrologic and water quality concerns in the watershed.

Naples Bay

Naples Bay is a shallow and narrow estuary that resides between Wiggins Pass to the north and Rookery Bay to the south (Figure 4.4-w). The contributing watershed has increased dramatically from 6,400 acres to 89,922 acres due to anthropogenic alterations.[139] Tributaries to the estuary include the Golden Gate Canal, Gordon River, Rock Creek and Haldeman Creek.

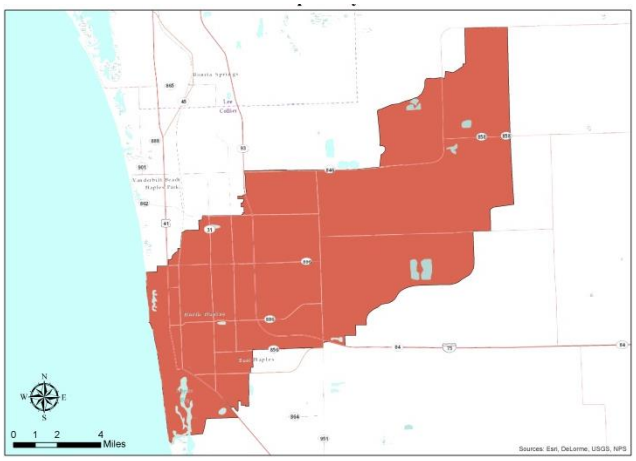


Figure 4.4-w Naples Bay

Naples Bay was first inhabited by the Calusa Indians 2,500 years ago, and the first American settlers did not arrive into the area until 1876. Development began soon after the construction of the Tamiami Trail in 1926, bringing the town's first tourists. Naples Bay was first dredged in 1930, followed by more intensive dredge-and-fill developments in the 1950s and 60s as population continued to increase. Naples today is known for its beaches and high-end shopping, is considered the "golf capital of the world,"[140] and is a premier location for tourism, retirees, and seasonal residents.[141] Its development, however, has led to constant intensive land alteration activities such as canal construction and urban development that have greatly impaired water quality and destroyed shoreline habitats along the bay.[142] According to a study conducted by the Conservancy of Southwest Florida, Naples Bay proper has lost approximately 70% of its mangrove forests, 80% of its oyster reefs, and 90% of its seagrass beds since 1950.[139]

Most of the Naples Bay watershed is urbanized, with little open space and preserve area remaining.[139] Only one percent (989 acres) of the Naples Bay watershed is conserved lands, consisting mostly of small isolated parks, such as the Gordon River Greenway Park and Preserve (124 acres total) or portions of larger preserves that overlap with adjacent watersheds, such as the 27,696-acre Corkscrew Regional Ecosystem Watershed (475 acres). The majority of listed species within the watershed live in these larger conservation areas, although some can be found along the coast in more developed areas. Red-cockaded woodpecker nests and a Florida Panther Secondary Zone occur in the Corkscrew Swamp and Picayune Strand areas, and bald eagles nest along the Naples Bay coast.[142,108] Many listed species of coastal birds, including the least tern, and multiple species of sea turtles, including loggerhead and green, are also found along the coast.[142]

Land Use

The major type of land use in Naples Bay is urban at 61%, followed by wetlands at 19% (Figure 4.4-x).

Population Estimates

Naples Bay is within Collier County. Communities within the watershed include North Naples, Golden Gate Estates, East Naples, and the City of Naples. Population estimates of the four largest communities shown in Table 4.4-o are taken from Collier County's permanent population estimates and projections.[143]

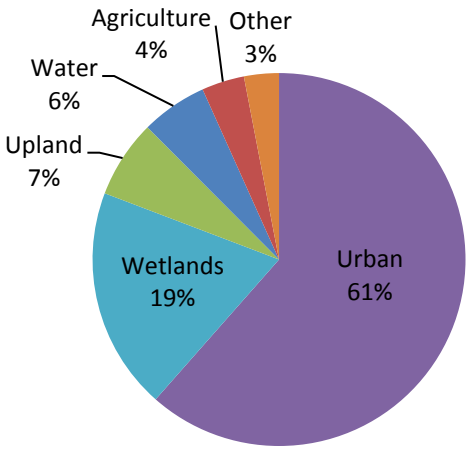


Figure 4.4-x Naples Bay Land Uses

Table 4.4-o Naples Bay Population Estimates

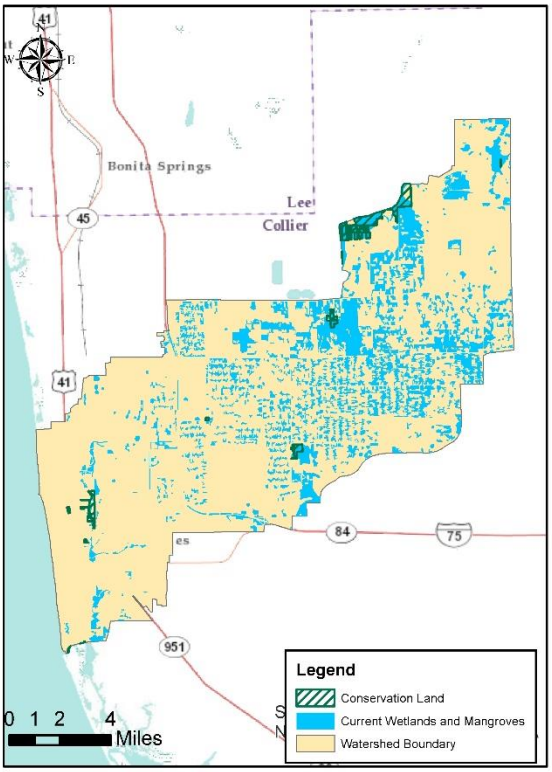
Planning Community	Population Estimates (2014)	Change in Population (2010-2014)
North Naples	56,362	2.4%
Golden Gate	45,490	1.3%
East Naples	22,399	0.3%
City of Naples	19,736 (2016)[57]	1.0%

Naples Bay

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	17,327	30%
Mangroves Remaining	436	19%
Combined Percent		**25%**
Percent Conservation Lands	1%	Minus
Overall Grade		**D-**

Total Acreage: 89,922 Total WBIDs: 9

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	8%	0.33
Severity of Impairment	70%	3.00
Combined GPA		**1.22**
Percent Impervious Surface	16.3%	Minus
Hydrology (Descriptive)		Minus
Overall Grade		**D-**



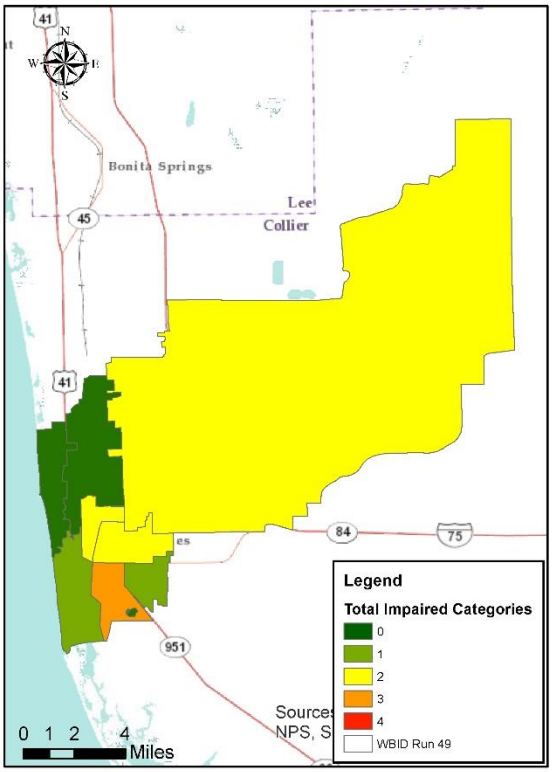


Figure 4.4-y Naples Bay Report Card

Wildlife Habitat:

The Naples Bay watershed has only 30% of the area's historic wetlands remaining and only 19% of historic mangrove coverage remaining. Naples Bay is also the most urbanized watershed evaluated in the Report Card, at 61%. The intensive urbanization has contributed to the lowest percentage of conservation lands in the report, at a mere 1% of the entire watershed. Thus, the Naples Bay Wildlife Habitat Grade is **D-**.

Very few conservation acquisitions have occurred in the past several years. Conservation Collier, the local land acquisition program, was operating in management status and only considering donations and bargain sales between 2011 and early 2017. In January 2017, the Board of County Commissioner's voted to reinitiate the acquisition component of the program. Some mangrove restoration attempts have been made in Naples Bay, and the City of Naples encourages the use of rip rap (slanted rocky material), instead of vertical sea walls, as a way to help create better habitat conditions for mangrove recruitment.[144] Now that the Conservation Collier program has been revitalized, it will be an avenue to protect additional areas within the watershed, identify wetland restoration opportunities, and provide urban greenspace for residents and visitors. Until the extreme changes in flow patterns to Naples Bay are addressed, mangrove restoration, as well as oyster reef and seagrass restoration, will be limited due to the salinity fluctuations and pollution input.

Water Quality:

The Naples Bay watershed's water quality is degraded with 92% of the region impaired for at least one parameter category (Table 4.4-p). The impervious surface cover is 16.4%. Combined with severe hydrologic alterations, including dredging, channelization, and development, the hydrologic qualifier is minus. Therefore, the Naples Bay Water Quality Grade is D-.

Table 4.4-p List of Category Impairments in Naples Bay

Naples Bay

Parameter Category	WBIDS Impaired	Acres Impaired
Metals	5	80,973.29
Oxygen	5	79,295.99
Pathogens	1	1,858.88
All	6	82,408.50
	Spatial Impairment:	82,408 acres
	Severity of Impairment:	162,128 acres

The major water quality impairments listed are oxygen (DO) and metals (copper and iron). DO is a combination of category 5 and category 4d (no causative pollutant identified). Changes since the 2011 Report Card evaluation include the delisting of nutrient impairments (chlorophyll-a now meets FDEP's assessment standard) and the delisting of the mercury impairments due to the adoption of the statewide mercury Total Maximum Daily Load (TMDL) – see Appendix 7.5. Copper is of major concern in Naples Bay and its tributaries due to the metal's toxicity to aquatic life. The City of Naples identified stormwater outfalls connected to the region's stormwater ponds as hotspots for copper due to the practice of treating algae outbreaks in ponds with copper sulfate.[145]

There is an adopted TMDL for one of the tributaries to Naples Bay, the Gordon River (DO, total nitrogen as the causative pollutant). However, a Basin Management Action Plan has not been adopted to implement the TMDL. Potential sources of nitrogen according to the TMDL "include runoff and erosion from developed areas, small-scale construction, residential and commercial fertilizer use, pets, residential septic tank failure, or poorly designed septic tanks."[146]

When the Golden Gate Canal was built to drain the Northern Golden Gate Estates canals, it drastically altered the hydrology of the area. As a result, freshwater flows increased during the wet season by 20 to 40 times historic flows, altering the sensitive balance that once supported fishes, oysters, and seagrasses in the bay.[147]

In order to address the numerous water quality and hydrologic problems facing Naples Bay, a number of projects need to be implemented: redirecting high flows away from the Golden Gate Canal and Naples Bay, providing stormwater treatment for pollution removal, and implementing restoration plans for already impaired waters.

Rookery Bay

The Rookery Bay watershed is located south of Naples and spans 127,261 acres (Figure 4.4-z). The main tributary to Rookery Bay is Henderson Creek.[148]

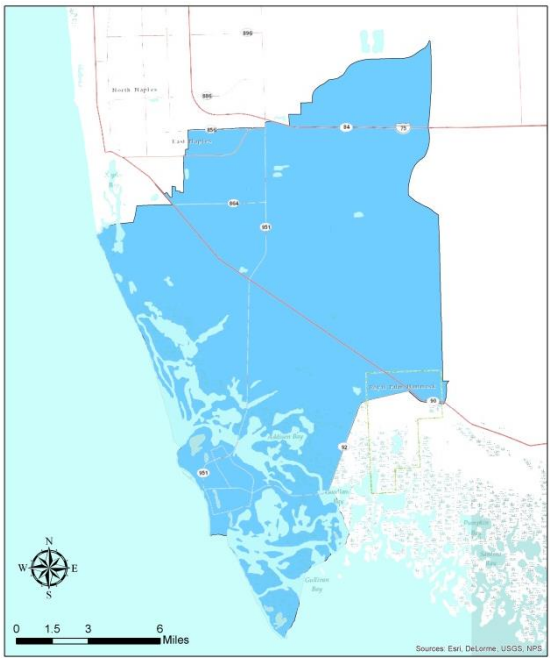


Figure 4.4-z Rookery Bay

Similar to other estuaries in the region, the Calusa Indians were the first settlers of Rookery Bay, occupying the land from 400 to 2,500 years ago.[149] Historically undeveloped, urban growth from Naples and Marco Island began to encroach on the Bay in the 1960s. In 1964, a proposal was developed for the construction of the "Road to Nowhere," a planned thoroughfare that would have connected Naples and Marco Island. The Conservancy of Southwest Florida (known as the Collier County Conservancy at that time), along with the National Audubon Society and The Nature Conservancy responded to this environmentally detrimental proposal, leading a community grassroots campaign that resulted in the purchase of over 3,000 acres. Together, these organizations successfully petitioned the State of Florida to designate Rookery Bay as a National Estuarine Research Reserve (NERR) in 1978.[150]

However, development continues south of the NERR in Marco Island and north of the NERR in the Lely Resort and agricultural areas. Today, Marco Island and East Naples continue to be popular communities for retirees and seasonal residents and tourists.[151] Canal systems and creeks receiving pollutants from human-influenced areas flow into the more natural areas of the watershed. Several large low-density residential communities have also continued to be built in Rookery Bay since 2011, including Marco Shores/Fiddler's Creek (4,439 acres), Heritage Bay (2,562 acres), Hacienda Lakes (2,262 acres), and Wentworth Estates/Treviso Bay (1,564 acres).[152]

Despite ongoing development, Rookery Bay is still predominately comprised of wetlands, including mangrove swamps, wet pinelands, and cypress swamps, as well as upland habitat including pine flatwoods. The northeast corner of the watershed overlaps with a Florida Panther Primary Zone, considered critical habitat to sustain its population.[108] The mangrove forests of Rookery Bay support a great diversity of species, including juvenile fishes and other marine life that depend on mangroves for shelter and sustenance. The coastlines are considered smalltooth sawfish critical habitat by the National Oceanic and Atmospheric Administration.[91] Birds such as herons, egrets, cormorants, and endangered wood storks use its islands for roosts and rookeries. Raptors, such as the American bald eagle and osprey, sea turtles, bobcats, and manatees can also be found in Rookery Bay.[150, 153]

Fifty-two percent of the Rookery Bay watershed (66,571 acres) is protected lands, 41,641 acres of which are part of the Rookery Bay NERR. Described as "one of the few remaining undisturbed mangrove estuaries in North America," the estuarine environment and surrounding upland hammocks of the bay provide prime habitat for a myriad of wildlife, including 150 species of birds and numerous threatened and endangered animals.[154] Other conservation areas include a portion of the 74,159-acre Picayune Strand State Forest (20,233 acres) and a portion of the 7,271-acre Collier-Seminole State Park (2,130 acres).

Land Use

The dominant forms of land use in Rookery Bay are wetlands at 50%, followed by urban at 17% and water at 14% (Figure 4.4-aa).

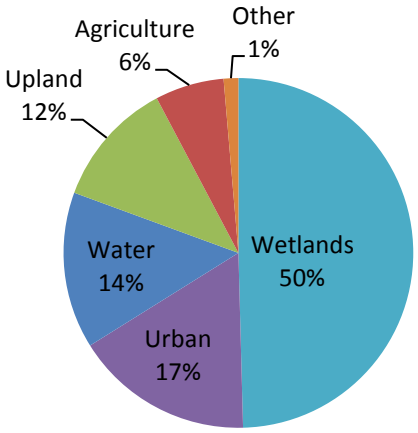


Figure 4.4-aa Rookery Bay Land Uses

Population Estimates

Rookery Bay is a part of Collier County. Communities within the Rookery Bay watershed include Marco Island, Naples Manor, and Lely Resort.[57] Population estimates are included in Table 4.4-q.

Table 4.4-q Rookery Bay Population Estimates

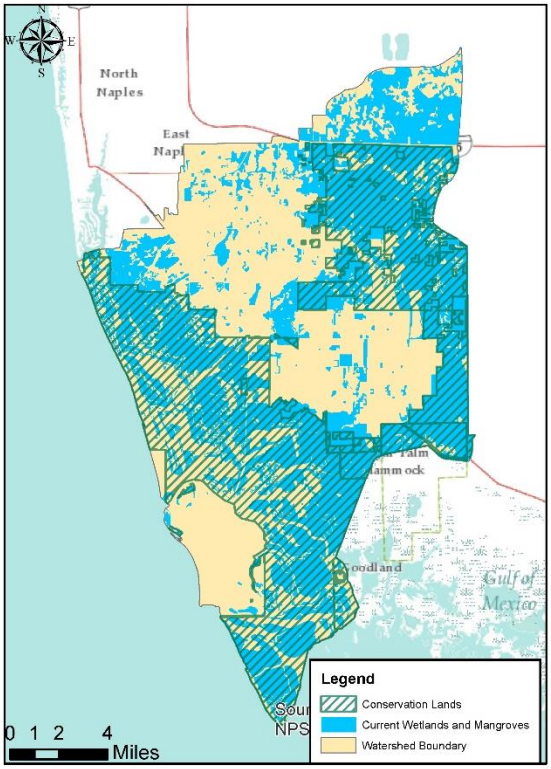
City	Population Estimate (2016)	Population Growth (2010-2016)
Marco Island	16,930	3.1%
Naples Manor	5,152 (2014)[155]	-7.3%[156]
Lely Resort	4,873 (2014)[157]	4.8%[158]

Rookery Bay

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	63,093	69%
Mangroves Remaining	21,421	72%
Combined Percent		**71%**
Percent Conservation Lands	52%	Plus
Overall Grade		**B+**

Total Acreage: 127,260 Total WBIDs: 5

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	58%	2.33
Severity of Impairment	83%	3.33
Combined GPA		**2.66**
Percent Impervious Surface	6.8%	None
Hydrology (Descriptive)		None
Overall Grade		**C**



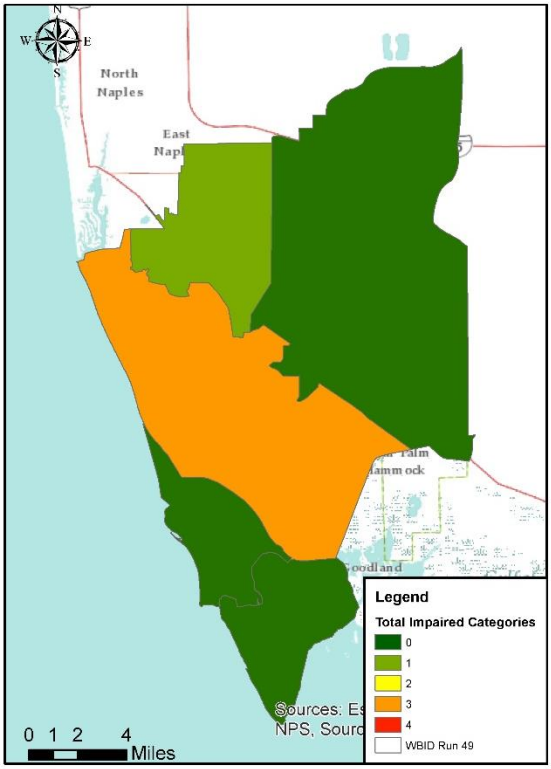


Figure 4.4-bb Rookery Bay Report Card

Wildlife Habitat:

The Rookery Bay watershed has 69% of the area's historic wetlands remaining and 72% of historic mangrove coverage remaining. The percentage of conservation lands is 52%, the third highest amount of preservation in the watersheds evaluated, and the area is recognized as unique habitat for wildlife. The Rookery Bay Wildlife Habitat Grade is B+.

Approximately 1,500 acres of wetlands have been converted to urban use since 2004, according to the most recent land use data, with many others located within ongoing Planned Unit Developments. The Rookery Bay National Estuarine Research Reserve and the Picayune Strand State Forest are the largest tracts of conserved area within the watershed boundary. No significant land acquisition has occurred since the 2011 Report Card, and the local conservation program, Conservation Collier, has not actively acquired land since 2011. However, in early 2017, the Board of County Commissioners voted to reinitate the acquisition component, and new property nominations are now being considered. Almost all wetland loss occurred on the highly developed Marco Island and in areas in the northern part of the watershed. The Conservancy of Southwest Florida is assisting in a mangrove restoration project on Fruit Farm Creek—an area of mangrove die-off near Goodland within the NERR. The restoration project aims to restore 64 acres of mangroves and benefit an additional 161 acres.

Water Quality:

Rookery Bay's watershed water quality is in the mid-range with 42% impaired for at least one parameter category (Table 4.4-r). The impervious surface cover in the Rookery Bay watershed is 6.9%, and there are planned and ongoing restoration projects to improve altered hydrologic function. Therefore, no hydrology qualifier is assigned. Rookery Bay's Water Quality Grade is **C**.

Table 4.4-r List of Category Impairments in Rookery Bay

Rookery Bay

Parameter Category	WBIDS Impaired	Acres Impaired
Nutrients	1	38,555.37
Oxygen	2	53,610.27
Pathogens	1	38,555.37
All	2	53,610.27
	Spatial Impairment:	53,610 acres
	Severity of Impairment:	130,721 acres

The greatest number of impairment listings are in one large area of the watershed, WBID 3278U, that encompasses much of Rookery Bay itself. The impairments include nutrients, oxygen (DO with

Biological Oxygen Demand as the causative pollutant), and fecal coliform. These impairments indicate stormwater runoff from the watershed with nutrients and fecal coliform impacting Rookery Bay. The water quality grade has improved since the 2011 Report Card likely as a result of the delisting of mercury impairments due to the adoption of the statewide mercury Total Maximum Daily Load (TMDL) – see Appendix 7.5.

The hydrology of the Rookery Bay watershed has been somewhat altered by development north of the reserve and throughout Marco Island. The alteration of the freshwater entering Rookery Bay's primary tributary, Henderson Creek, from historic sheetflow to a roadside canal has resulted in decreased water retention during the wet season and hypersaline conditions in Henderson Creek during periods of drought.

The City of Marco Island, with the assistance of the Conservancy of Southwest Florida, passed a fertilizer ordinance in 2016 that is designed to reduce nutrient loads and improve water quality. Currently, no TMDLs are adopted in the Rookery Bay watershed; however, in response to a request by the Conservancy, WBID 3278U is now on FDEP's TMDL priority development list.

Ten Thousand Islands

The Ten Thousand Islands watershed is a 1,542,441 - acre network of land, islands, small bays, and tributaries, with the eastern extent of the watershed reaching into Everglades National Park, the northern end reaching into Hendry County, and the southern end stretching into Monroe County (Figure 4.4-cc). Tributaries including Blackwater River, Faka Union Canal and River, and the Barron Canal and River, flow into several bays, including Pumpkin, Faka Union, and Fakahatchee.[159]

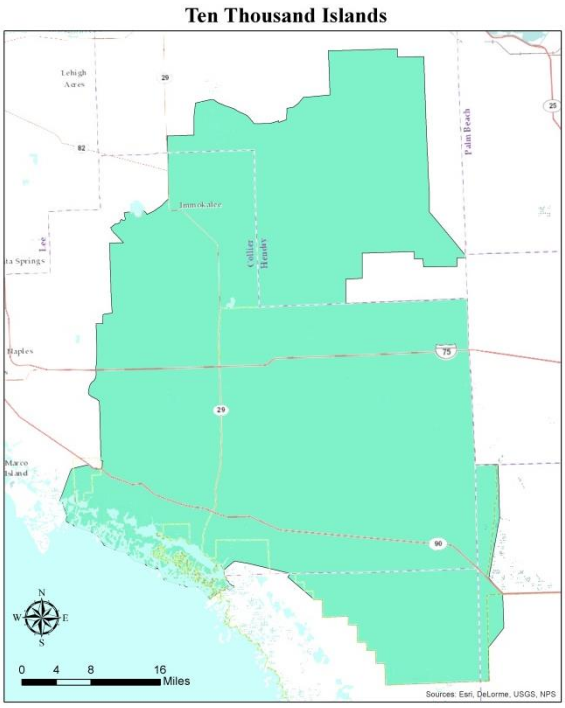


Figure 4.4-cc Ten Thousand Islands

An abundance of seafood and fishing opportunities drew humans to the area for thousands of years, starting with the Calusa Indians. Early pioneer settlers of the region eventually moved to the coastal destinations of Naples and Marco Island, resulting in the Ten Thousand Islands staying relatively undeveloped.[160] However, the natural sheet flow of freshwater in the area north of the Ten Thousand Islands has been significantly affected by the construction of canals during the development of the Southern Golden Gate Estates (GGE) subdivision.[161] The string of 58 miles of canals constructed as part of this project led to the diversion of freshwater flows into one large canal (Faka Union Canal) that drains into Faka Union Bay, thus lowering salinity in the Bay while raising salinity in adjacent waters.[162] The establishment of large-scale canal communities through dredge and fill operations within the Faka Union Canal system and the development of Southern GGE, Port of the Islands, Everglades City, and Goodland led to destruction of important habitat for the numerous species historically found in abundance in the region.[161] Projects such as the Picayune Strand Restoration Project have been initiated within the region to help restore natural flows and return impacted portions of the watershed to approximately historic conditions.[163]

The watershed is made up of various habitats, including cypress swamps, mixed shrubs, and pine flatwoods, and its vast mangrove swamps and freshwater marshes provide exceptional feeding and nursery grounds.[164] Nearly 200 fish species and 200 bird species are documented from these waters, including several endangered species such as the Florida manatee, snail kite, peregrine falcon, wood stork, and loggerhead, green, and Kemp's ridley sea turtles.[165] The estuary is also considered critical habitat for the smalltooth sawfish, by the NOAA.[91] Nature preserves also provide home to over six species of endangered or threatened animals, including the red-cockaded woodpecker, wood stork, Everglades snail kite, Cape Sable seaside sparrow, and the Florida manatee.[166] Most of the watershed is included in Florida Panther Primary and Secondary Zones, considered critical areas to sustain their population.[108]

Sixty-nine percent (1,063,663 acres) of the watershed is protected, giving the Ten Thousand Islands the highest percentage of conservation lands of the watersheds assessed in the Report Card. The watershed is home to 29,499 acres of the 35,000-acre Ten Thousand Islands National Wildlife Refuge. The refuge is composed almost entirely of mangrove forests and is considered the largest of its type in North America.[160] The majority of the 728,370-acre Big Cypress National Preserve (727,109 acres) is also located within the Ten Thousand Islands watershed. Another major protected area is the Fakahatchee Strand Preserve State Park (78,386 acres), famous for its orchids and bromeliads. The park is also the largest strand swamp in the world.[167, 168]

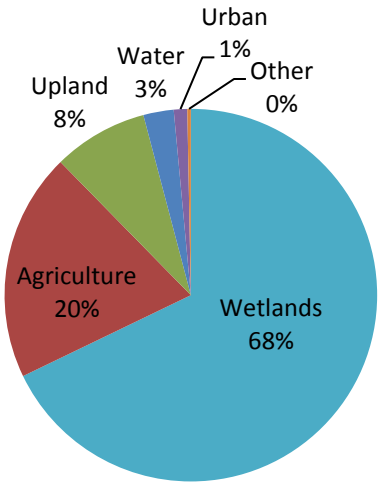


Figure 4.4-dd Ten Thousand Islands Land Uses

Land Use

The most prominent forms of land use in the Ten Thousand Islands watershed are wetlands at 68% and agriculture at 20% (Figure 4.4-dd).

Population Estimates

The Ten Thousand Islands watershed covers portions of Collier and Hendry counties. Communities within the Ten Thousand Islands watershed include Immokalee, Everglades City, Chokoloskee, and Ave Maria.[57] Population Estimates for Immokalee, Chokoloskee, and Everglades City are shown in Table 4.4-s. There is currently no population estimate data available for Ave Maria.

Table 4.4-s Ten Thousand Islands Population Estimates

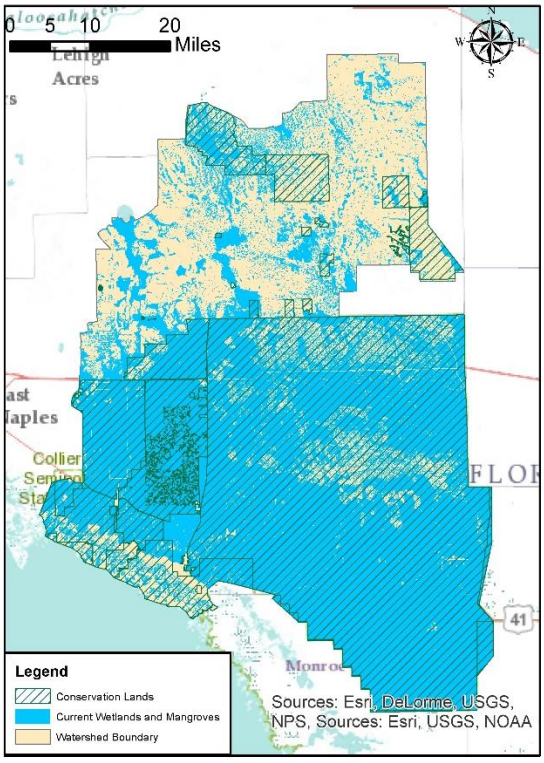
City	Population Estimate (2016)	Population Growth (2010-2016)
Immokalee	24,905 (2014)	3.1%
Chokoloskee	523 (2014)[169]	45.6%[170]
Everglades City	432	8.0%

Ten Thousand Islands

WILDLIFE HABITAT		
Grade Criteria	Acres	Percent/ Qualifier
Wetlands Remaining	1,046,564	89%
Mangroves Remaining	61,912	99%
Combined Percent		**94%**
Percent Conservation Lands	69%	Plus
Overall Grade		**A+**

Total Acreage: 1,565,549 Total WBIDs: 16

WATER QUALITY		
Grade Criteria	Percent Unimpaired	GPA/ Qualifier
Spatial Impairment	51%	2.00
Severity of Impairment	88%	3.67
Combined GPA		**2.56**
Percent Impervious Surface	0.2%	Plus
Hydrology (Descriptive)		Plus
Overall Grade		**C+**



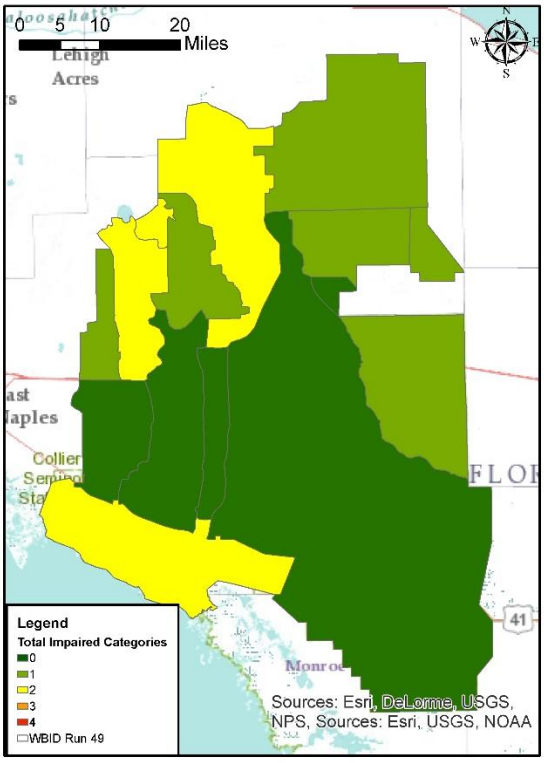


Figure 4.4-ee Ten Thousand Islands Report Card

Wildlife Habitat:

The Ten Thousand Islands watershed has 89% of the region's historic wetlands remaining and 99% of its historic mangrove coverage. The Ten Thousand Islands is renowned for its extensive mangrove forests and wildlife habitat and has the highest percentage of conservation lands (69%) of the watersheds evaluated in the Report Card. Consequently, the Ten Thousand Islands Wildlife Habitat Grade is **A+**.

The watershed includes vast tracts of preserved lands, including the Ten Thousand Islands National Wildlife Refuge, Big Cypress National Preserve, Fakahatchee Strand Preserve State Park, and the Picayune Strand State Forest. The Picayune Strand State Forest comprises the former Southern Golden Gate Estates planned subdivision, for which roads and drainage canals were built before the development failed and which impacted the habitat and hydrology of the area. The Picayune Strand Restoration Project, part of the Comprehensive Everglades Restoration Plan, involves plugging canals, building pump stations, and removing roads. The Conservancy of Southwest Florida's science team is participating in monitoring studies to gauge species recovery.

Water Quality:

The Ten Thousand Islands watershed water quality is in the mid-range, with 49% of the region impaired for at least one parameter category (Table 4.4-t). The watershed has the lowest percentage of impervious surface cover at 0.3%. The significant alterations caused by the Southern Golden Gate Estates are being substantially addressed by the Picayune Strand Restoration Project, resulting in a plus qualifier for hydrology. Therefore, the Ten Thousand Islands Water Quality Grade is **C+**.

Table 4.4-t List of Category Impairments in Ten Thousand Islands

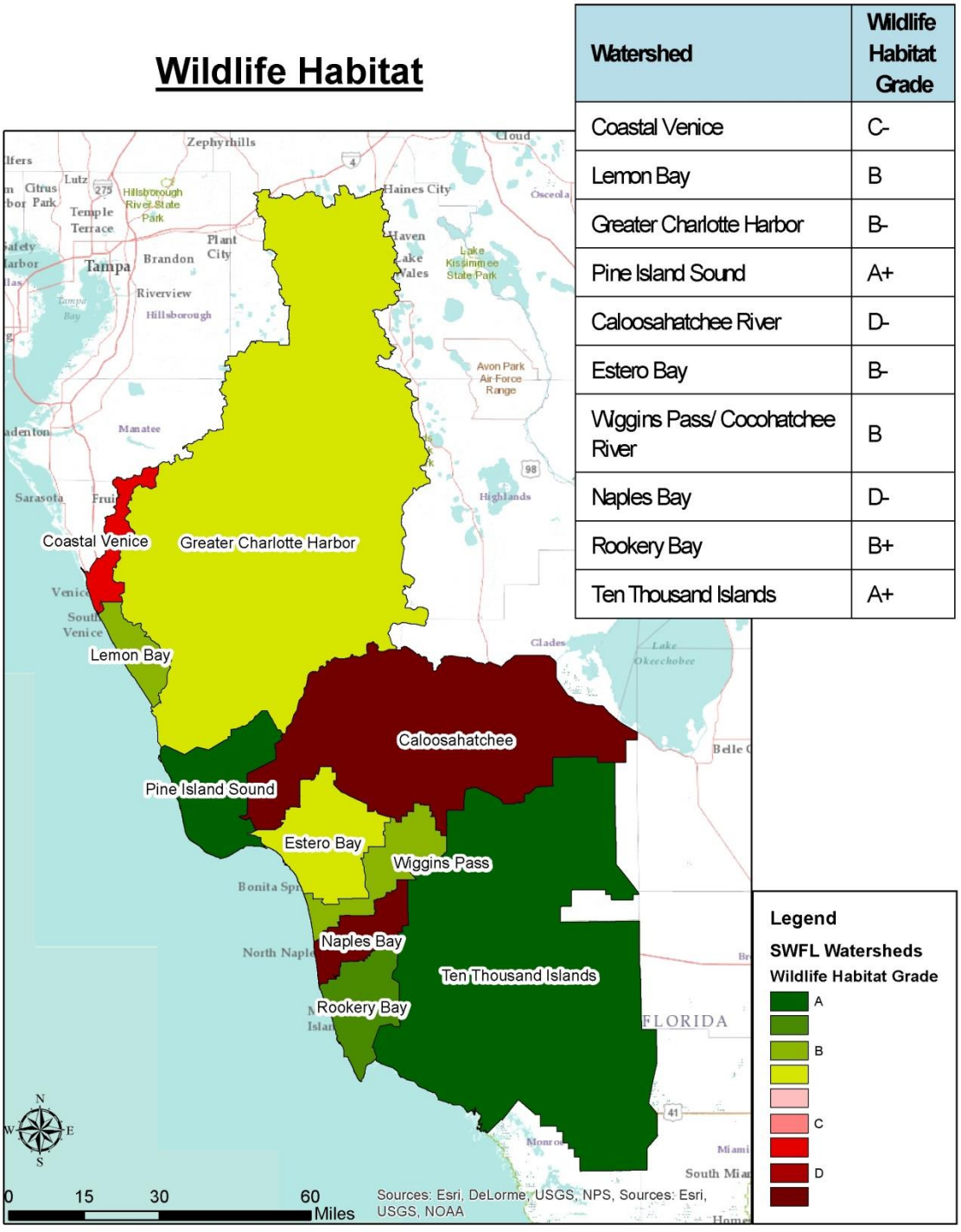
Ten Thousand Islands

Parameter Category	WBIDS Impaired	Acres Impaired
Nutrients	2	181,701.95
Oxygen	10	757,879.84
Pathogens	2	134,063.68
All	10	757,879.84
	Spatial Impairment:	757,879 acres
	Severity of Impairment:	1,073,645 acres

Low DO is the most prevalent impairment listing. The DO listings are a combination of category 5, with nutrients as the causative pollutant, and category 4d, with no causative pollutant identified. Agriculture is the second most common land use in the watershed besides wetlands, and runoff from agricultural operations could be contributing to nutrient related pollution problems. Mercury was the most pervasive impairment listing in the Ten Thousand Islands for the 2011 Report Card, and the water

quality score has improved in this report as a result of the delisting of mercury impairments due to the adoption of the statewide mercury Total Maximum Daily Load (TMDL) – see Appendix 7.5.

No TMDLs or Basin Management Action Plans (BMAPs) have been adopted in the Ten Thousand Islands watershed. Although hydrology has been significantly altered, particularly in the Picayune Strand, restoration in the area has filled the Prairie and Merritt Canals, and plans are underway to remove all roads and fill the additional canals. The planned and ongoing hydrologic restoration projects have improved hydrologic function in the watershed.



Watershed	Wildlife Habitat Grade
Coastal Venice	C-
Lemon Bay	B
Greater Charlotte Harbor	B-
Pine Island Sound	A+
Caloosahatchee River	D-
Estero Bay	B-
Wiggins Pass/ Cocohatchee River	B
Naples Bay	D-
Rookery Bay	B+
Ten Thousand Islands	A+

Figure 4.4-ff Wildlife Habitat Grades

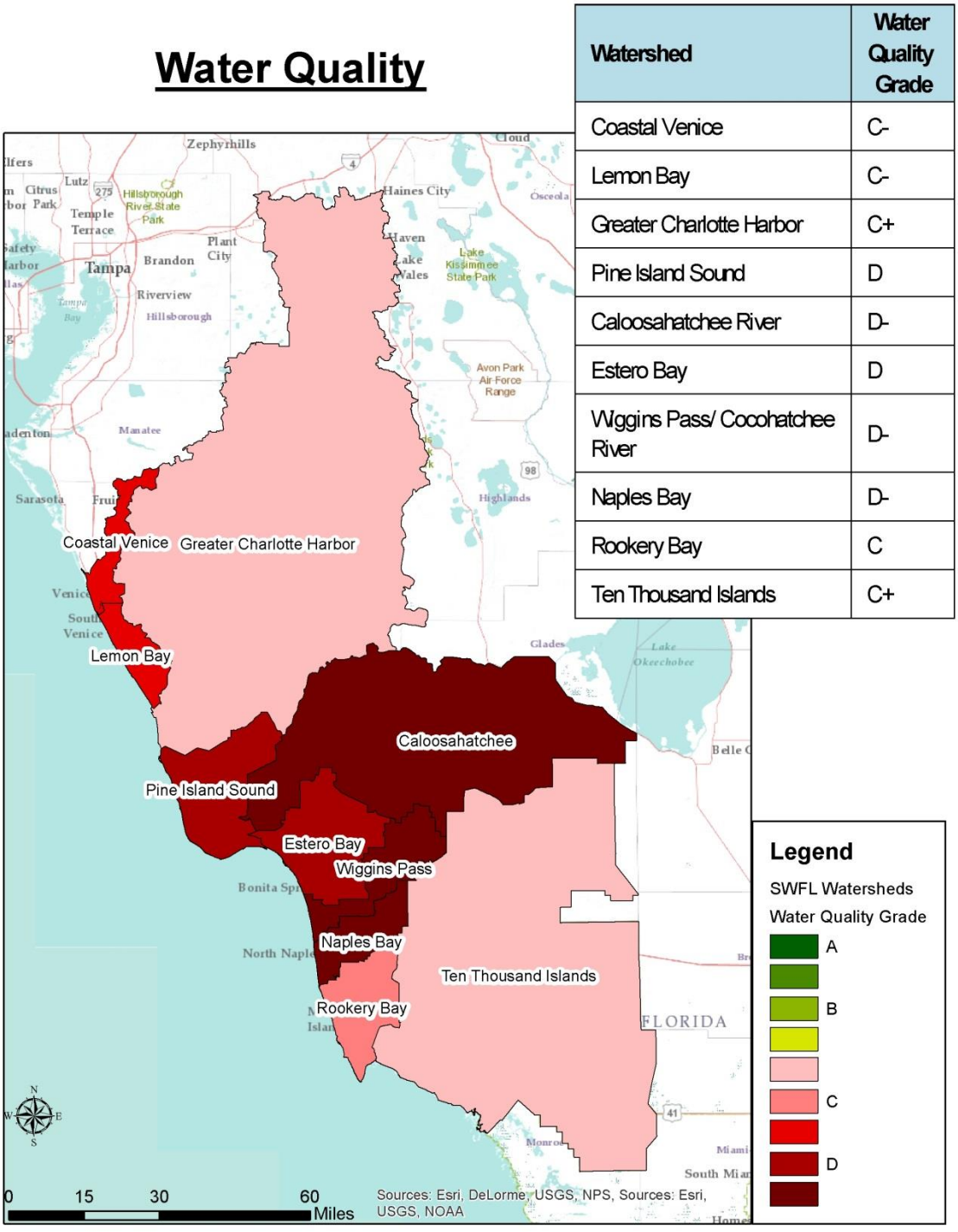


Figure 4.4-gg Water Quality Grades

4.5 Recommendations

4.5.1 Policy Recommendations

Prevent Additional Loss of Wetlands

The alteration of southwest Florida's wetland landscapes for the benefit of urban and agricultural development has drastically impacted drainage patterns, depleted water supply, and degraded water quality and wildlife habitat[171].

Historically, large projects like the Central and Southern Florida Flood Control Project authorized by Congress in 1948 did not take into account the ecological consequences of draining vast swaths of the historic Everglades. Another example is the southern Golden Gate Estates planned development that constructed canals and roads in approximately 55,000 acres of Collier County and destroyed wetland habitats and restricted groundwater recharge.

On both large and small-scale projects, local, state and federal agencies rarely deny permits for developments that fall within wetland or wildlife habitat areas.[172] Despite the "no net loss" wetlands policy at the federal and state level, which directs the three-step, avoid, minimize and mitigate strategy for wetland impacts, minimization measures are usually nominal and do not substantially reduce the loss of these sensitive lands to intensification. Mitigation measures can typically account for replacing lost function of the wetlands, but not necessarily the loss of wetland acreage; this results in an overall loss of wetland acres over time. Moreover, cumulative impacts of wetland and habitat loss, both coastal and inland, are not fully accounted for when the agencies make permit application decisions. The wetland permitting system at both the state and federal level does not require like-for-like replacement of wetlands. Consequently, in southwest Florida there has been a disproportionate loss of short-hydroperiod wetlands - seasonal wetlands important for wildlife habitat and aquifer recharge. The Waters of the United States rulemaking proposed at the Federal level in 2014 would have reinstated more protections for seasonal and isolated wetlands. Unfortunately, the Rule has not taken effect yet due to legal challenges and is in danger of being severely weakened or eliminated altogether.

Wetland loss calculated for the 2017 Report Card watersheds range from 11% in the Ten Thousand Islands to 70% in the Naples Bay watershed, with an average of 39% across all ten watersheds. The current upswing in the economy is reflected in the increased number of development applications and proposals, some of which may imperil the remaining wetlands and flowways. Attempts to permit projects that would impact mangroves and other salt water wetlands are also on the rise.

The consequences of the loss of wetlands' habitat, recharge and cleansing capabilities are far-reaching. Less water is held on the landscape to recharge aquifers and water drains off more quickly and at higher volumes.

The Conservancy recommends that local, state and federal decision-makers and agencies implement and enforce existing and new policies and regulations to protect critical wetlands and flowways. In

addition, the Conservancy recommends improving the standards of review for projects impacting wetlands and wildlife habitat, and increasing protections for wetlands, such as supporting proposals like the Waters of the United States rulemaking.

Support Hydrologic Restoration

Altered hydrology severely impacts the quantity, quality, timing and distribution of water deliveries to coastal areas. Therefore, restoring hydrology to pre-development conditions (to the greatest extent practicable) is an important strategy for protecting and restoring southwest Florida's estuaries. Hydrologic alterations can occur through increases in impervious surface cover, such as pavement; construction activities such as dredge and fill operations; canal construction; channelization of existing waterways; building water control structures; and road construction, which causes subsurface impaction[173] interfering with tidal flushing and both surface water and groundwater flow[174]. Another potential impact on hydrology is over-allocation of available water supplies through consumptive use permits. When water is over-allocated through permitting, it can result in lowering the water table, depletion of aquifers and also contribute to low flows in streams and rivers that flow into estuaries.

In many cases, it is impossible to completely restore an area to historic conditions. However, restoration can improve water retention and filtration and enhance water supply and water quality. Hydrologic restoration projects also contribute to wildlife habitat enhancement both within the estuaries and within the contributing watershed. The Picayune Strand project in Collier County can be a model for large-scale successful restoration. The project scope includes filling 48 miles of canals, degrading and removing 227 miles of roads, and building three pump stations to rehydrate the wetland areas.[175]

There are many other restoration projects planned or ongoing throughout the ten watersheds as detailed in Appendix 7.3. Often, the limiting factor for achieving timely hydrologic restoration is funding constraints. Restoration to correct hydrologic conditions can be an expensive endeavor. However, the ecologic and economic benefits derived from restoring hydrologic function in the watersheds is critical for maintaining the region's viability both from an environmental and economic standpoint.

The Conservancy recommends that decision-makers prioritize hydrologic restoration projects for funding and seek collaborative partnerships in order to achieve restoration to support southwest Florida's water quality, wildlife habitat, quality of life and economic viability.

Restore Water Quality

Water quality is an ongoing challenge throughout Florida. According to FDEP, in the 2016 305(b) report, 67% of assessed rivers and streams, 73% of assessed estuaries and 100% of assessed canals were not meeting state water quality standards (these percentages include waterbodies in category 5 and waterbodies with TMDLs).[176] These percentages only reflect waterbodies for which sufficient data was

available to meet the requirements for assessment. The numbers may be even higher, but without sufficient sampling and data collection, this is impossible to determine. Regardless, sufficient data is available to demonstrate that estuarine watersheds in southwest Florida are similarly struggling to meet applicable water quality standards.

Poor water quality can manifest in a number of ways, some visible – such as harmful algae blooms – and some invisible– like metals or bacteria. Yet whether seen or unseen, these indicators of poor water quality can be detrimental to both wildlife and human health. Due to southwest Florida's reliance on tourism and waterfront real estate, declining water quality is both an environmental and economic concern. A 2015 report published by the Florida Realtors Association indicated that a one-foot decrease in water clarity has an estimated 541 million-dollar negative impact on Lee County's property values.[177] Lee County includes portions of the Caloosahatchee, Pine Island Sound, Estero Bay, and the Wiggins Pass/Cocohatchee watersheds, areas with a significant influence on southwest Florida's economy and quality of life.

A number of steps can be taken in order to address water quality problems in Florida.

- Ensure protective water quality standards are in place and enforced. Prevent weakening of existing water quality standards and the adoption of new standards or assessment practices that weaken classification systems causing a negative impact on downstream recipients. Additionally, enforcement of the standards through effective permit limits, stormwater management, and best management practices (BMPs) are all critical to protect water quality. Some of the recent changes in Florida's water quality standards are discussed in Appendix 7.5 and include changes to nutrients and dissolved oxygen criteria.

- Adopt and implement measures for water quality restoration such as Total Maximum Daily Loads (TMDLs) and Basin Management Action Plans (BMAPs) in a timely manner. TMDL limits are set once a waterbody becomes impaired, and BMAPs are stakeholder and agency-driven restoration plans implemented to meet the TMDL. TMDLs and BMAPs exist throughout southwest Florida (see Appendix 7.7). However, the BMAPs in place in the Estero Bay and Caloosahatchee watersheds are continuing to see nutrient trends increasing in areas, despite some progress in meeting load reductions required by the TMDL through project implementation.[178] In Collier County, no BMAPs are in place to address the TMDLs adopted over seven years ago. Finally, the adoption of the statewide mercury TMDL has led to many waterbodies being removed from the verified impaired list for mercury, but has not addressed meeting the TMDL through a BMAP process.

- Adopt and maintain local stormwater and fertilizer ordinances. In order to adequately protect local water quality, county and city governments should adopt strong and protective ordinances to limit the harmful impacts of stormwater and fertilizers on waterways. Nutrient pollution, one of the most prevalent water quality issues in southwest Florida, can originate from several different sources, including inadequately treated stormwater and the improper application of fertilizer. Effective stormwater and fertilizer ordinances can aide in reducing nutrient pollution.

- Control pollution at the source. This is the cheapest and most effective means of protecting water quality. Adequately treating water onsite, whether it is urban or agricultural runoff, or discharges from wastewater treatment plants, prevents pollution from entering waterbodies, and can save time and money for local, state and federal agencies.

Therefore, to adequately protect and restore water quality the Conservancy recommends effective source control to treat water on-site, protective and enforceable water quality standards, protective local stormwater and fertilizer ordinances, and adherence to TMDLs and implementation of BMAPs.

Update Statewide Stormwater Management Standards for New Development and Redevelopment

Inadequate stormwater management (i.e., insufficient retention and treatment of stormwater on-site), creates widespread water quality impacts in southwest Florida. Nonpoint source pollution from stormwater carries many of the common pollutants that can impair the region's waters.[179] Today sophisticated stormwater management technology is readily available and continuing to apply outdated stormwater standards puts the region's waterbodies and estuaries at risk.

Traditional stormwater ponds (wet detention) typically used in new developments only remove approximately 40% of nitrogen and 70% of phosphorus generated.[180] "Treatment train" systems that utilize a number of different types of BMP systems in concert, such as swales, dry retention, constructed wetlands, filter marshes, pervious pavement, etc., are more effective at pollutant removal.

Between 2008 and 2010, updated stormwater regulations were considered, but not adopted, by FDEP during the development of a statewide stormwater rule. Reinitiating such rulemaking now is very important given that the real estate industry is thriving and driving the construction of new developments throughout southwest Florida. Local stormwater ordinances or stormwater utilities are other methods municipalities can employ to address stormwater runoff. Local municipalities can require more protective standards for new developments than the current standards applied by the state of Florida. Whereas, a stormwater utility can provide the resources to upgrade stormwater infrastructure or implement innovative technologies. Until updated statewide standards are adopted, the current strategy for stormwater treatment in new developments will continue to undermine efforts at water quality protection and restoration. For example, within the BMAP areas in the Estero Bay and Caloosahatchee watersheds, even though filter marshes and other projects have been implemented and there is a strong fertilizer ordinance, nutrient concentrations are still trending up in many areas. The extensive development continuing within the watersheds is the most likely contributor to this situation.

The Conservancy recommends the re-initiation and adoption of an updated and effective statewide stormwater treatment rule.

Protect Critical Environmental Lands for Water and Wildlife

Areas of intact wetlands and wildlife habitat still exist in southwest Florida, but are becoming increasingly vulnerable to development. Numerous regional studies including the Southwest Florida Feasibility Study/Southwest Florida Comprehensive Watershed Management Plan, Critical Lands and Waters Identification Project, and the Density Reduction/Groundwater Resource Area Study have identified target protection areas. These areas support essential wetlands and groundwater recharge zones for water supply, as well as habitat for some of Florida's most endangered species. As southwest Florida's population continues to increase and the urban boundary moves further inland from the coast, critical flowways, wildlife corridors and aquifer recharge areas are put at greater risk by expanding development and infrastructure.

In the past several years, southwest Florida and the entire state have reaffirmed the public's strong support for protecting natural areas through conservation land acquisition. In 2014, Florida's Water and Land Legacy constitutional amendment passed with 75% of Florida voters affirming the need to reinstate funding for the Florida Forever state land acquisition program. In 2016, 84% of Lee County voters supported the continuation of the Conservation 20/20 program, and in 2017 Collier County reinitiated the land acquisition component for Conservation Collier.

Despite strong public support for acquiring conservation land, Florida Forever remains underfunded by the state legislature. Florida Forever projects are located throughout the estuarine watersheds, and the resources necessary to complete these land acquisitions are critical. Conservation easements through Florida Forever and the Rural and Family Lands Program also require additional funding. Conservation easements offer a way to protect the natural resources or agricultural character of a property by removing development and/or intensification rights, while the landowner retains title to the land itself. Another key program through Florida Forever, Florida Communities Trust, offers grants to partner with local communities for open space protection and recreational opportunities.

Protecting natural areas is foundational for the continued sustainability of not only estuarine watersheds, but also the entire state. Furthermore, it is the most cost-effective way of preserving southwest Florida's water quality and drinking water supply for future generations. Such land acquisition projects work in conjunction with other water protection mechanisms.

The Conservancy recommends a strong emphasis by the state's elected leaders to fully fund state land acquisition and conservation easement programs to support landscape level conservation priorities. The Conservancy also recommends continued support of county land acquisition programs in order to meet the specific needs of local communities. Prioritizing the protection of natural areas will safeguard the state's tourism-based economy and its extraordinary water and habitat resources.

Create Planning Tools that Direct Intensification Away from Sensitive Natural Resources

Innovative land use planning techniques can be an important mechanism for balancing the needs of the environment, agriculture and future development. Unfortunately, such planning policies may not function in the manner originally envisioned for a variety of reasons, including a lack of buy-in from local elected officials, resistance on the part of landowners or program complexity. Whether the program uses incentives, such as Transfer of Development Rights, or design flexibility to encourage specific types of development in appropriate locations, the Conservancy advocates the following principles as guidance for smarter planning:

- Location, location, location: Avoiding impacts to critical natural resource areas should always be the top priority. For example, in Eastern Collier County, we continue to advocate for changes to the Rural Lands Stewardship Area program that would direct future new towns and cities away from primary panther habitat.

- Type of development: Sprawl is costly, and that cost is shouldered by taxpayers. The proliferation of massive, platted subdivision in the 1950's – 1970's, combined with the more recent popularity of large, gated residential communities requires extensive transportation and associated amenities. Conversely, the opposite of sprawl is appropriately located mixed-use development, which focuses on providing walkable, transit-accessible communities less dependent on vehicles to meet basic everyday needs.

- Timing and sequencing of development – Redevelopment and urban infill should be prioritized over expanding urbanization into rural, agricultural areas. Agricultural lands often serve as important habitat for listed species, such as the Florida panther, and are important for our nation's food independence. That being said, advancing sustainable agricultural practices that improve water conservation and water quality in southwest Florida's working landscapes through Best Management Practices and other mechanisms is another critical component of improving watershed health.

- Dense, compact development can be part of the solution – density can allow for more walkable, transit-oriented development, which results in a number of ecological benefits. For example, a more compact footprint for development can tie directly to a reduction in water use. Within southwest Florida, water use per person is extremely high, and about half of this water use goes to landscape maintenance. Higher density on a smaller footprint can result in more compact development (with less lawn to water) thus decreasing water usage.

Transportation planning is tied closely to land use planning and, just as new developments need to be directed to areas where they will least impact hydrology, wetlands, wildlife movement and key habitat areas, so too should new and expanded roadways be located away from sensitive natural areas. Numerous projects in Southwest Florida, such as the 951 Extension in north Collier and south Lee counties and a new I-75 interchange in eastern Collier County, threaten to bisect key water and wildlife habitat areas. New roadways extending out to rural areas, such as the Vanderbilt Beach Extension, will spur sprawl-style development more than they alleviate congestion and serve existing residents' needs.

Transportation improvements should avoid impacting key natural resources and focus on meeting existing community needs.

The Conservancy recommends that land use and transportation planning initiatives direct impacts away from sensitive ecological resources, while protecting agricultural lands that support important habitat needs.

Implement Comprehensive and Consistent Water Quality Monitoring

Water quality data collection is foundational for determining whether a waterbody is or is not meeting water quality standards. Without data, there is no information upon which to base assessments or identify when and where water quality problems originate. Consistent sampling provides a long-term dataset to assess the health of estuarine ecosystems and associated watersheds.

Currently, the clearinghouse for Florida's water quality data is through FDEP's Watershed Assessment Program and is housed in the online database STORET. As discussed in Appendix 7.4, different entities (local governments, FDEP, the water management districts, etc.) collect water quality data and upload it to STORET. FDEP uses the data in STORET in the rotating watershed assessments to determine whether waters are meeting water quality standards. These assessments form the basis for the water quality grades in the Estuaries Report Card. Over the past several years, FDEP has made many of the assessment lists (like the verified impaired waterbodies) more readily accessible to the public with website-based tools. However, there were still a number of accessibility challenges and data gaps encountered in the compilation of the Report Card. For example, many waterbodies throughout the watersheds are categorized in the "no data", or "insufficient data" categories for various parameters using the assessments that were available at the time of the Report Card's compilation (see Appendix 7.6).

Another potential influence on data availability is the promulgation of revised water quality standards or changes in assessment practices. Generally, standards are revised in order to reflect new science, sometimes as a result of federally promulgated criteria by EPA, sometimes as a state initiated process through the Clean Water Act required Triennial Review of State Water Quality Standards. When standards change, one of the results can be different data sampling requirements and assessment methodology. Some examples include: more samples may be required, or samples taken at specific times of the year in order to be temporally independent, or the samples may go from an annual average to an annual geometric mean. If data sampling is not increased (whether through lack of staff resources/training, funding, or other constraints), it can lead to more waterbodies with insufficient data to make an assessment determination. See Appendix 7.5 for a discussion of recently adopted water quality standards for dissolved oxygen and nutrients.

Florida's environment, economy and quality of life rely heavily on the health of streams, rivers, lakes, estuaries and coastal waters. Thus, identifying when waterbodies are polluted or at risk of becoming polluted is the underpinning for any water quality protection and restoration program. Moreover, a

data collection program at the scale required by Florida's vast mosaic of waterbodies necessitates robust funding and technological resources, as well as sufficient staffing in order to be successful.

Therefore, the Conservancy recommends that the state government and local jurisdictions prioritize funding for water quality data collection and assessment in order to identify water quality problems quickly and accurately.

4.5.2 Public Recommendations

Ways YOU can Protect Our Water and Wildlife Habitat!

Although large-scale water restoration projects and strong, enforceable regulations are important, everyone can take action to improve the quality of local waterways.

- **Dispose of Your Waste Appropriately.** Waste often collects in stormwater drains, increasing pollution. Make sure that you don't put any waste into stormwater drains, including fertilizers, motor oils, paints, grass, and pet waste. Wash your car on your lawn. Dispose of hazardous waste (including motor oil) at your county's collection facility. Participate in your county's yard waste collection program. Learn how to compost your food waste.[181] Never dispose of grass clippings or other yard waste down storm drains, into waterways, or onto impervious surfaces. [182]

- **Minimize the Impact of Your Yard.** Fertilizers, herbicides, and pesticides are key pollutants in stormwater. To reduce these impacts, do not apply fertilizer before a rain event, do not allow fertilizer to be dispersed too close to impervious surfaces (like the sidewalk, driveway, or street) or waterbodies (like canals, swales, or storm drains), use products with slow-release nitrogen, and keep your grass clippings on the lawn as a natural fertilizer or use summer-safe products that do not contain nitrogen or phosphorous. Use of reclaimed water for irrigation would reduce the amount of fertilizers to be used on your lawn. Be aware of local fertilizer ordinances and make sure your lawn company is following best practices.[Error! Bookmark not defined.] Replacing your patio, walkways, and driveway with permeable pavers will also increase the amount of water retention in your yard, and decrease runoff.

- **Conserve Water.** Water levels are stressed during the winter months with the increase in population and lack of rainfall, and overall population in Florida continues to grow – resulting in greater demands on finite water supplies. According to 1000 Friends of Florida's Water 2070 Report, "the single most effective strategy to reduce water demand in Florida is to significantly reduce the amount of water used for landscape irrigation."[183] By conserving water, you will also be reducing your water bill! Visit Lee County's Water Conservation site and review the recommendations in the Water 2070 Report for lists of water-saving techniques for your home and your lawn.[184]

- **Maintain Your Septic Tank.** Septic tank leaks are not only harmful to the environment, but are also expensive to fix (and no fun to mess with!) Prevent damage to your tank by getting it pumped every 4 to 5 years, avoid flushing wipes (even flushable ones), and spread out your laundry loads over the week.[Error! Bookmark not defined.] Have your septic tank inspected regularly.

- **Participate in Cleanup Days.** Many counties have volunteer workdays to remove litter near coastal areas. Help clean up a local spot for a few hours at an event near you!181

- **Convert your yard into a Florida-friendly Landscape.** Having a native lawn will maximize the yard's perviousness (ability to absorb water) and can eliminate the need for fertilizers or yard chemicals. The University of Florida has a Florida-Friendly Landscape™ program that can help get you started.[185] Natives for Your Neighborhood is another helpful south Florida resource.

- **Join a Volunteer Water Quality Monitoring Program.** Monitoring water quality is critical to evaluating the health of an estuary. The Report Card found that there is often not enough data available to know whether all of our waterbodies are meeting state standards. There are two notable water monitoring groups that residents can join in the region. The Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network, comprised of over 100 volunteers, regularly conducts water quality monitoring throughout the six Aquatic Preserves in the Charlotte Harbor Estuary. After receiving initial classroom training, volunteers collect monthly water samples and input their data. To learn more, visit the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network website.[186] Residents can also join the Florida LakeWatch program consisting of 1,800 trained volunteers who monitor 600+ lakes, rivers and coastal sites in more than 40 counties. Find a LakeWatch site near you.

- **Contact Your Government Representatives.** Government officials at the local, state and federal levels make decisions impacting whether a residential development or hydrologic restoration project will be built as well as many other decisions that impact the health of our estuaries. Call or send an e-mail to your representatives, asking them to approve projects that improve the environmental health of your estuary. Sign up for the Conservancy's action alerts to be notified when important issues are being considered that need your input!

- **Become a member of the Conservancy.** The Conservancy works on behalf of 6,000 member families to protect Southwest Florida's natural resources and wildlife. The more members we have, the stronger voice we have as an organization when speaking with government agencies and businesses. Also, your annual contribution will fund our research and advocacy to protect the environment.

- **Support local, state and federal policies that protect wetlands and other environmentally-sensitive lands.** One acre of wetland can store 1-1.5 million gallons of floodwater[187], and wetlands help filter out pollutants. Other natural landscapes provide critical buffer areas for waterbodies as well.

- **Support land acquisition efforts to protect and permanently preserve coastal wetlands.** This not only benefits the environment, but is also good for your wallet. An economic study completed in 2008 estimated that coastal wetlands provided $23.2 billion on an annual

basis for storm protection.[188] With 1,350 miles of shoreline[189], Florida needs these natural buffers.

- **Get out there and enjoy nature!** Unplug from your technology, round up family and friends and take a walk through a preserve, a kayak trip in an estuary or a swamp walk through the cypress. Consider one of the many educational programs, boat rides or other activities offered by the Conservancy. Being immersed in nature is fun and good for you.

- **Share your Knowledge!** People who know about environmental issues are more likely to take steps to reduce their impact. Distribute copies of this Report Card and other educational materials to your family, friends, and neighbors. Learn about local, state and federal environmental regulations. Encourage others to reduce their waste pollution. Set up an educational activity for your kids or a class to demonstrate the impacts of pollution and habitat loss on the environment and wildlife.

APPENDICES

5 APPENDIX A: Detailed Methodology

5.1 Constraints

Several constraints were encountered during the development of the 2017 Estuaries Report Card, which limited the amount and type of data available and also restricted direct comparison of results with those from the 2005 and 2011 versions.

Boundary Revisions

The watershed boundaries in the Report Card are based upon the Florida Department of Environmental Protection's (FDEP) Waterbody Identification numbers (WBIDs) segments, which together are aggregated into watersheds associated with each estuary. FDEP modifies these boundaries periodically, based upon input from stakeholders and local governments or local agency staff, in order to best represent the flow and characteristics of the waterbody. WBID changes occurred between WBID version Run35 used for the 2011 Report Card and WBID version Run49 used for Estero Bay, Wiggins Pass/Cocohatchee, Naples Bay, Rookery Bay, and the Ten Thousand Islands watersheds in the 2017 Report Card (Figure 5.1-a). When boundary modifications are made, it can alter not only the WBID boundary itself but also the acreage of the watershed. Differences in acreage totals, like historic mangrove or wetland coverage, and current land use coverages, results in baseline data changes from one Report Card to the next.

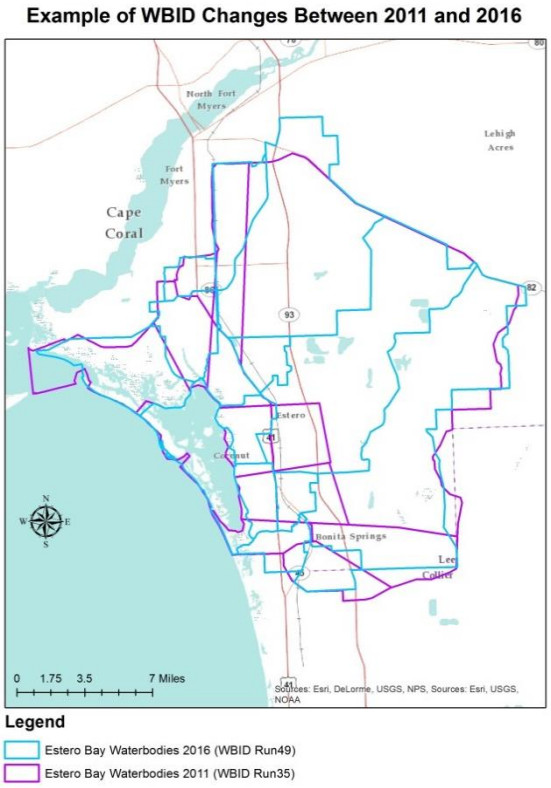


Figure 5.1-a Boundary Revisions in Estero Bay between WBID Runs 35 and 49

The Conservancy considered various options, including using old watershed boundaries, to address this discrepancy. However, the Water Quality grading is based upon assessment data tied to specific WBIDs, and using prior watershed boundaries would not accurately portray the most recent water quality assessments. Moreover, although the acreages for mangroves and wetlands did change in several watersheds, the percentages remaining did not change appreciably. Therefore, the Conservancy chose to use the most updated versions of the watershed boundaries associated with the water quality assessment data in order to consistently calculate the Water Quality grades. The WBID changes in the watersheds have been documented and include the acreage alterations (Table 5.1-a).

Table 5.1-a Acreage Differences between WBID Runs 35 and 49

Watershed	Acreage difference between WBID Runs 35 and 49
Estero Bay	629
Wiggins Pass/Cocohatchee River	135
Naples Bay	-2,615
Rookery Bay	292
Ten Thousand Islands	-7,458

Availability of Water Quality Assessment Data

FDEP's watershed assessment cycle runs on an annual rotation through five different watershed groups in Florida, generally assessing one group per year (Figure 5.1-b). One complete assessment of all five groups is known as a cycle. Watersheds in the Report Card include parts of Groups 1, 2, and 3. The 2011 Report Card utilized data current through Cycle 2 for Groups 1, 2, and 3.

Assessments for Groups 4 and 5 were completed in 2010 and 2011/2012, respectively, to round out Cycle 2. Group 1 Cycle 3 was completed in 2012/2013. Due to the adoption of new water quality standards for Nutrients and Dissolved Oxygen in 2013, FDEP delayed the Group 2 Cycle 3 assessment until 2014. Subsequently, issues with implementing the new water quality standards, particularly the nutrient standards, caused additional delay in the assessment process. The Group 2 Cycle 3 revised lists were published in late 2015, and the Group 3 Cycle 3 draft lists were published in January 2016. As of April 1, 2016, Group 2 had not been adopted by Secretarial Order, and Group 3 remained in draft form. Therefore, neither Group 2 nor Group 3 could be used in the 2017 Report Card.

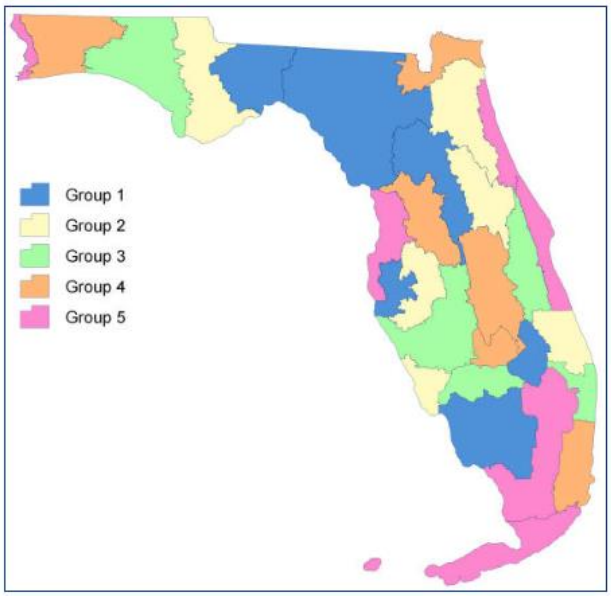


Figure 5.1-b Groups for FDEP Water Quality Assessment

As a result, the 2017 Report Card was only able to use new data for the Water Quality grades in the Group 1 watersheds—Estero Bay, Wiggins Pass/Cocohatchee, Naples Bay, Rookery Bay, and Ten Thousand Islands. The remaining five watersheds' calculations were run again, using essentially the same data set as the 2011 ERC. There were a few amendments to the assessment lists in 2014 that have been captured in the 2017 Report Card calculations. Future Report Cards will ideally benefit from new watershed assessment data for all ten estuaries.

5.2 GIS Methodology

Calculating the Land Area for each Watershed

1) WBID Run 35 & 49 shapefiles were created for each watershed
    a. WBID Run 35 & 49 shapefiles were downloaded from the FDEP website (Table 5.2-a)
    b. WBIDs in a specific watershed were selected by attributes, then a watershed layer from selected attributes was created
        i. Some watersheds can be selected by their Planning Unit. For other watersheds, specific WBIDs had to be selected. All of the WBIDs that were outer beaches or part of the Gulf of Mexico (8000's range) were removed from selection.

Table 5.2-a List of WBIDs with each Watershed

Watershed	Planning Unit	WBIDs
Coastal Venice (Run 35)	Sarasota Bay	1924, 1924A, 1924B, 1987, 1994, 1996, 2002, 2009, 2009A, 2015, 2015A, 2016, 2017, 2018
Lemon Bay (Run 35)	Lemon Bay	All < 8000
Greater Charlotte Harbor (Run 35)	Charlotte Harbor Proper, Lower Myakka River, Lower Peace River, Middle Peace River, Peace River, Upper Myakka River, Upper Peace River	All < 8000
Caloosahatchee River (Run 35)	Caloosahatchee Estuary, East Caloosahatchee, Orange River, Telegraph Swamp, West Caloosahatchee	All
Pine Island Sound (Run 35)	Pine Island	All < 8000
Estero Bay (Run 49)	Estero Bay	All < 8000
Wiggins Pass/ Cocohatchee River (Run 49)	Southwest Coast	3259A, 3259B1, 3259W, 3278C, 3278D, 3278E, 3278F, 3278Q1
Naples Bay (Run 49)	Southwest Coast	3259T, 3278K, 3278Q2, 3278R1, 3278R2, 3278R3, 3278R4, 3278R5, 3278S
Rookery Bay (Run 49)	Southwest Coast	3278O, 3278P, 3278U, 3278V, 3278Y
Ten Thousand Islands (Run 49)	Interdrainage Area, Southwest Coast	All in Interdrainage Area. Southwest Coast use 3259I, 3259M, 3278G, 3278H, 3278I, 3278L, 3289A

a. To create watershed Boundary, the Dissolve tool was used on the WBID Run shapefile

2) Total land area was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics).

Calculating Current Land Use

1) Current Land Use shapefiles had to be created for each watershed. To have the most up-to-date data, several years of land use data in both SFWMD and SWFWMD had to be combined. The following watersheds required the specific land use data sets (Table 5.2-b).

Table 5.2-b Sources of 2017 Report Card Land Use Data

Watershed	Land Use Data
Coastal Venice	2011 SWFWMD
Lemon Bay	2011 SWFWMD
Greater Charlotte Harbor	2008 SFWMD, 2011 SWFWMD, 2012 SFWMD
Caloosahatchee River	2008 SFWMD, 2011 SWFWMD, 2012 SFWMD
Pine Island Sound	2011 SWFWMD, 2012 SFWMD
Estero Bay	2012 SFWMD
Wiggins Pass/ Cocohatchee River	2012 SFWMD
Naples Bay	2012 SFWMD
Rookery Bay	2012 SFWMD
Ten Thousand Islands	2004 SFWMD, 2008 SFWMD, 2012 SFWMD

a. The datasets were clipped to appropriate watershed boundaries

b. For watersheds requiring more than one dataset, the shapefiles had to be layered by most recent year, and overlapping data had to be avoided. To do this, the 2012 layer was intersected with each of the older layers separately. Then, the intersection was erased from each older layer. Then, the 2 erased older layers were intersected with each other, and the resulting intersection was erased from the oldest layer. Then, the 3 shapefiles from all three years were joined using the Union tool.

i. For example: Charlotte Harbor has 2012, 2011, and 2008 data

1. Intersect 2012 and 2011.
2. Erase the Intersection from 2011, which becomes "Final 2011" layer
3. Intersect 2012 and 2008
4. Erase the intersection from 2008, which becomes "Erased 2008" layer
5. Intersect "Final 2011" and "Erased 2008"

6. Erase the intersection from 2008, which becomes the "Final 2008" layer
7. Union the 2012, "Final 2011", and "Final 2008" layers

2) The number of acres for each land use in a given watershed were calculated as follows:

a. To calculate the number of acres for each data point, the field "Acres" (double) was added to the attribute table and the geometry was calculated (acres).

b. To identify each land use, specific FLUCCS codes had to be selected. Land Uses were divided into the following FLUCCS codes (Table 5.2-c).

Table 5.2-c FLUCCS Code General Descriptions

FLUCCS code range	Land Use
1000s	Development
2000s	Agriculture
3000s	Non-forested Upland
4000s	Forested Upland
5000s	Open Water
6000s	Wetlands
7000s	Barren Land
8000s	Transportation and Utilities

c. The attribute table view was switched to viewing only the selected attributes

d. The sum of the "Acres" field was calculated and entered into a spreadsheet.

e. In the spreadsheet, Non-forested Upland and Forested Upland land uses were combined to create the "Upland" Land Use. Barren Land and Transportation and Utilities were combined to create the "Other" Land Use.

<u>Calculating Percentage of Wetlands Remaining</u>

1) Predevelopment Vegetation shapefiles were created for each watershed. Data from SFWMD and SWFWMD had to be combined to cover the entire region.
   a. The SFWMD and SWFWMD shapefiles were downloaded
   b. To avoid overlapping, the layers were intersected.
   c. The intersection was erased from the SWFWMD shapefile.
   d. The erased SWFWMD file and the SFWMD file were combined using the UNION tool.
   e. In the combined file, all wetlands land use features had to be selected

      i. "Veg Soils" = Cypress, Hydric Flatwood, Hydric Hammock, Mangrove, Tidal Marsh, Marsh, Swamp Forest, Wet Prairie, Scrub Cypress

ii. "COMMUNITY" = Cypress Swamp, Hardwood Swamp, Herbaceous Wetlands, Mangrove Swamps, Salt Marsh

f. A layer was created from these selected features.

g. The new layer was clipped to each watershed boundary

2) The total acreage of predevelopment wetlands was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics).
3) Current Wetlands shapefiles were created for each watershed, with data coming from the most recently updated Land Use data (to create the Land Use shapefiles, see above)

a. The updated Land Use file for the watershed was added to the map
b. All data points within the 6000s (wetlands) FLUCCS code range were selected
c. A layer was created from the selection

4) Total acreage of current wetlands was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics)
5) The 2017 Report Card wetlands acreage was also compared to the 2011 Report Card (ERC) wetlands acreage. To create the 2011 ERC Land Use shapefiles, refer back to 2011 ERC methodology.

a. The new and 2011 ERC Land Use shapefiles for each watershed were added to the map (in 2011 ERC wetlands analysis folder)

b. A 2011 ERC Current Wetlands shapefile was created using the same methods as the 2017 ERC, outlined above

c. In order to identify lands in the 2011 ERC that had been converted to wetlands in the 2017 ERC, the 2011 ERC Land Use shapefile was clipped to the 2017 ERC Current Wetlands shapefile
    i. Information from individual FLUCCS codes was summarized in the attribute table, while calculating the sum of acres in each FLUCCs code
    ii. Categories were further condensed in Excel to the 8 major land use ranges outlined above
d. In order to identify wetlands in the 2011 ERC that had been converted to other land uses in the 2017 ERC, the 2017 ERC Land Use shapefile was converted to the 2011 ERC current wetlands shapefile
    i. Information from individual FLUCCS codes was summarized in the attribute table, while calculating the sum of acres in each FLUCCs code
    ii. Categories were further condensed in Excel to the 8 major land use ranges outlined above

e. In order to map the location of specific land use changes, specific FLUCCs code ranges were selected in the new land use changes shapefiles.

Calculating the Percentage of Mangroves Remaining

1) Predevelopment Mangrove shapefiles were created for each watershed. Data from SFWMD and SWFWMD had to be combined to cover the entire region (The created predevelopment wetlands shapefile can also be used).
    a. Add the combined predevelopment vegetation layer for each watershed (see instructions above for how to create it)
    b. The attributes from the following fields were selected and a layer was created from the selection
        i. "Vegsoils"= "Mangrove"
        ii. "Community"= "Mangrove Swamps"
2) Total acreage of predevelopment mangroves was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics).
3) Shapefiles for current Mangroves were created for each watershed. The most updated data came from the FFWCC 2014 dataset.
    a. Data for 2014 Mangrove land area was downloaded from FFWCC website.
    b. Data was clipped to each of the watershed boundaries
4) Total acreage of current mangroves was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics).

Calculating the Percentage of Conservation Lands

1) A shapefile was created with Conservation Lands and Aquatic Preserves for each watershed.
    a. The December 2014 Conservation Land and 2011 Aquatic Preserves shapefiles were downloaded from the FNAI website.
    b. To avoid double-counting, the two shapefiles were intersected
    c. The intersection was erased from the Aquatic Preserves 2011 layer.
    d. The erased layer and Conservation Lands Dec2014 Layer were combined using the Union tool.
    e. The combined shapefile was clipped to each watershed boundary
2) Total acreage of conservation lands was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics)

Calculating Acres of Impaired Waters

1) Spreadsheets were prepared for each basin group that contained the WBID, watershed, level of impairment (4d or 5) and parameter category.
    a. The water monitoring data was downloaded from the FDEP website.
    b. The parameter column was renamed "parameter" and a new column was added named "parameter category".
    c. The parameter column was sorted A-Z, and parameters not included in the Conservancy of Southwest Florida watershed parameter categories were deleted.
    d. Each parameter was assigned to the appropriate parameter category (Table 5.2-d).

Table 5.2-d General Parameters Used for 2017 Report Card

Parameter Category	Parameters
Biology	Biology
Metals	Cadmium, Copper, Iron, Lead, Mercury
Nutrients	Chlorophyll-a (chl-a), Historic chl-a, Trophic State Index (TSI), Historic TSI, TSI Trend, Unionized Ammonia
Oxygen	Biological Oxygen Demand (BOD), Dissolved Oxygen (DO)
Pathogens	Bacteria, Fecal Coliform
Physical	Alkalinity, Chloride, Dissolved Solids, Specific Conductance, pH, Turbidity/Total Suspended Solids (TSS)

    c. The spreadsheet was sorted by parameter category.
    d. Each parameter category, as well as a list with all of the parameters, was copied and pasted into separate worksheets in the Excel workbook (i.e., one worksheet for Biology, one worksheet for Physical, All Impairments, etc.)
2) Shapefiles were created for each watershed by impaired parameter category
    a. WBID Run shapefiles for each watershed were copied and pasted into a folder for each basin and then renamed by parameter (i.e., LemonBay5Metals).
    b. All WBID Run shapefiles were added to map.
    c. Using the "join" function, each spreadsheet was joined to a shapefile utilizing the "keep only matching records" function (Note: any joins that returned zero records were not kept).
    d. For each of the joined records, data were exported and saved as a shapefile.
    e. This new shapefile was added to the map.
3) Total acreage of each of the impaired parameter categories was calculated by adding the field "Acres" (double) in the attribute table, then calculating the geometry of the field to acres, and then calculating the sum (statistics)
4) To create the maps, parameter categories listed in Categories 4d and 5 were combined using the Union tool

Calculating the Number of Impaired Parameters for each Watershed

1) As noted above, six parameter categories were used to categorize the types of impairments under which the WBIDs were listed. However, a WBID can have more than one impaired parameter in a given parameter category (e.g., cadmium and copper). The GIS files only list a WBID when a category has been impaired at least once, which is why ArcGIS was used for this calculation.
2) Shapefiles were created to combine all of the impaired parameters in a watershed
    a. The impaired parameter category shapefiles were added for a specific watershed (e.g., LemonBay5Metals, LemonBay5Nutrients, etc.)
    b. The impaired parameter category shapefiles (Oxygen, Metals, etc.) were combined into one shapefile using the Merge tool.
        i. The merge left some WBIDs in separate columns from the rest of the data. To ensure all data were counted, editing mode was started, and all of the WBID numbers that were separated were copied/pasted into the first WBID column.
    c. The number of impaired categories was calculated and added to the attribute table
        i. The WBID Column was summarized to get the number of times that WBID is listed, and the resulting table was added onto the map
        ii. The new table of counts was joined to the merged shapefile using the "Match All Records" function
3) To make the map, the symbology of the merged file was organized by the Category "WBID Counts."
    a. Values not included in that watershed were added to maintain a full spectrum
    b. Another watershed WBID Run shapefile was added underneath the watershed impairment file to represent WBIDs with no impairments

Calculating the Number of Acres of Waters with missing data

1) The same steps above were used to calculate the acres of waters with missing data, except that WBIDs listed in Categories 3a, 3b, and 3c were used and joined to a single shapefile containing all ten estuaries. To do this, the 10 watershed WBID Run shapefiles were added to a map, and then the Merge tool was used for all of them to make one shapefile. Categories 3a and 3b were combined into one Excel workbook/list, and Category 3c had a separate Excel workbook.

Calculating the Number of Impervious Acres

1) Shapefiles of Impervious Surface for each watershed were created as follows:
    a. A national Impervious Surface raster file was downloaded from the 2011 National Land Cover Database housed by the Multi-Resolution Land Characteristics Consortium website.

   b. The Raster file was clipped to each of the ten watershed boundaries, using the Raster Processing-Clip tool. Both the "Use Input Features for Clipping Geometry" and "Maintain Clipping Extent" functions were selected.
   c. The clipped raster was converted to a polygon using the Raster to Polygon tool.
   d. The new shapefile and the watershed file were combined using the Union tool.
   e. Any data outside the WBID boundaries were removed by selecting the attribute (WBID = "") in the combined layer, switching the selection, creating a new layer from the selected features, and exporting the resulting layer.

2) All Open Water was removed from the layer to reflect land cover imperviousness.
   a. The Land Use shapefiles created for the watershed were added to the map (see Calculating Current Land Use above)
   b. All FLUCCS codes in the 5000s open water category were selected.
   c. The Selection was switched to reflect only land data, and then a layer was created from the selection
   d. The Impervious Surface/watershed layer was clipped to the Land Use Selection layer
3) The number of impervious acres had to be calculated using the GRIDCODE percentages of imperviousness listed in the NLCD dataset.
   a. The number of acres for each data input was calculated by adding the field "Acres" and calculating the geometry to "Acres"
   b. A new field was added, "Acres_IS", and calculated using the following equation
      i. Acres_IS = (GRIDCODE/ 100) * "Acres"
   c. The total sum was calculated for "Acres_IS"

6 APPENDIX B: Wildlife Habitat Data

6.1 Percentages of Wetlands Remaining by Watershed

Table 6.1-a Percentages of Wetlands Remaining

Coastal Venice

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	20,992	33%	10,293	16%	49%
Total Land Area	62,961	100%	62,961	100%	

Lemon Bay

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	9,630	15%	6,667	11%	69%
Total Land Area	62,320	100%	62,320	100%	

Greater Charlotte Harbor

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	571,768	28%	419,793	20%	73%
Total Land Area	2,075,831	100%	2,075,831	100%	

Pine Island Sound

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	56,178	30%	38,685	21%	69%
Total Land Area	187,110	100%	187,110	100%	

Caloosahatchee River

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	358,072	41%	131,350	15%	37%
Total Land Area	880,879	100%	880,879	100%	

Estero Bay

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	113,819	57%	64,581	33%	57%
Total Land Area	198,137	100%	198,137	100%	

Wiggins Pass/ Cocohatchee River

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	69,762	58%	48,772	41%	70%
Total Land Area	119,610	100%	119,610	100%	

Naples Bay

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	57,134	64%	17,327	19%	30%
Total Land Area	89,922	100%	89,922	100%	

Rookery Bay

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	90,891	71%	63,093	50%	69%
Total Land Area	127,261	100%	127,261	100%	

Ten Thousand Islands

	Pre- development (Acres)	Pre- development (%)	Current (Acres)	Current (%)	Percent Remaining
Wetlands	1,181,044	77%	1,046,564	68%	89%
Total Land Area	1,542,441	100%	1,542,441	100%	

6.2 Explanation for Wetlands Discrepancies from 2011 Estuaries Report Card

Several difficulties were encountered when comparing the 2017 wetlands analyses to the analyses conducted in the 2011 Report Card (Table 6.2-a). First, half of the watersheds had at least one WBID addition, subtraction, or alteration, resulting in a new watershed boundary. Therefore, many acres of wetlands moved between watersheds. The changes in total land area also affected the land use percentages.

The most up-to-date land use was also derived from several different years of data, some of which were used for the 2011 Report Card. A small portion of Ten Thousand Islands analysis used 2004 data, the oldest of the samples. Furthermore, analyses of Charlotte Harbor, Caloosahatchee, and Ten Thousand Islands used some data from 2008. Therefore, some portions of the watersheds may not reflect present land use.

Table 6.2-a Differences in Land Use Data between 2017 and 2011 ERC

	WBID Runs Used		Land Use Data	
Watershed	**2017 ERC**	**2011 ERC**	**2017 ERC**	**2011 ERC**
Coastal Venice	35	35	2011 SWFWMD	2006 SWFWMD
Lemon Bay	35	35	2011 SWFWMD	2006 SWFWMD
Greater Charlotte Harbor	35	35	2012 SFWMD, 2011 SWFWMD, 2008 SFWMD	2006 SWFWMD
Pine Island Sound	35	35	2012 SFWMD, 2011 SWFWMD	2004 SFWMD
Caloosahatchee River	35	35	2012 SFWMD, 2011 SWFWMD, 2008 SFWMD	2006 SWFWMD, 2004 SFWMD
Estero Bay	49	35	2012 SFWMD	2004 SFWMD
Wiggins Pass/ Cocohatchee River	49	35	2012 SFWMD	2004 SFWMD
Naples Bay	49	35	2012 SFWMD	2004 SFWMD
Rookery Bay	49	35	2012 SFWMD	2004 SFWMD
Ten Thousand Islands	49	35	2012 SFWMD, 2008 SFWMD, 2004 SFWMD	2004 SFWMD

In the 2011 Report Card, the acreage of historic wetlands was calculated by overlapping two sets of predevelopment land use data. For this Report Card, it was decided that a more accurate representation would be attained by merging the two sets so wetlands from both sources were included in the analysis. This change in methodology impacted the following watersheds where the overlap occurs: Lemon Bay, Greater Charlotte Harbor, and Caloosahatchee.

Significant changes in current wetlands coverage from the 2011 Report Card were found in the following watersheds: Greater Charlotte Harbor, Estero Bay, Rookery Bay, and Ten Thousand Islands (Table 6.2-b). After further investigation, several possible reasons were identified for these changes.

Table 6.2-b Differences in Wetlands Remaining between 2017 and 2011 Report Card

	Percentage of Current Wetlands		Percentage of Wetlands Remaining	
Watershed	**2017 ERC**	**2011 ERC**	**2017 ERC**	**2011 ERC**
Greater Charlotte Harbor	20%	17%	73%	64%
Estero Bay	35%	33%	57%	62%
Rookery Bay	50%	55%	69%	78%
Ten Thousand Islands	68%	65%	89%	90%

Greater Charlotte Harbor

Between the 2011 and 2017 Estuaries Report Cards, the total acreage of existing wetlands increased by 3%, and the total acreage of predevelopment wetlands increased by over 1%. The first reason for this significant increase is the increase in area of land use between the two Report Cards. The 2011 Report Card used only land use data from SWFWMD, even though it did not cover the entire watershed. The 2017 Report Card corrected this by adding data from SFWMD. This new land area calculation contains over 11,000 acres of wetlands and over 20,000 acres of predevelopment wetlands not previously accounted for. After further analysis, it was determined that the most significant types of land uses that were considered wetlands for the 2017 Report Card were categorized as forested uplands, mining activities, and agriculture in the 2011 Report Card analysis. This is illustrated in Table 6.2-c, by comparing areas that were not considered wetlands in 2011 to the same areas in 2017, and vice versa.

Table 6.2-c Changes in Land Uses in the 2011 GIS Shapefiles Relative to 2017 Shapefiles for Greater Charlotte Harbor

2011 ERC Lands Changed to Wetlands	**Acres**
Forested Upland	32,903
Mining	16,235
Agriculture	11,602
Non Forested Upland	7,226
Water	4,873
Urban	1,646
Other +	241
Total Wetlands Gained	**74,726**

2011 ERC Wetlands Changed to Other Land Use Categories	**Acres**
Forested Upland	4,776
Agriculture	4,240
Mining	3,500
Urban	2,235
Water	1,943
Non Forested Upland	1,664
Other +	278
Total Wetlands Lost	**18,636**

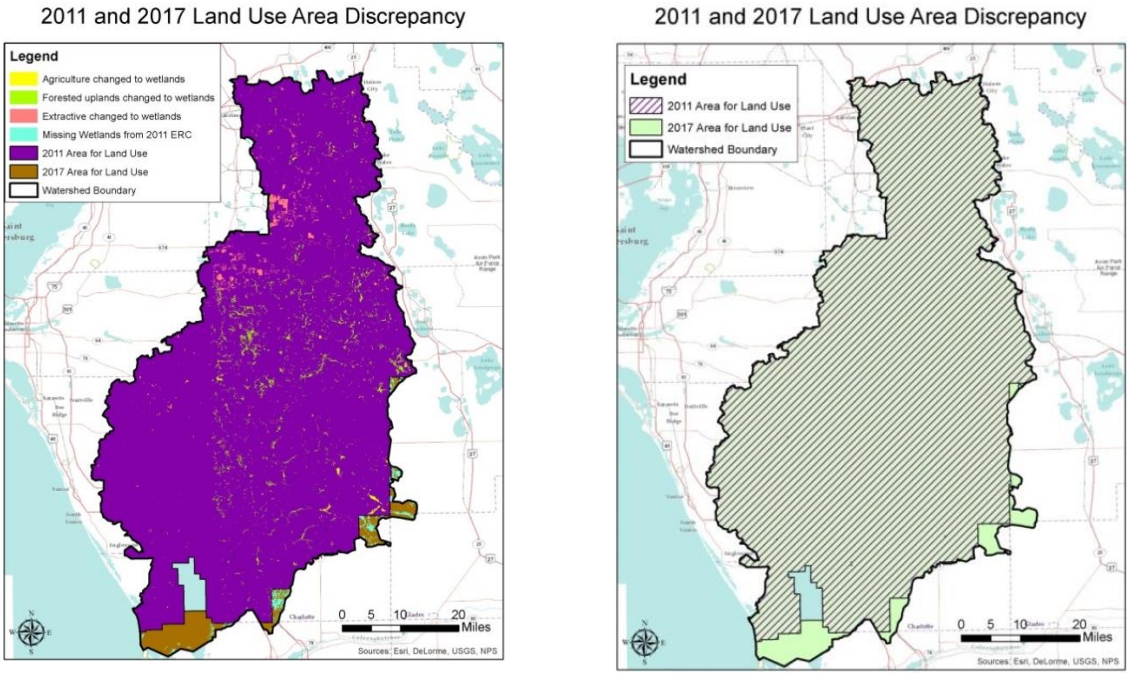


Figure 6.2-a Land Use Changes in Greater Charlotte Harbor

Estero Bay

Estero Bay experienced a slight 2% decrease in current wetland coverage between the 2011 and 2017 Report Cards. The difference between the WBID Run 35 and 49 boundaries altered slightly, with wetland acreages lost in some places and gained in others, which would alter the number of acres of wetlands (Table 6.2-d). However, even within the overlapped portion, a significant amount of wetlands was lost from the 2011 Report Card. After further analysis, it was determined that most of the wetlands were replaced by urban and forested upland land uses.

Table 6.2-d Changes in Land Uses in the 2011 GIS Shapefiles Relative to 2017 Shapefiles for Estero Bay

2011 ERC Lands Changed to Wetlands		Acres
Forested Upland		605
Urban		365
Water		299
Agriculture		244
Non Forested Upland		142
Other	+	52
Total Wetlands Gained		**1,706**

2011 ERC Wetlands Changed to Other Land Use Categories		Acres
Urban		2,550
Forested Upland		2,460
Other		1,408
Non Forested Upland		1,143
Agriculture		995
Water	+	468
Total Wetlands Lost		**9,024**

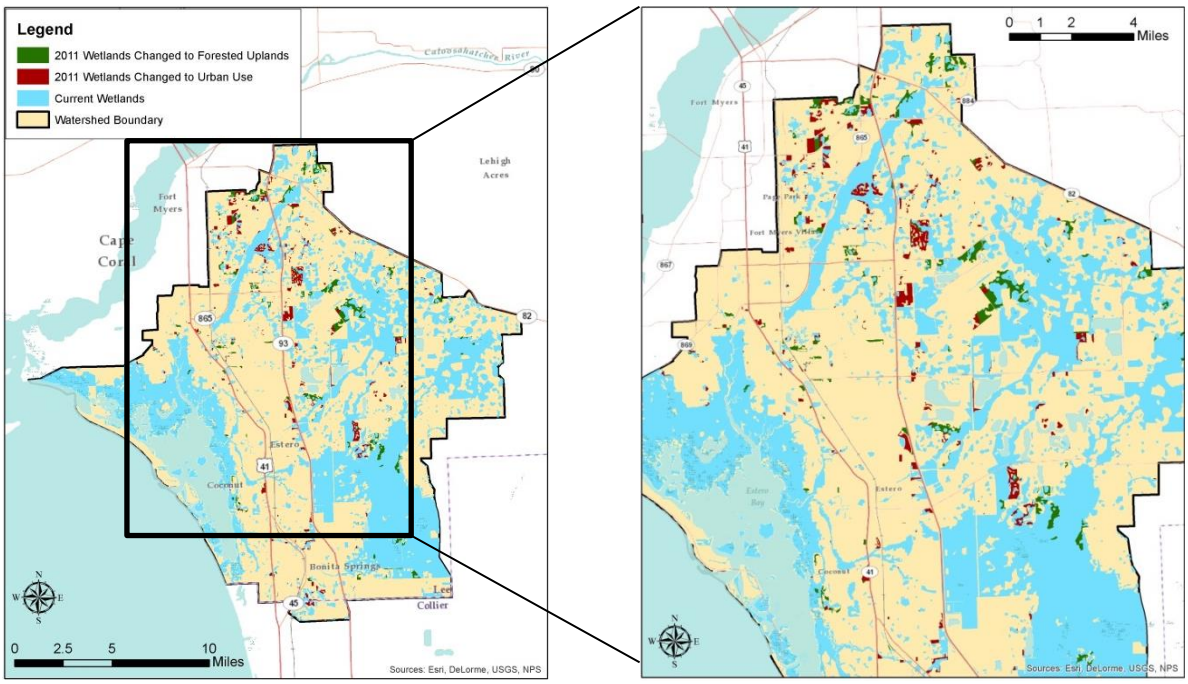


Figure 6.2-b Changes in Land Uses in Estero Bay

Rookery Bay

Rookery Bay exhibited a net decrease in wetland acres (5%) between the 2011 and 2017 Report Cards. This decrease was due to the replacement of wetlands by upland and urban land uses. A significant portion of these lost wetlands occurred within Planned Unit Developments (PUDs). The watershed boundary increased only slightly between Runs 35 and 49, so a minimal number of wetlands were added to the watershed (Table 6.2-e).

Table 6.2-e Changes in Land Uses in the 2011 GIS Shapefiles Relative to 2017 Shapefiles for Rookery Bay

2011 ERC Lands Changed to Wetlands	Acres
Forested Upland	453
Urban	355
Water	167
Agriculture	72
Non Forested Upland	16
Other +	3
Total Wetlands Gained	**1,066**

2011 ERC Wetlands Changed to Other Land Use Categories	Acres
Urban	4,726
Forested Upland	1,461
Other	1,228
Non Forested Upland	881
Agriculture	284
Water +	50
Total Wetlands Lost	**8,630**

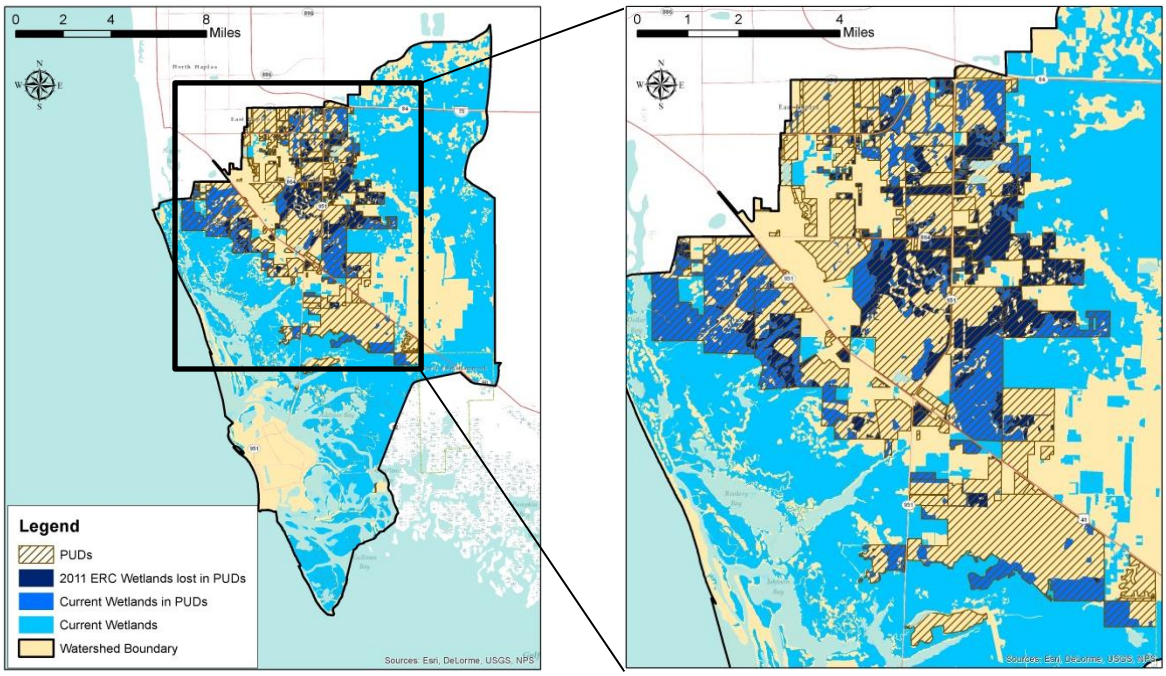


Figure 6.2-c Wetlands Affected by PUDs in Rookery Bay

Ten Thousand Islands

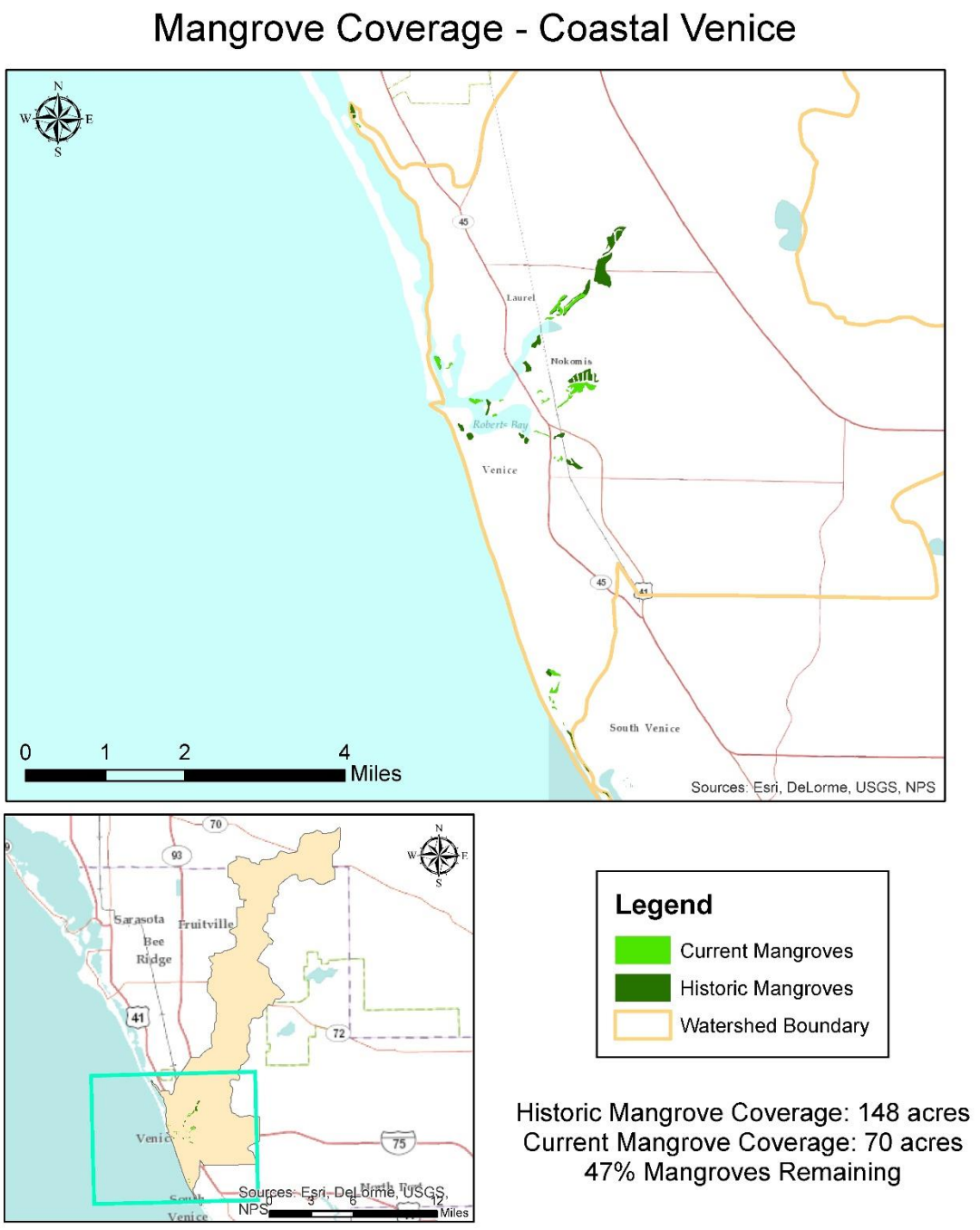
According to the 2011 Report Card, the total area of the Ten Thousand Islands watershed was 1,640,228 acres, with 65% of the watershed covered in wetlands at that time. However, the correct amount of acreage for the watershed in WBID Run 35 was 1,549,900 acres, or 69% of the watershed being covered in wetlands. With this correction, the difference between the 2017 and 2011 Report Cards was significantly reduced. Part of this difference was also accounted for by WBID Boundary changes from Run 35 to Run 49.

Conclusions

For watersheds exhibiting a significant decline in wetland coverage from 2011 to 2017, wetlands had been converted to urban land use and forested uplands. The destruction of wetlands for urban development is not surprising given ongoing patterns of increasing population and development in the region. However, the apparent change from wetlands to forested uplands demands closer inspection, as wetlands and forested uplands are completely different complexes of ecosystems. Rainfall and water levels dictate the types of flora and fauna that can be found in each system. Hence, a wetland does not become a forested upland within several years by itself. Two possible explanations may explain this change: (1) wetlands were anthropogenically drained and lost their water saturation, or (2) GIS methodologies have been updated to better differentiate between wetland and upland tree canopies. The former is possible because wetlands may be drained to prepare an area for development or agriculture, reduce insect problems, and increase the market value of the land. The latter is also

possible, as technology and the accuracy of information are always improving. The analyses also identified wetlands changing to and from open water, a situation that is more difficult to explain. Although a full exploration into the reasons behind these land use changes is outside the scope of this report, it is useful to hightlight that by replicating analyses, the process is refined and more information is gathered about the data and changes in the watersheds.

6.3 Percentage of Mangroves Remaining



Data Source
Current Mangrove Cover: FLORIDA MANGROVES - 2014, Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute
Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida - Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 6.3-a Percent Mangroves Remaining- Coastal Venice

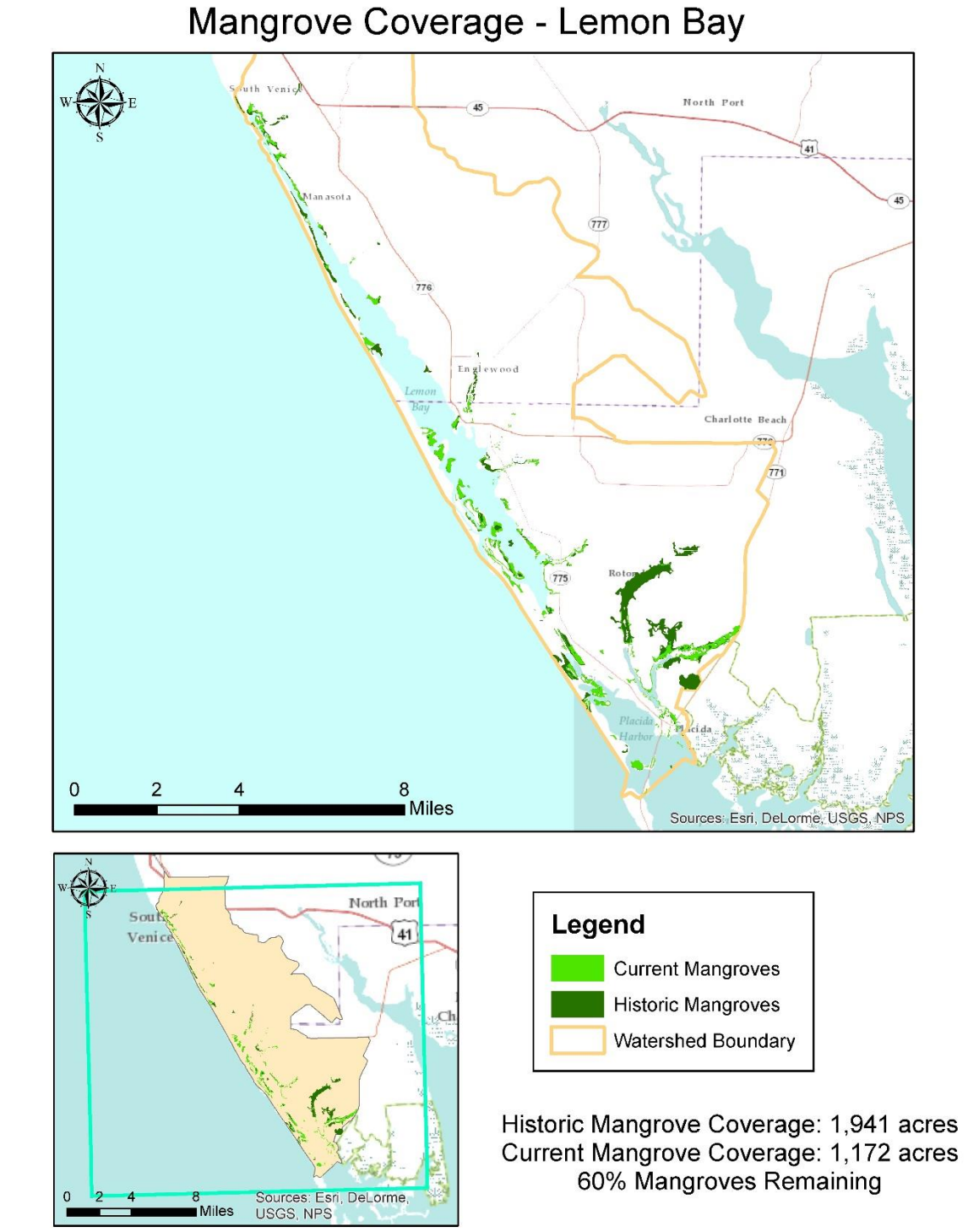
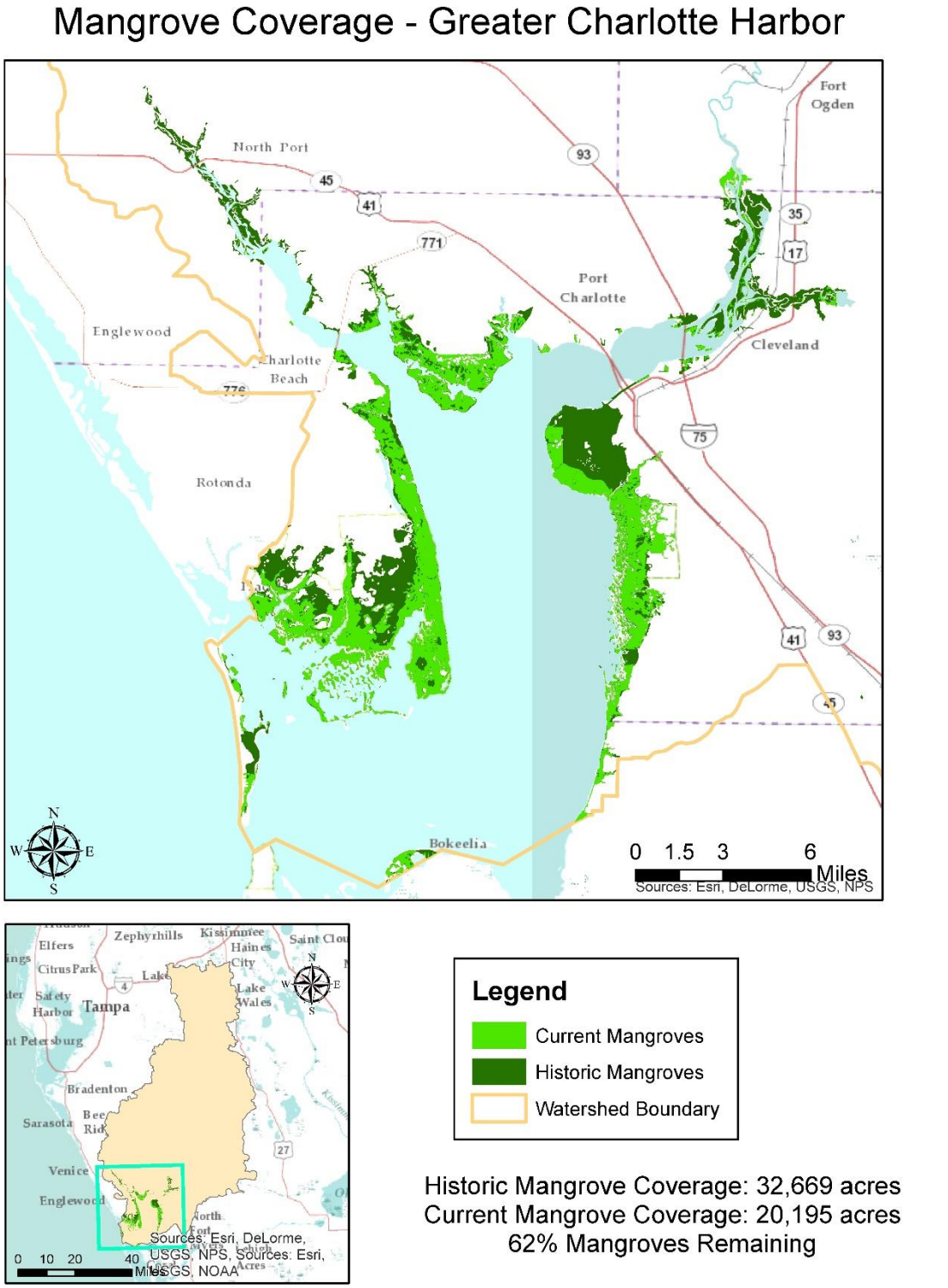


Figure 6.3-b Percent of Mangroves Remaining- Lemon Bay



Data Source
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Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida - Florida Department of Environmental Protection
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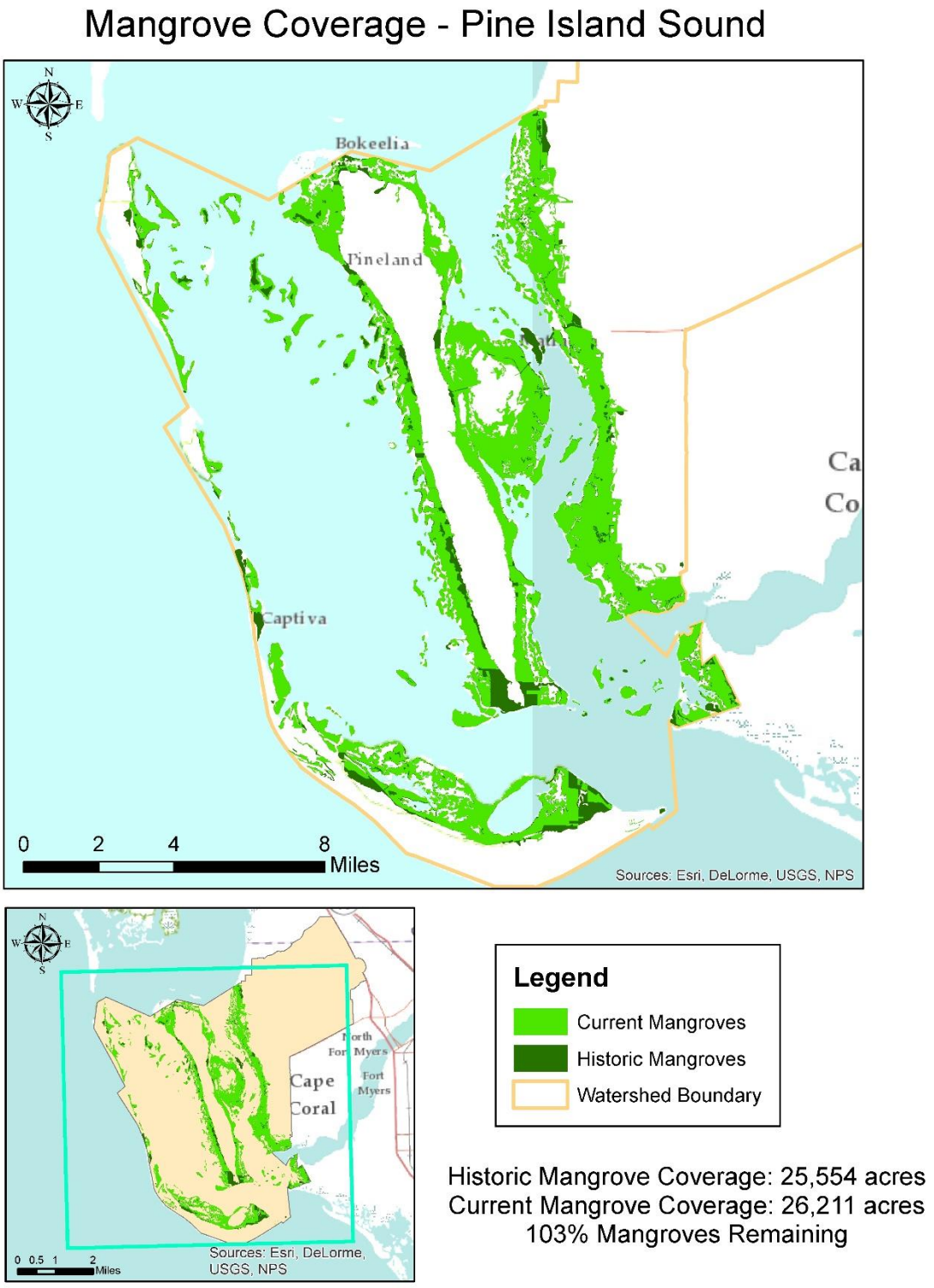
Figure 6.3-c Percent Mangroves Remaining- Greater Charlotte Harbor



Data Source
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Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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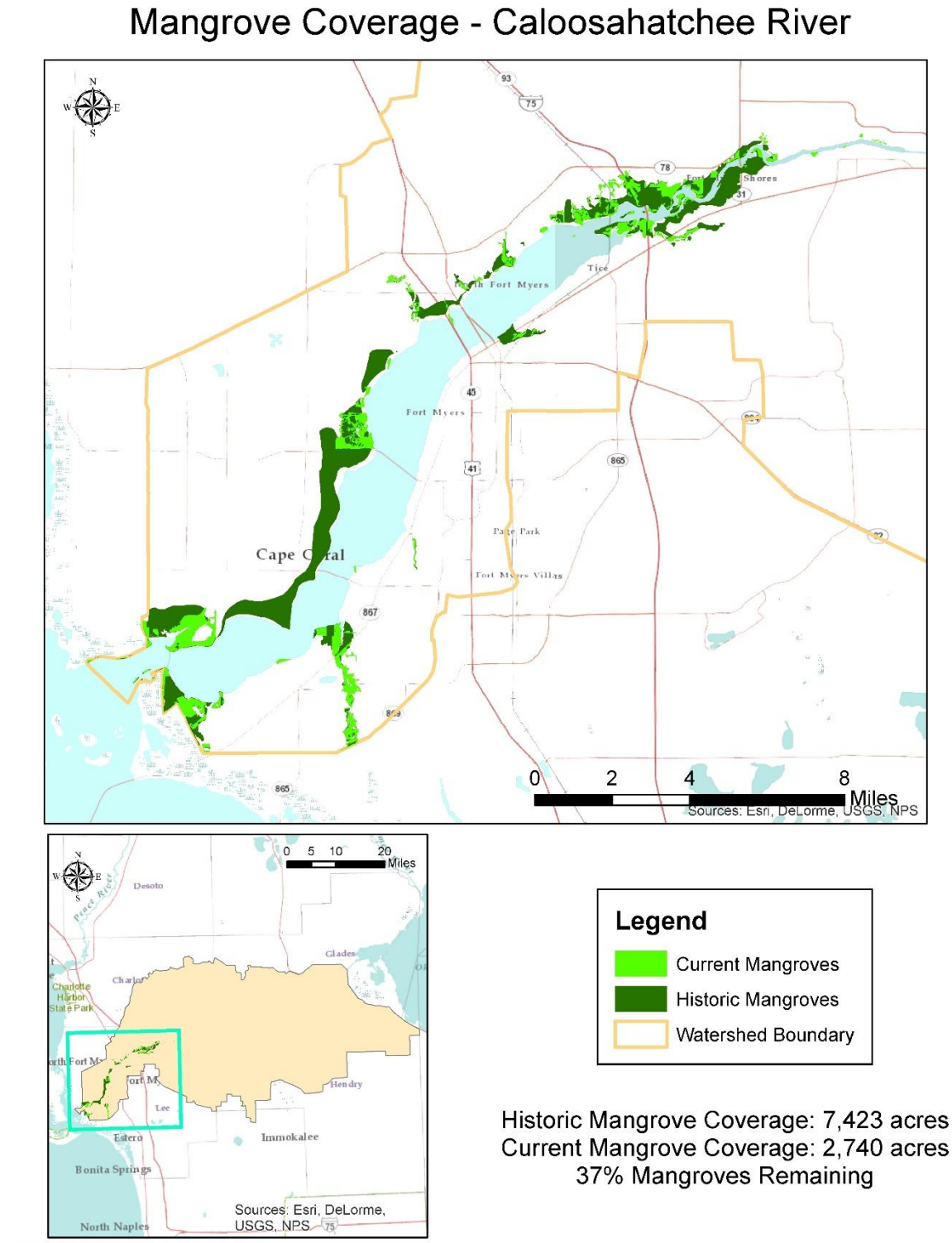
Figure 6.3-d Percent Mangroves Remaining- Pine Island Sound



Data Source
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WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida - Florida Department of Environmental Protection
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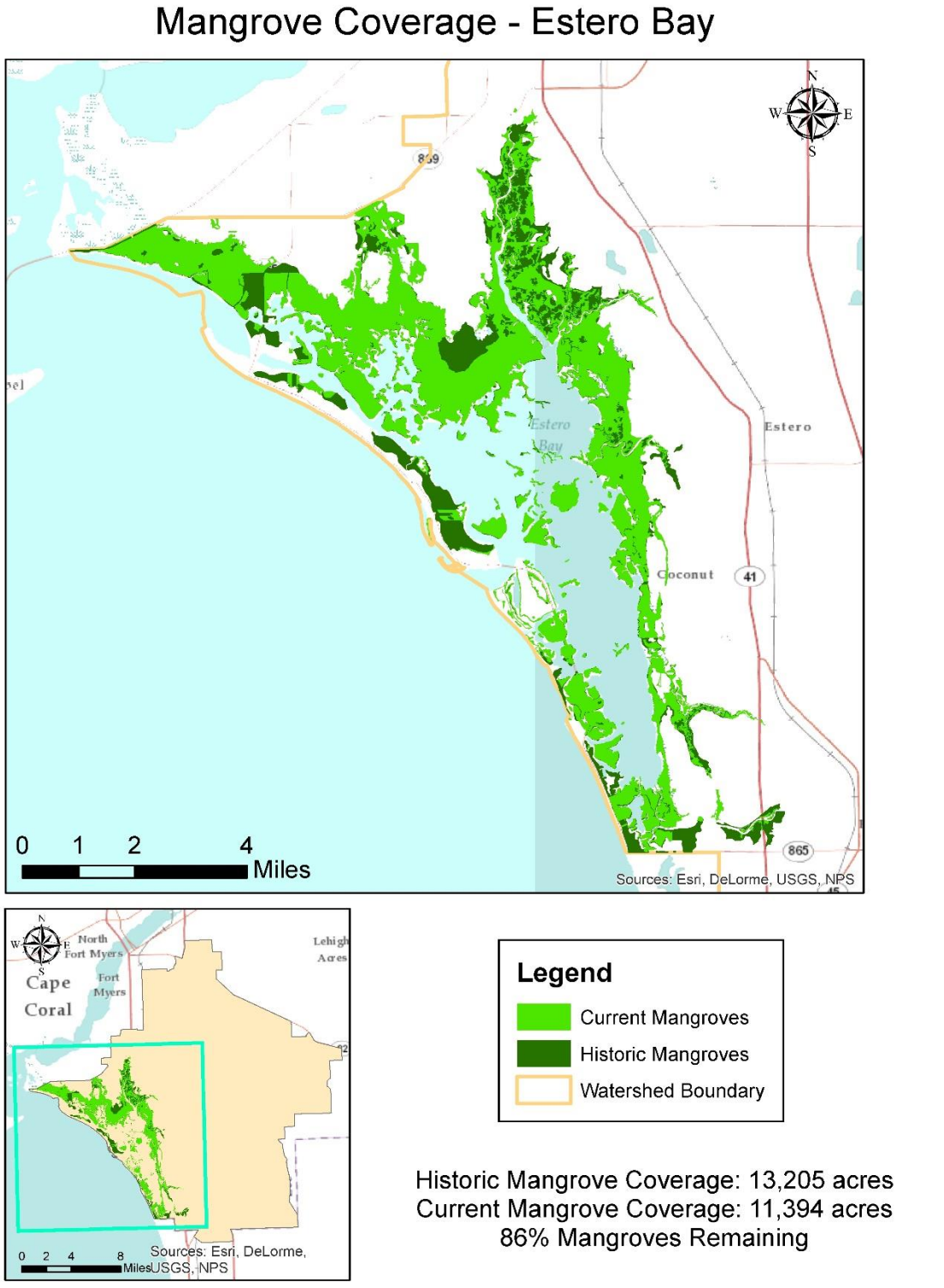
Figure 6.3-e Percent Mangroves Remaining- Caloosahatchee River



Data Source
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Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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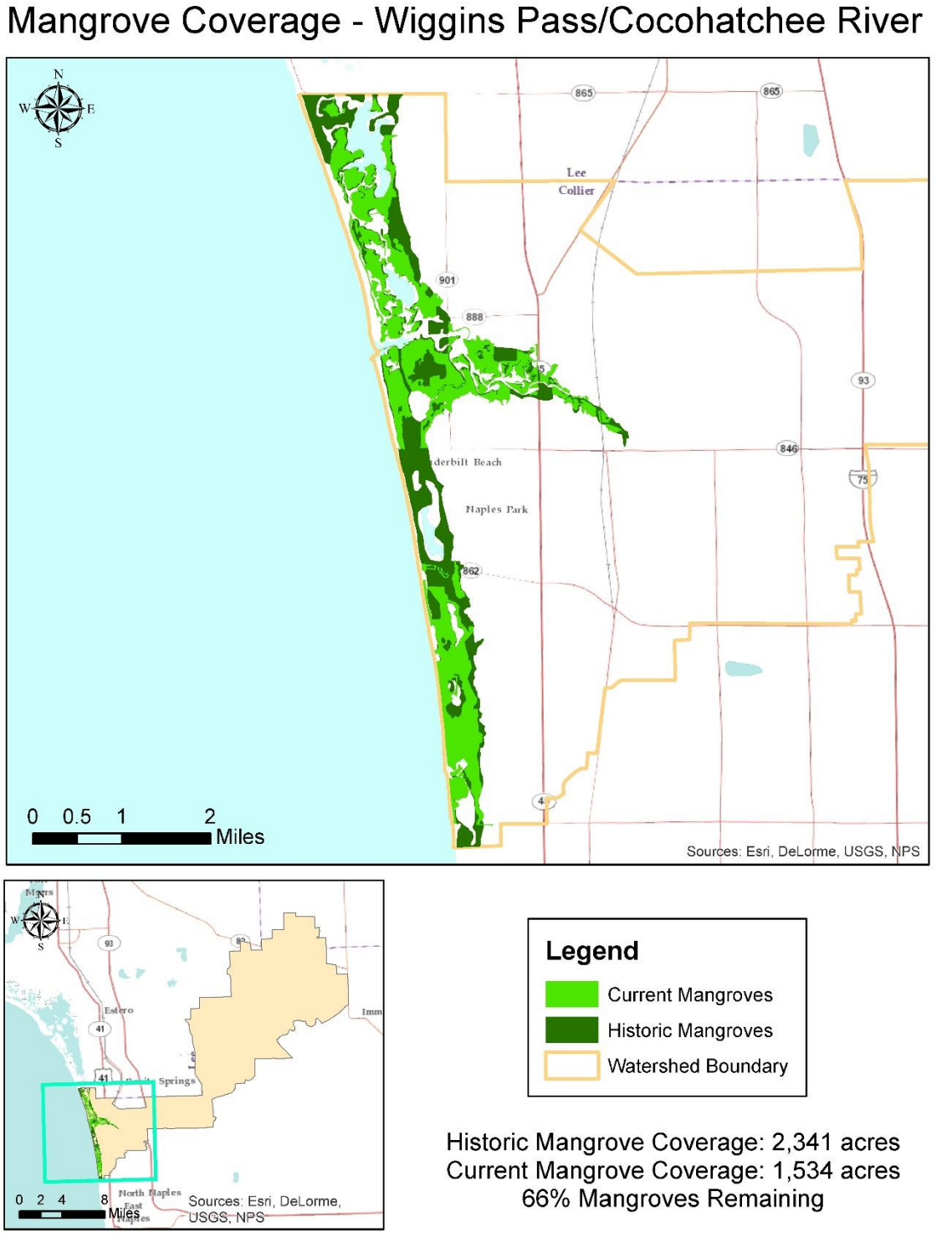
Figure 6.3-f Percent of Mangroves Remaining- Estero Bay



Data Source
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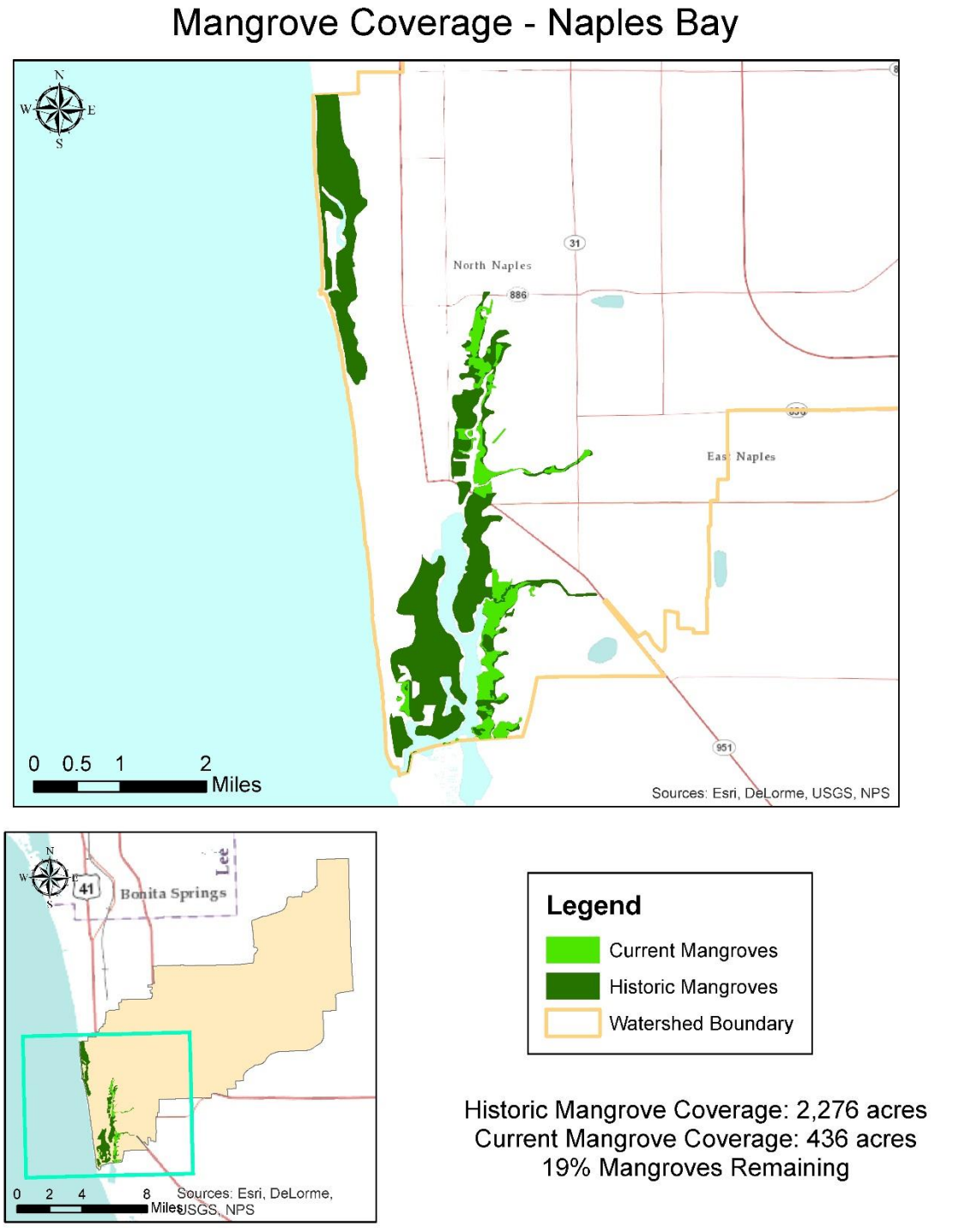
Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 6.3-g Percent Mangroves Remaining- Wiggins Pass/ Cocohatchee River



Data Source
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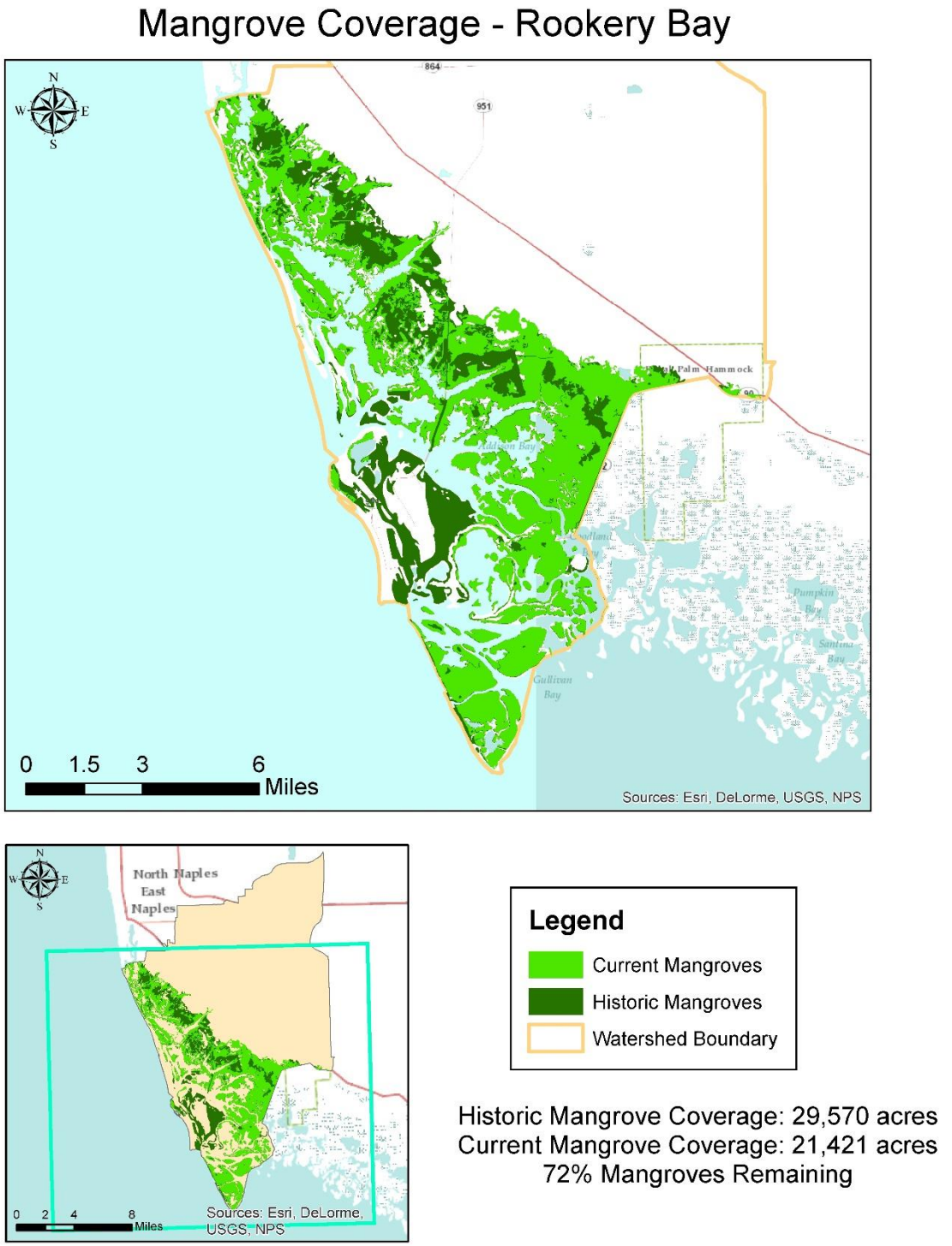
Historic Mangrove Cover: Derived from Southwest Florida Feasibility Study Pre-Development Vegetation - 2002, South Florida Water Management District
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 6.3-h Percent Mangroves Remaining- Naples Bay



Data Source
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WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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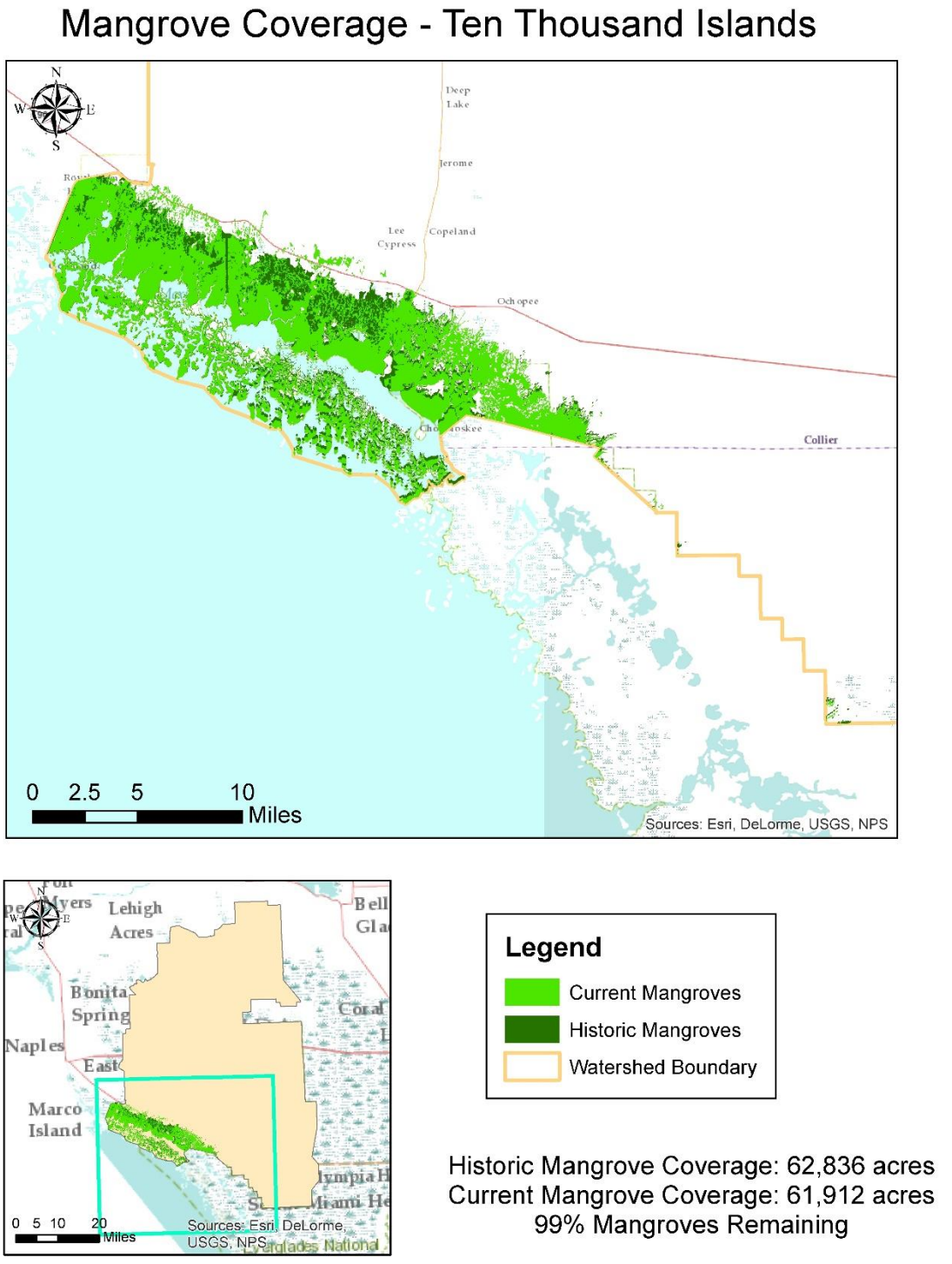
Figure 6.3-i Percent Mangroves Remaining- Rookery Bay



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WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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Figure 6.3-j Percentage of Mangroves Remaining- Ten Thousand Islands

6.4 Percentage of Conservation Lands- Maps

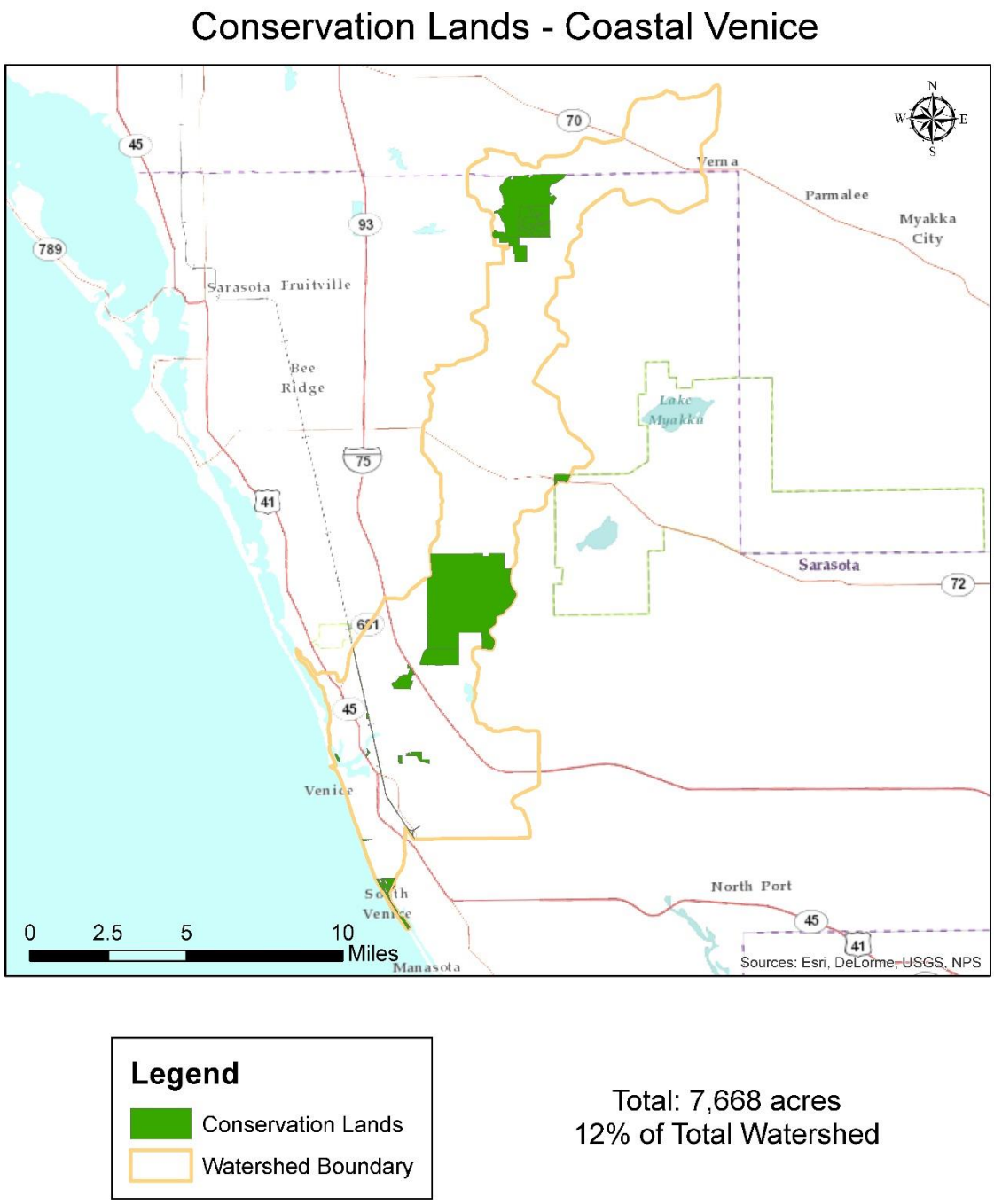
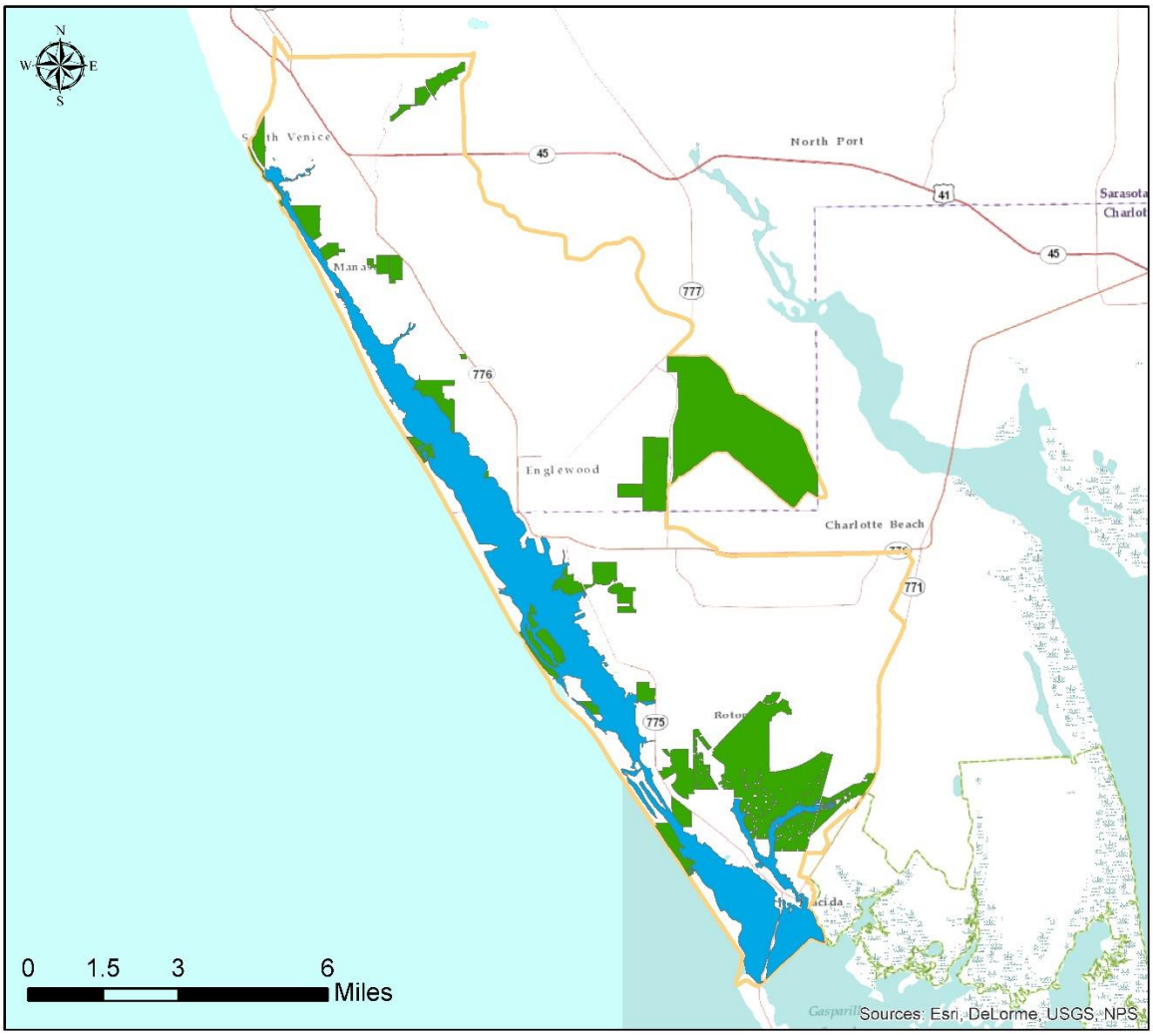


Figure 6.4-a Percentage of Conservation Lands- Coastal Venice

Conservation Lands - Lemon Bay



Legend

- Conservation Lands
- Aquatic Preserves
- Watershed Boundary

Total: 16,221 acres
26% of Total Watershed

NOTE: The overlapping area of Conservation Lands and Aquatic Preserves was subtracted from the total

Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
Aquatic Preserves: AQUAP_DEC11, Aquatic Preserve Boundaries in Florida - 2011, Florida Department of Environmental Protection
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida - Florida Department of Environmental Protection
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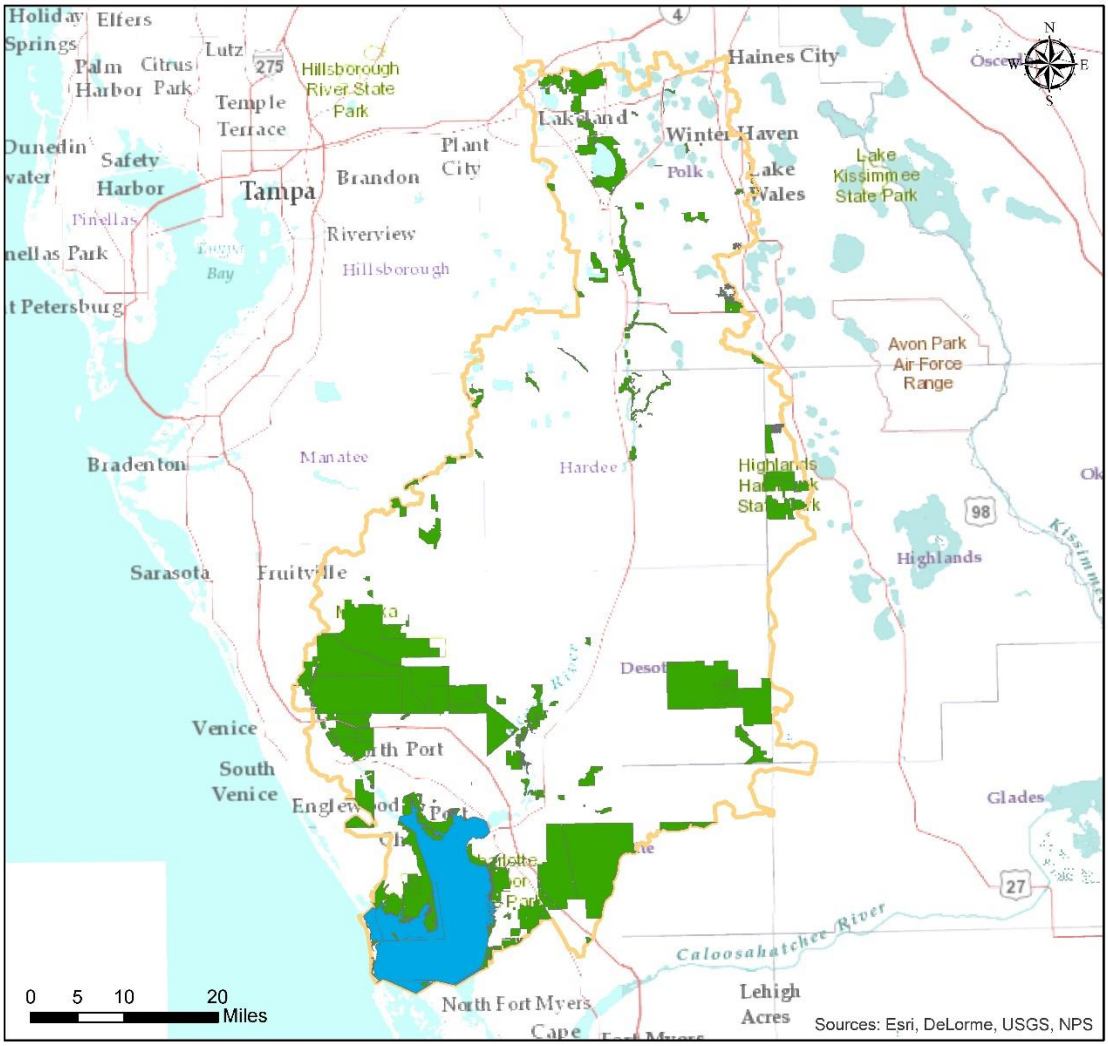
Figure 6.4-b Percentage of Conservation Lands- Lemon Bay

Conservation Lands - Greater Charlotte Harbor



Legend

- Conservation Lands
- Aquatic Preserves
- Watershed Boundary

Total: 389,649 acres
19% of Total Watershed

NOTE: The overlapping area of Conservation Lands and Aquatic Preserves was subtracted from the total

Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
Aquatic Preserves: AQUAP_DEC11, Aquatic Preserve Boundaries in Florida - 2011, Florida Department of Environmental Protection
Water Body Identification numbers (WBIDs): WBID Run 35, 2008, Florida Department of Environmental Protection
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Figure 6.4-c Percentage of Conservation Lands- Greater Charlotte Harbor

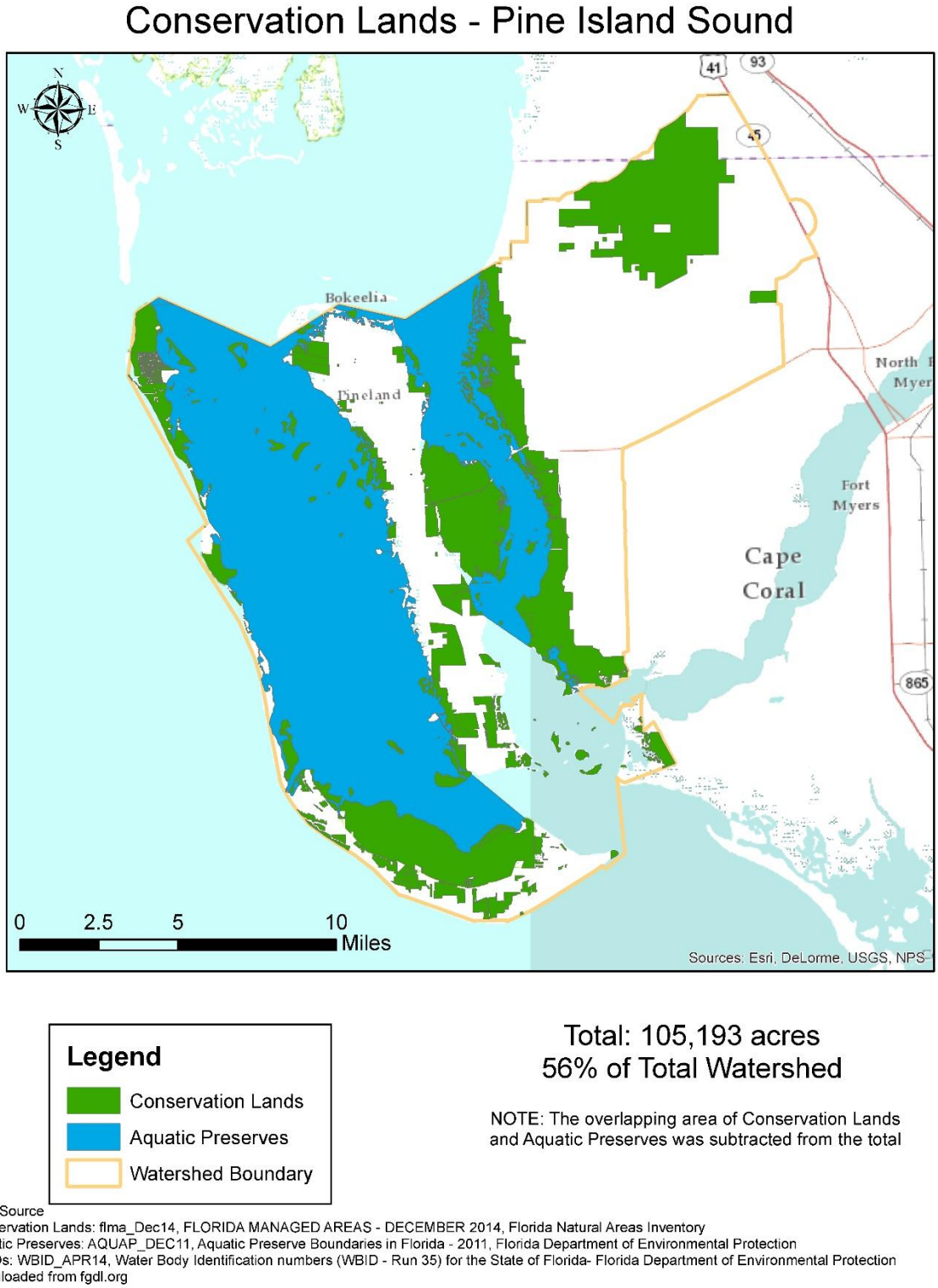
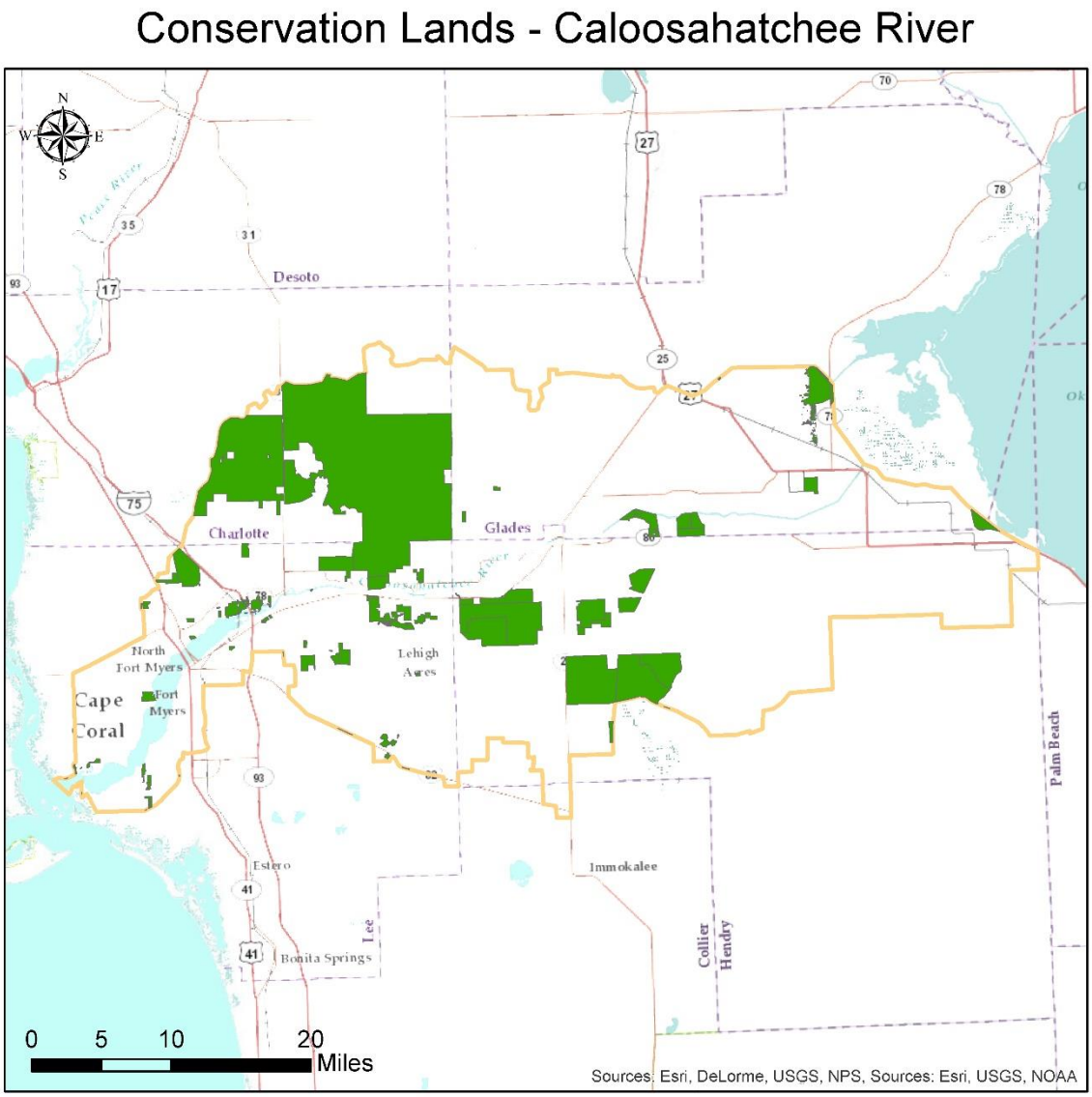
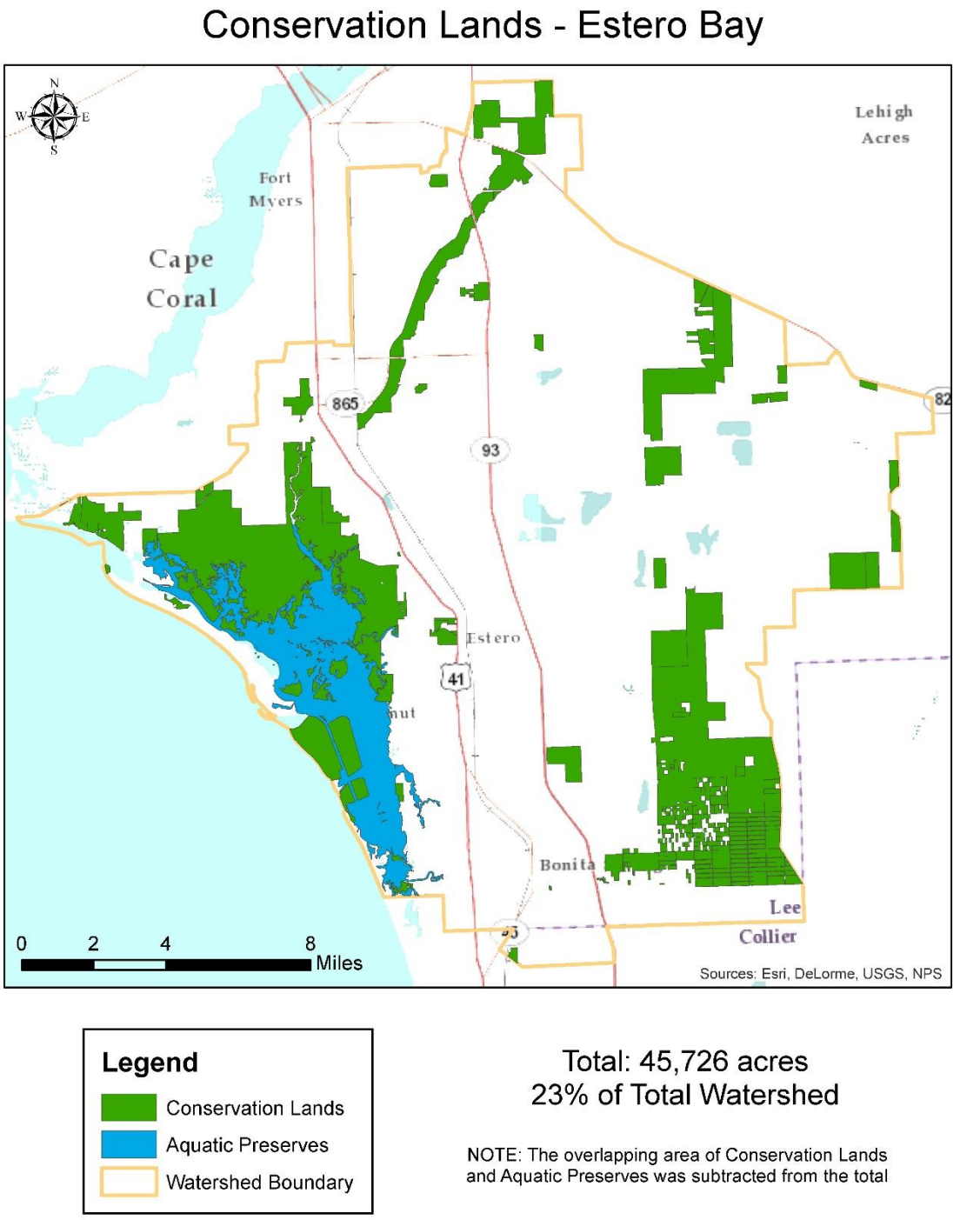


Figure 6.4-d Percentage of Conservation Lands- Pine Island Sound



Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 6.4-e Percentage of Conservation Lands- Caloosahatchee River



Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
Aquatic Preserves: AQUAP_DEC11, Aquatic Preserve Boundaries in Florida - 2011, Florida Department of Environmental Protection
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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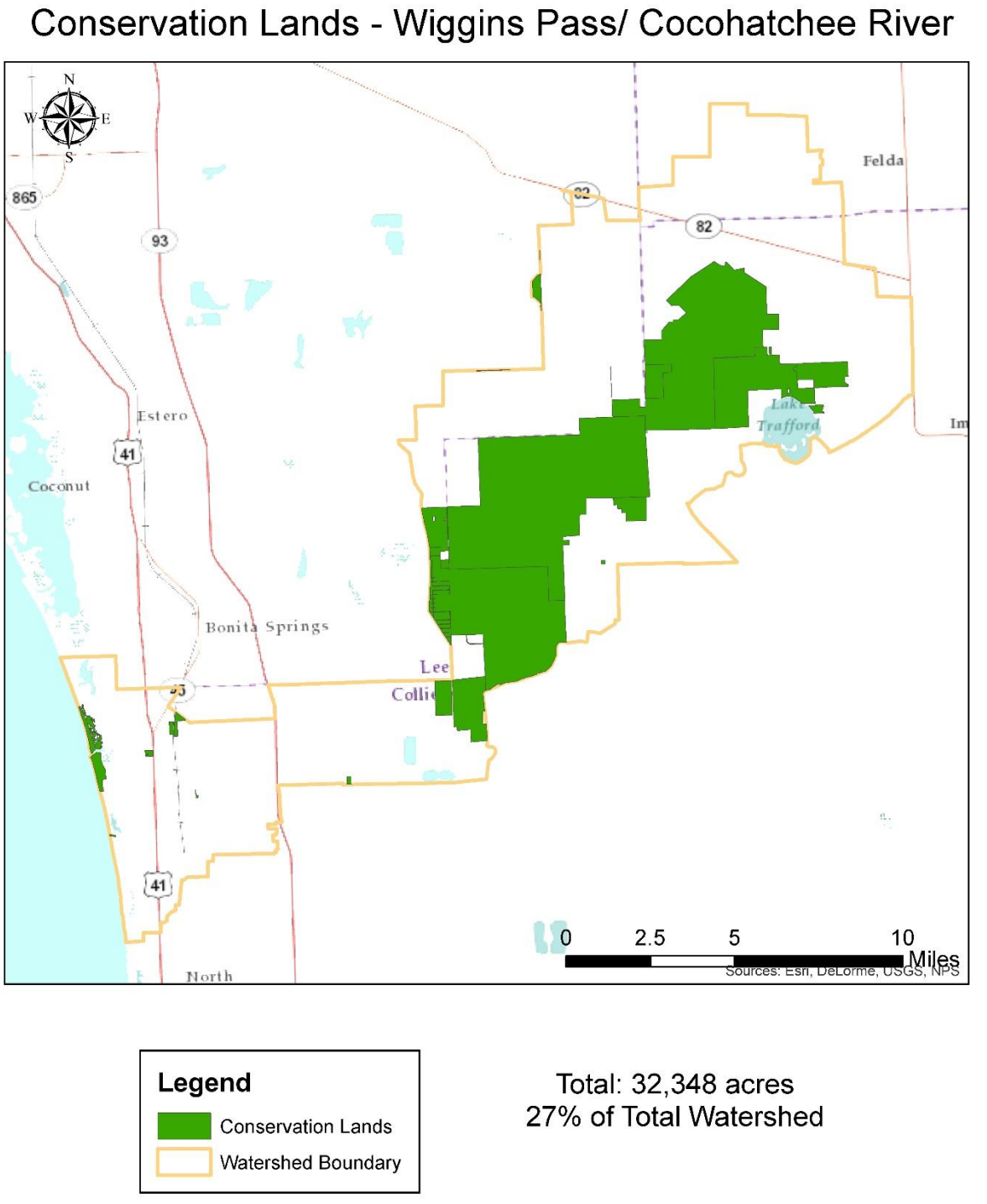
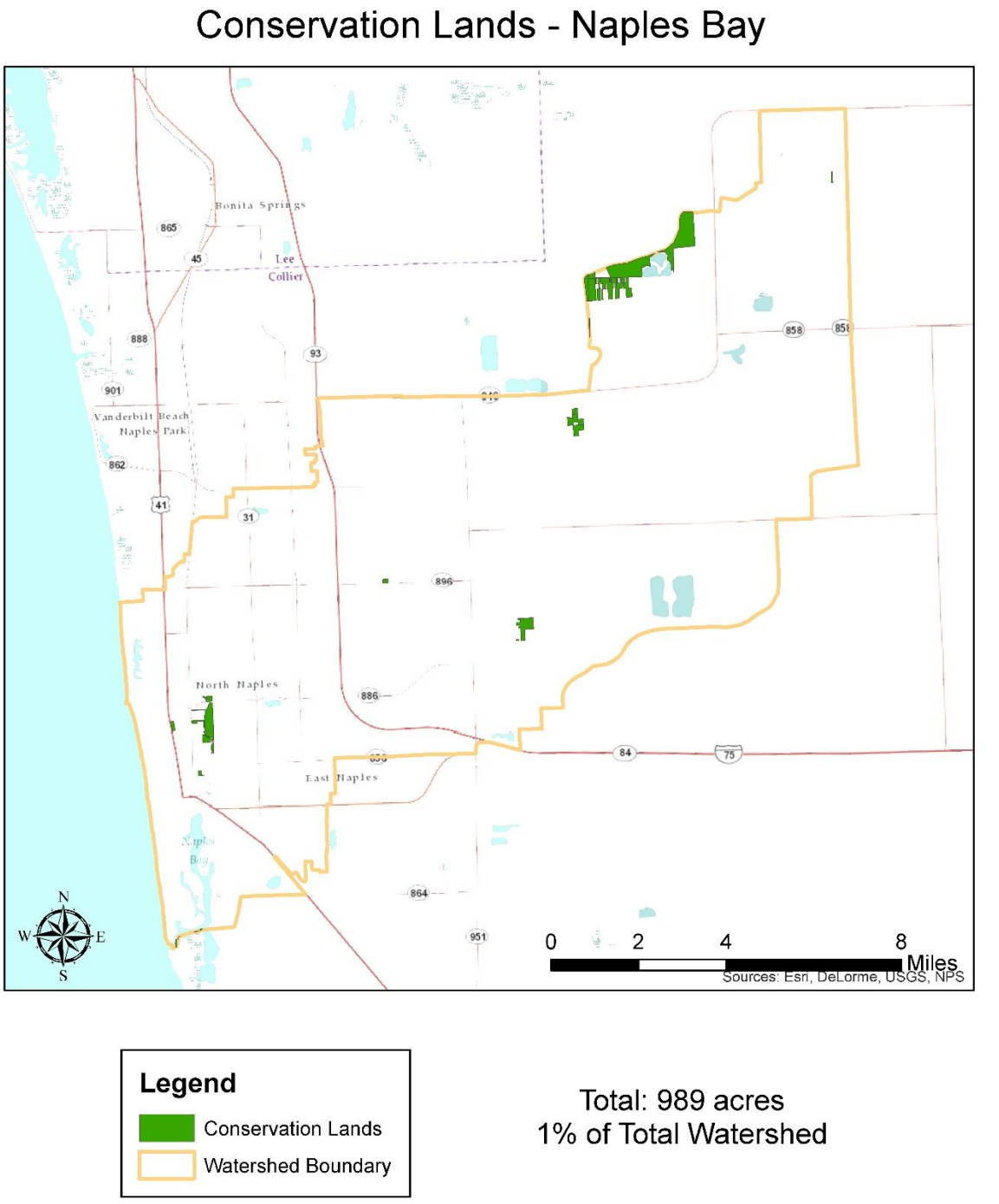
Figure 6.4-f Percentage of Conservation Lands- Estero Bay



Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 6.4-g Percentage of Conservation Lands- Wiggins Pass/ Cocohatchee River



Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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Figure 6.4-h Percentage of Conservation Lands- Naples Bay

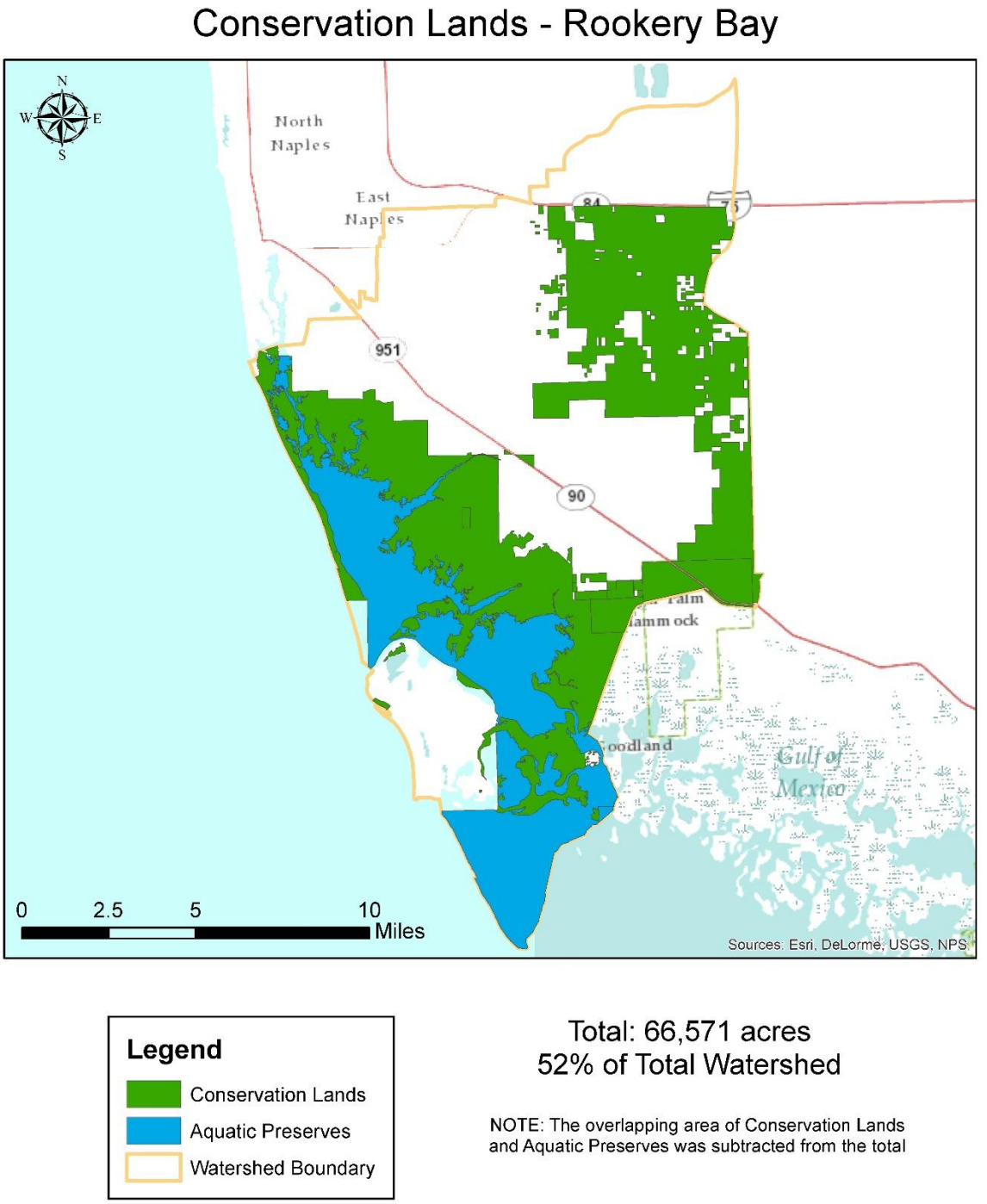
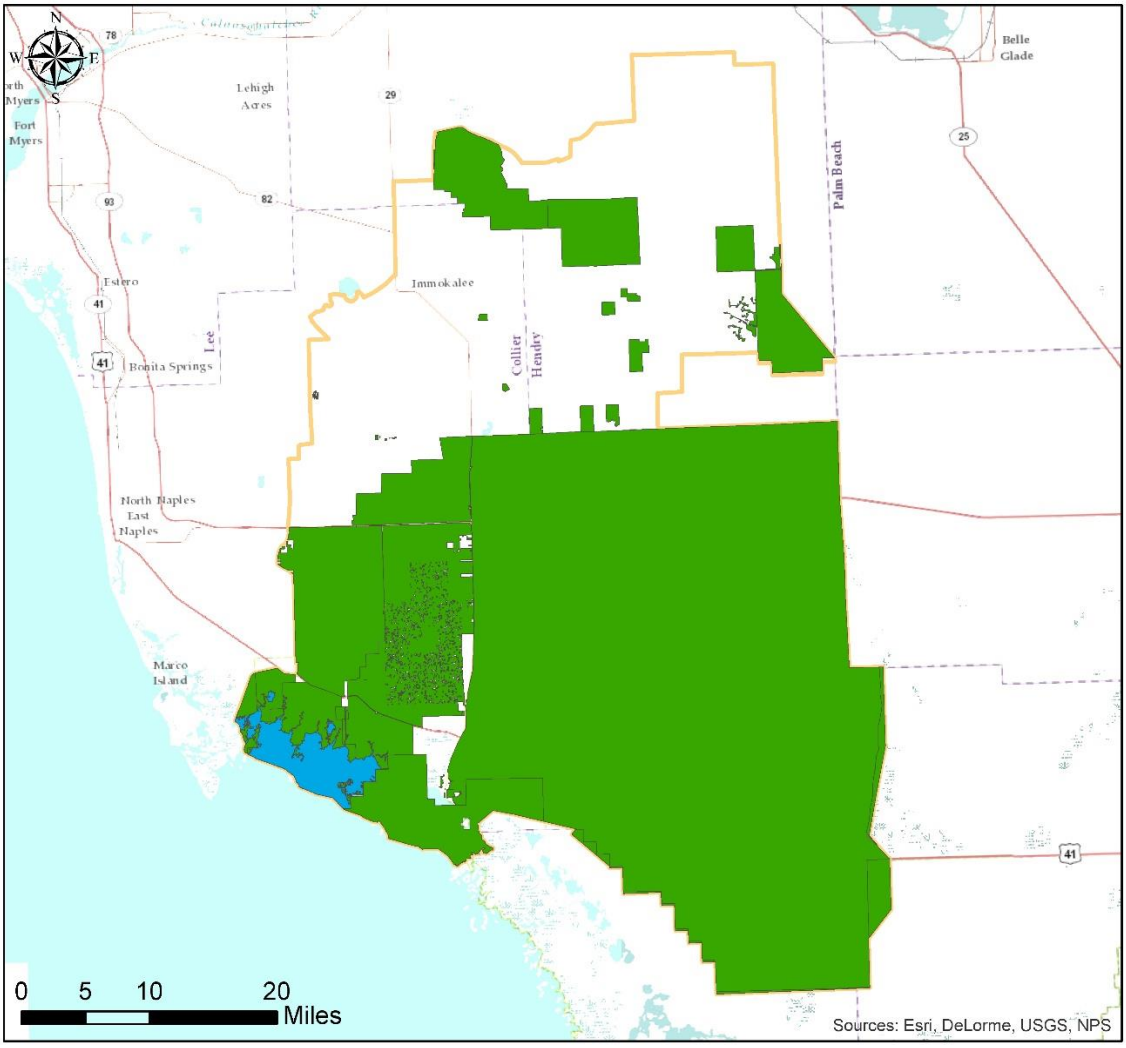


Figure 6.4-i Percentage of Conservation Lands- Rookery Bay

Conservation Lands - Ten Thousand Islands



Legend

- Conservation Lands
- Aquatic Preserves
- Watershed Boundary

Total: 1,063,663 acres
69% of Total Watershed

NOTE: The overlapping area of Conservation Lands and Aquatic Preserves was subtracted from the total

Data Source
Conservation Lands: flma_Dec14, FLORIDA MANAGED AREAS - DECEMBER 2014, Florida Natural Areas Inventory
Aquatic Preserves: AQUAP_DEC11, Aquatic Preserve Boundaries in Florida - 2011, Florida Department of Environmental Protection
WBIDs: WBID_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida - 2014, Florida Department of Environmental Protection
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Figure 6.4-j Percentage of Conservation Lands- Ten Thousand Islands

6.5 Percentage of Conservation Lands- Complete Lists

Table 6.5-a Percentage of Conservation Lands- Complete List, by Watershed

Coastal Venice

Conservation Lands Name	Acreage
Caspersen Beach County Park	134.4
Curry Creek Preserve	81.5
Fox Creek	163.4
Gum Slough TNC Conservation Easement	213.0
Heritage Ranch Conservation Easement	1,635.9
Heritage Ranch Section 12 Gopher Tortoise Recipient Sites	433.6
Knight Trail Park	378.1
Legacy Trail	88.5
Myakka River State Park	64.1
Pinelands Reserve	4,332.5
Pocono Trail Preserve	8.0
Rattlesnake Island	12.1
Rocky Ford	114.5
Service Club Park	7.5
Shamrock Park and Nature Center	1.0
Total	**7,668.1**

Total Watershed Area:	62,961
Percent Conservation Lands:	12%
Qualifier:	**Minus**

Lemon Bay

Conservation Lands Name	Acreage
Ainger Creek Trails	145.8
Alligator Creek Conservation Area	212.4
Amberjack Environmental Park	222.9
Blind Pass Beach	66.3
Buck Creek Preserve	79.1
Cape Haze Aquatic Preserve	2.9
Caspersen Beach County Park	23.3
Cedar Point Environmental Park	110.3
Charlotte Harbor Preserve State Park	2,610.9
Don Pedro Island State Park	245.1

Gasparilla Sound - Charlotte Harbor Aquatic Preserve	888.6
Indian Mound Park	6.5
James E. Cook Memorial Preserve	31.5
Kiwanis/Buchan Park	6.4
Lemon Bay Aquatic Preserve	6,993.6
Lemon Bay Park and Environmental Center	208.7
Manasota Scrub Preserve	159.5
Myakka State Forest	3,344.6
Oyster Creek Regional Park	257.2
Rotunda Community Park and Preserve	32.1
Shamrock Park and Nature Center	96.6
South Venice Lemon Bay Preserve	231.6
Stump Pass Beach State Park	210.2
Thornton Key Preserve	35.0
Total	**16,221.1**
Total Watershed Area:	62,320
Percent Conservation Lands:	26%
Qualifier:	**None**

Greater Charlotte Harbor

Conservation Lands Name	Acreage
Alligator Creek	146.2
Altman Tract Conservation Easement	555.6
Audubon - Pennington Nature Park	9.7
Babcock Ranch Preserve	2,126.4
Bartow Trailhead at Fort Fraser	8.7
Biscayne Trust Conservation Easement	176.8
Beker	614.2
Bocilla Preserve	170.5
Bok Tower Gardens Knoll	0.3
Bok Tower Gardens Knoll Planted Pines	17.2
Bok Tower Gardens Pine Ridge Preserve	26.7
Bok Tower Gardens Preserve	58.8
Boran Ranch Mitigation Bank	386.9
Bowlegs Creek	919.4
Bright Hour watershed	32,241.3
Calusa Land Trust and Nature Preserve of Pine Island, Inc.	0.6

Camp Meeting Ground Branch Conservation Easement	14.5
Cape Haze Aquatic Preserve	12,217.6
Carlton Ranch, Inc.	4,742.6
Cayo Costa State Park	13.0
Cayo Pelau Preserve	127.7
Charlotte Flatwoods Environmental Park	487.9
Charlotte Harbor Buffer Preserve	152.5
Charlotte Harbor Environmental Center	18.1
Charlotte Harbor Preserve State Park	27,853.4
Circle B Bar Reserve	1,267.8
Clear Springs	1,426.0
Crooked Lake West	757.8
Crooked Lake West - Stuart Tract	0.7
Crooked Lake Wildlife and Environmental Area	1,085.9
Crowly Museum and Nature Center	191.6
Cypress Gardens Conservation Easement	150.6
Deep Creek Properties	420.4
Deer Prairie Creek/Churchill and Jordyn Parcels	894.5
Deer Prairie Creek Preserve	6,135.5
Duette Preserve	716.4
Edward Chance Reserve	938.4
FPC Hines Conservation Easement	1,647.3
Fred C. Babcock - Cecil M. Webb Wildlife Management Area	47,905.9
Gasparilla Island State Park	126.3
Gasparilla Sound - Charlotte Harbor Aquatic Preserve	81,484.1
Hardee Lakes Conservation Easement	441.2
Hathaway Park	14.3
Headwaters at Duette Preserve	292.9
Highlands Hammock State Park	9,200.2
Homeland	1,926.5
Hookers Prairie Link Conservation Easement	181.5
IMC - Peace River Park	464.9
Island Bay National Wildlife Refuge	25.8
Jelks Preserve	582.4
Lake Hancock	6,008.5
Lakeland Highlands Scrub	293.1
Lake Wales Ridge National Wildlife Refuge	38.0
Lake Wales Ridge Wildlife and Environmental Area	599.7

Lake Wales Trailways	1.2
Laurent/Peace River	48.2
Lemon Bay Aquatic Preserve	1.2
Lewis Longino Preserve	3,422.3
Little Payne Creek	299.3
Longino Ranch Conservation Easement	3,981.6
Lower Peace River Corridor	2,105.8
Mackay Gardens and Lakeside Preserve	131.0
Manson Jenkins Conservation Easement	185.0
Matlacha Pass Aquatic Preserve	394.0
Morgan Park	210.7
Myakka Forest Addition	3.1
Myakka Islands Point	89.0
Myakka Mitigation Bank	380.0
Myakka Pines	58.8
Myakka Prairie Conservation Easements	2,899.6
Myakka River	3,993.6
Myakka River State Park	37,133.6
Myakka State Forest	4,887.0
Myakkahatchee Creek Conservation Easement	7,631.4
Myakkahatchee Creek Environmental Park	165.6
Oaks Park	11.7
O-Bar-O Ranch Conservation Easement	163.3
Old Miakka Preserve	132.0
Ollie's Pond Park	41.6
Paynes Creek Historic State Park	398.6
Peaceful Horse Ranch State Forest	4,214.1
Peace River Hammock	42.3
Peace River Mitigation Bank	484.6
Pine Island Sound Aquatic Preserve	2,096.3
Pinelands Reserve	1,707.4
Polk County Conservation Easement	561.9
Polk Lake	390.5
Prairie Creek Preserve	1,644.3
Prairie Pines Preserve	145.5
Prairie/Shell Creek	609.5
Rocky Ford	767.0
RV Griffin Reserve (GDC)	5,919.8

Saddle Blanket Scrub Preserve	365.1
Saddle Creek County Park	729.1
Saddle Creek Sanctuary	443.2
Shell Creek Preserve	366.9
Sleeping Turtles Preserve North	200.7
Sleeping Turtles Preserve South	209.4
South Fort Meade Hardee County Conservation Easement	2,048.9
South Peace River	365.2
South River Road	71.5
Street Sanctuary	28.3
Sun 'N Lake Preserve	1,341.1
Sunrise Park	40.3
Tenoroc Fish Management Area	7,077.4
Tippecanoe Environmental Park	346.4
Tippecanoe II Florida Scrub-Jay Mitigation Area	182.9
T. Mabry Carlton, Jr. Memorial Reserve	24,577.3
Upper Myakka River watershed	2,357.1
Upper Saddle Creek/Schaller Tract	37.2
Venice Myakka Park	11.1
Walton Ranch	3,745.3
Warm Mineral Springs Creek	4.2
Well Field Scrub-Jay Habitat	73.0
Wetlands Reserve Program Easement #103	1,728.3
Wetlands Reserve Program Easement #104	260.7
Wetlands Reserve Program Easement #105	519.3
Wetlands Reserve Program Easement #106	534.7
Wetlands Reserve Program Easement #164	972.9
Wetlands Reserve Program Easement #165	10.4
Winter Haven to Lake Alfred Trail	43.8
Yucca Pens Preserve	65.7
Yucca Pens Unit	5,234.5
Total	**389,649.1**
Total Watershed Area:	2,075,831
Percent Conservation Lands:	19%
Qualifier:	**Minus**

Pine Island Sound

Conservation Lands Name	Acreage
Bocilla Preserve	24.3
Bowman's Beach Regional Park	173.9
Buttonwood Preserve	262.9
Calusa Land Trust and Nature Preserve of Pine Island, Inc.	1,245.6
Carver Preserve	189.1
Cayo Costa State Park	2,399.6
Cayo Costa Unit	8.5
Charlotte Flatwoods Environmental Park	3.8
Charlotte Harbor Buffer Preserve	294.6
Charlotte Harbor Preserve State Park	14,050.9
Estero Bay Preserve State Park	399.4
Galt Preserve	262.1
Gasparilla Sound - Charlotte Harbor Aquatic Preserve	421.6
J. N. Ding Darling National Wildlife Refuge	6,358.6
Kurgis Conservation Easement	6.8
Lighthouse Beach Park	30.4
Matlacha Pass Aquatic Preserve	12,496.7
Matlacha Pass National Wildlife Refuge	567.3
Murdock Point Cayo Costa	99.7
Norberg Research Natural Area	105.2
Pine Island Flatwoods Preserve	921.0
Pine Island National Wildlife Refuge	473.1
Pine Island Preserve at Matlacha Pass	228.3
Pine Island Sound Aquatic Preserve	51,838.1
Pond Apple Park	8.6
Punta Rassa Preserve	6.7
Randell Research Center	55.1
Sanibel-Captiva Conservation Foundation Conservation Lands	1,701.7
Silver Key	66.0
Smokehouse Bay Preserve	209.5
St. James Creek Preserve	116.0
Yellow Fever Creek Preserve	198.6
Yucca Pens Preserve	160.4
Yucca Pens Unit	9,809.2

Total	**105,193.3**
Total Watershed Area:	187,110
Percent Conservation Lands:	56%
Qualifier:	**Plus**

Caloosahatchee River

Conservation Lands Name	Acreage
Alva Scrub Preserve	1,154.4
Babcock Ranch Conservation Easement	302.3
Babcock Ranch Preserve	71,112.9
Billy Creek Preserve	50.7
Buckingham Trails Preserve	572.2
C-43 Basin Storage Reservoir - Part 1	5,303.8
Caloosahatchee Basin Water Storage Reservoir	7,133.1
Caloosahatchee Creeks Preserve	1,270.6
Caloosahatchee National Wildlife Refuge	18.2
Caloosahatchee Regional Park	768.8
Caloosahatchee River Basin Water Quality Treatment and Testing Facility	2,441.5
Charlotte Harbor Preserve State Park	44.6
Columbus G. Macleod Preserve	9.2
Cow Slough/Deep Lagoon	130.5
Daniels Preserve at Spanish Creek	243.3
Deep Lagoon Preserve	274.1
Estero Bay Preserve State Park	5.1
Fisheating Creek	146.1
Fisheating Creek Wildlife Management Area	31.8
Floraglades Preserve	69.5
Florida Panther Conservation Bank II Conservation Easement	462.8
Four Mile Cove Ecological Preserve	349.9
Fred C. Babcock-Cecil M. Webb Wildlife Management Area	19,664.6
Greenbriar Swamp Preserve	394.2
Harn's Marsh	578.5
Herbert Hoover Dike	727.8
Hickey Creek Wildlife and Environmental Area	785.2
Hickey's Creek/Greenbriar Connector	80.5
Hickey's Creek Mitigation Park	82.2
Hickory Swamp Preserve	66.6

Imperial Marsh Preserve	4.8
Labelle Ranch, Inc. Conservation Easement	3,018.3
Lakes Park	0.3
Lone Ranger Ranch TNC Conservation Easement	537.5
Manatee Park	21.4
Meadowbrook Park	34.2
Moya Preserve	118.0
Nicodemus Slough Flowage Easement	2,582.7
Okaloacoochee Slough State Forest	5,876.2
Okaloacoochee Slough Wildlife Management Area	2,992.6
Old Bridge Preserve	48.2
Orange River Parcel	6.4
Orange River Preserve	63.3
Panther Passage Conservation Bank Conservation Easement	1,298.2
Persimmon Ridge Preserve	36.1
Pop Ash Creek Preserve	307.3
Powell Creek Preserve	77.2
Prairie Pines Preserve	2,538.4
River of Grass	24.1
Rotary Park Environmental Center	99.9
Savannah Lakes	390.0
Six Mile Cypress Slough Preserve North	5.9
Spirit of the Wild Wildlife Management Area	7,648.0
Telegraph Creek Preserve	1,726.8
West Marsh Preserve	205.9
Wetlands Reserve Program Easement #177	718.5
Wild Turkey Strand Preserve	9.1
Yellow Fever Creek Preserve	140.9
Total	**144,805.2**

Total Watershed Area:	880,879
Percent Conservation Lands:	16%
Qualifier:	**Minus**

Estero Bay

Conservation Lands Name	Acreage
Big Hickory Island Preserve	251.3
Bowditch Point Park	17.3
Calusa Nature Center and Planetarium	104.7
Corkscrew Regional Ecosystem Watershed	10,728.2
Corkscrew Regional Mitigation Bank	636.7
Eagle Lake Preserve	41.1
Estero Bay Aquatic Preserve	10,414.0
Estero Bay Preserve State Park	10,945.7
Estero Marsh Preserve	243.9
Flag Pond Preserve	66.9
Flint Pen Strand	920.5
Gator Hole Preserve	175.0
Hidden Cypress Preserve	428.5
Imperial Flowway	12.8
Imperial Marsh Preserve	517.7
Imperial River Preserve	46.2
Koreshan Preserve	37.7
Koreshan State Historic Site	196.2
Lakes Regional Park	285.6
Lovers Key State Park	1,317.1
Matanzas Pass Preserve	58.1
Matlacha Pass National Wildlife Refuge	150.2
Mound Key Archaeological State Park	119.9
Mullock Creek Preserve	4.3
Oak Creek Preserve	3.7
Pine Lake Preserve	174.5
Railhead Scrub Preserve	48.9
Sam Galloway Tract at Imperial Marsh Preserve	290.2
San Carlos Bay - Bunche Beach Preserve	734.7
Six Mile Cypress Slough Preserve	2,404.0
Six Mile Cypress Slough Preserve North	1,213.4
Wild Turkey Strand Preserve	3,136.8
Total	**45,725.8**
Total Watershed Area:	198,144
Percent Conservation Lands:	23%

Qualifier: **Minus**

Wiggins Pass/ Cocohatchee River

Conservation Lands Name	Acreage
Alligator Flag Preserve	18.7
Barefoot Beach Preserve County Park	197.7
Caracara Prairie Preserve	380.3
Cocohatchee Creek Preserve	3.8
Corkscrew Regional Ecosystem Watershed	16,492.5
Corkscrew Regional Mitigation Bank	6.8
Corkscrew Swamp Sanctuary	11,678.6
Delnor-Wiggins Pass State Park	174.0
Flint Pen Strand	63.8
Lake Trafford Impoundment	634.6
Limpkin Marsh Preserve	9.0
Pepper Ranch Preserve	2,460.3
Railhead Scrub Preserve	87.5
Sam Galloway Tract at Imperial Marsh Preserve	109.8
Vanderbilt Beach County Park	5.0
Wet Woods Preserve	25.6
Total	**32,348.0**

Total Watershed Area: 119,610

Percent Conservation Lands: 27%

Qualifier: **None**

Naples Bay

Conservation Lands Name	Acreage
Corkscrew Regional Ecosystem Watershed	474.9
Freedom Park	12.5
Gordon River Greenway Park	83.9
Gordon River Greenway Preserve	41.6
Logan Woods Preserve	6.8
Nancy Payton Preserve	72.0
Panther Walk Preserve	4.5
Red Maple Swamp Preserve	198.0
Riverside Circle Wetland Area	5.2
Rivers Road Preserve	75.7
Rookery Bay National Estuarine Research Reserve	4.6
The Naples Preserve	9.7
Total	**989.4**

Total Watershed Area:	89,922
Percent Conservation Lands:	1%
Qualifier:	**Minus**

Rookery Bay

Conservation Lands Name	Acreage
Collier-Seminole State Park	2,130.2
McIlvane Marsh	371.8
Otter Mound Preserve	2.5
Picayune Strand State Forest	20,233.1
Rookery Bay Aquatic Preserve	80.2
Rookery Bay National Estuarine Research Reserve	41,640.9
Rookery Bay Reserve Lands	327.3
Shell Island Preserve	82.7
Ten Thousand Islands National Wildlife Refuge	1,660.1
Tigertail Beach County Park	42.0
Total	**66,570.8**

Total Watershed Area:	127,261
Percent Conservation Lands:	52%
Qualifier:	**Plus**

Ten Thousand Islands

Conservation Lands Name	Acreage
Big Cypress Mitigation Bank	2,193.7
Big Cypress National Preserve	727,108.8
BR Bar Ranch Conservation Easement	562.3
Camp Keais Strand	33.0
Camp Keais Strand (SFWMD)	53.3
Cape Romano - Ten Thousand Islands Aquatic Preserve	49.8
Collier-Seminole State Park	5,140.6
Deer Fence Canal	515.2
Dinner Island Ranch Wildlife Management Area	21,706.1
Everglades and Francis S. Taylor Wildlife Management Area	3,039.0
Everglades National Park	48,892.3
Fakahatchee Strand Preserve State Park	78,385.5
Florida Panther Conservation Bank Conservation Easement	1,933.0
Florida Panther National Wildlife Refuge	26,355.4
Jentgen Parcel	96.9
Okaloacoochee Slough State Forest	26,470.7
Picayune Strand State Forest	53,926.9
River of Grass	18,144.7
Rookery Bay National Estuarine Research Reserve	8,731.9
Rookery Bay Reserve Lands	595.4
Stormwater Treatment Areas	53.2
Ten Thousand Islands National Wildlife Refuge	29,498.6
Wetlands Reserve Program Easement #101	6,678.3
Wetlands Reserve Program Easement #120	1,263.9
Wetlands Reserve Program Easement #133	151.7
Wetlands Reserve Program Easement #150	400.2
Wetlands Reserve Program Easement #151	744.0
Wetlands Reserve Program Easement #169	217.1
Wetlands Reserve Program Easement #171	646.6
Winchester Head	75.0
Total	**1,063,663.1**
Total Watershed Area:	1,542,441
Percent Conservation Lands:	69%
Qualifier:	**Plus**

7 APPENDIX D: Water Quality Data

7.1 Understanding the 303(d) List and the Watershed Assessment Process

The Conservancy of Southwest Florida uses the 303(d) lists of waters that do not meet state water quality standards in the water quality assessment for the Estuaries Report Card.

Under §303(d) of the Clean Water Act (CWA), states are required to identify waterbodies that do not meet, or are projected to not meet, state water quality standards and report those waterbodies to the EPA. The CWA requires EPA to review the lists submitted by the states and either approve or disapprove the lists wholly or in part by issuing a decision document. If EPA disapproves the list, then the agency is required to identify the waterbodies that should be included on the states' 303(d) lists, which EPA refers to as "waters added by EPA." Once a waterbody is added to the 303(d) list and approved by EPA, the waterbody may only be delisted if EPA approves the delisting and the state's delisting requirements have been met.

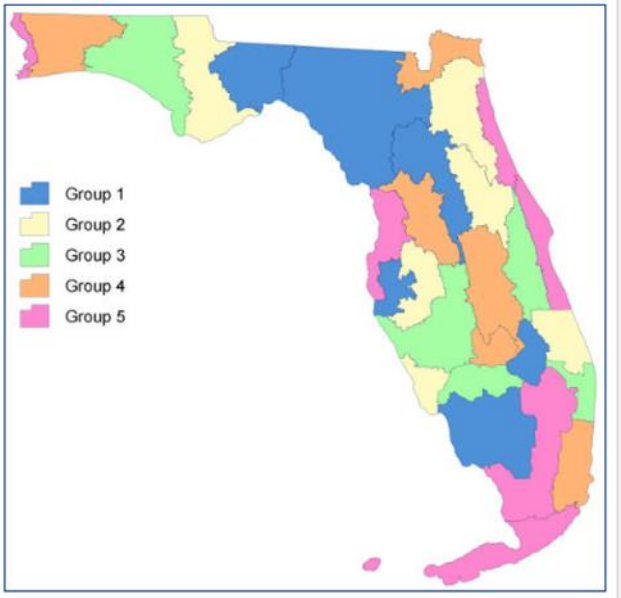


Figure 7.1-a FDEP Assessment Groups

Florida first submitted a 303(d) list in 1998, which was approved by EPA and became the baseline for water quality tracking in the state. Subsequently, the state legislature enacted the Total Maximum Daily Load statute in 2000, and FDEP promulgated the Impaired Waters Rule (IWR) to implement that statute. Under the IWR, there are three lists of waterbodies, called the Planning List, the Study List, and the Verified List. The Planning List includes waterbodies that are potentially not meeting water quality standards and are included in Category 3c. The Study List includes waterbodies that do not meet water quality standards, but no causative pollutant has been identified and is identified in Category 4d. This category typically applies to Biology or Dissolved Oxygen parameters and is submitted to EPA, along with those waterbodies in Category 4e, and those on the Verified List in Category 5. The distinction between the Study List and Verified List is that FDEP will not pursue a TMDL until a causative pollutant has been identified for 4d waterbodies.

To identify waterbodies that do not meet state water quality standards, FDEP has divided the state into 5 basins (Fig. 7.1-a). Each basin is reviewed on a 5 year rotating cycle, so that an updated 303(d) list is released approximately every 5 years for each basin. The data used in the assessment is stored in a centralized database called STORET, which stands for STOrege and RETreival. Data providers, including local governments and volunteer monitoring programs, upload water quality sampling results to

supplement FDEP's and the water management district's water quality sampling datasets. (Note: in 2017, FDEP is moving to a different online database called Watershed Information Network or WIN)

The watersheds assessed in the Report Card are in basin groups 1 (Estero Bay, Wiggins Pass/Cocohatchee River, Naples Bay, Rookery Bay, and Ten Thousand Islands), 2 (Pine Island Sound, Lemon Bay, and Charlotte Harbor Proper), and 3 (Coastal Venice, Caloosahatchee, and the rest of Greater Charlotte Harbor).

The Group 1 and Group 2 Cycle 2 Verified Lists were adopted by the state in May of 2009, and EPA approved in part and disapproved in part these lists in September 2009. The Group 3 Cycle 2 Verified List was adopted by the state in January 2010, and EPA approved in part and disapproved in part this list in May 2010. The Group 1 Cycle 3 Verified list was adopted by the state in February 2013. EPA has not issued a decision document on the Group 1 Cycle 3 Verified Lists at the time of the Report Card's publication. Groups 2 and 3 Cycle 3 were not finalized by FDEP in time for inclusion in the 2017 Report Card.

Limitations of the 303(d) Lists

FDEP currently classifies waterbodies by Assessment Category (Table 7.1-a).

According to the CWA, states are required to adopt a set of water quality standards for surface waters that will ensure that waterways can support the use for which they are designated, such as swimming, fishing, or drinking. Designated uses in Florida are divided into six classifications, and each use classification has a specified set of water quality criteria or standards to protect human health and aquatic life.[190] The watershed assessment determines which of the assessment categories a waterbody falls into for each of the parameters for which it is assessed. Hypothetically, the waterbody may be in category 2 for copper, category 4d for DO, and category 5 for fecal coliform.

Table 7.1-a FDEP Assessment Categories

Assessment Category	Assessment Category Definitions
1	Attains all designated uses
2	Attains some designated uses and insufficient or no information or data are present to determine if remaining uses are attained
3a	No data and information are present to determine if any designated use is attained
3b	Some data and information are present but not enough to determine if any designated use is attained
3c	Enough data and information are present to determine that one or more designated uses may not be attained according to the Planning List methodology

4a	Impaired for one or more designated uses but does not require TMDL development because a TMDL has already been completed
4b	Impaired for one or more designated uses but does not require TMDL development because the water will attain water quality standards due to existing or proposed measures
4c	Impaired for one or more criteria or designated uses but does not require TMDL development because impairment is not caused by a pollutant
4d	The waterbody does not meet applicable criteria, but no pollutant can be identified; therefore a TMDL will not be developed at this time
4e	Impaired, but recently completed or on-going restoration activities are underway to restore the designated uses of the waterbody
5	Water quality standards are not attained and a TMDL is required

FDEP's application of these categories has created discrepancies between the state adopted Verified List and the EPA approved 303(d) List. EPA allows categories 4a, 4b, and 4c to be excluded from the 303(d) List, whereas they have determined that category 4d and 4e still require a TMDL.

The Conservancy has concerns with how categories 4a, 4b, and 4c are applied in Florida's assessment process for the following reasons:

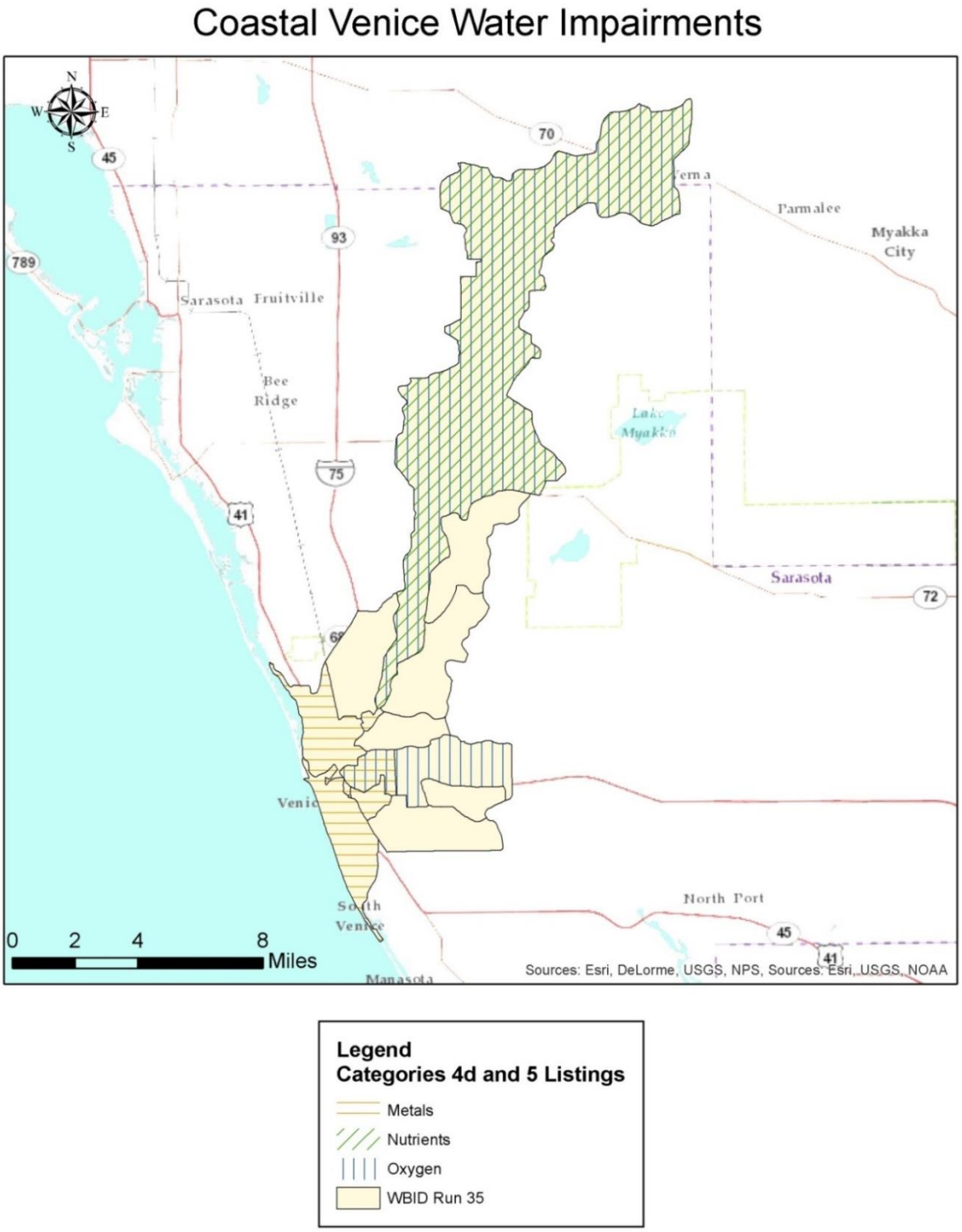
- 4a: TMDLs in the state of Florida are not representative of the sum of the individual waste load allocations for point and load allocations for nonpoint sources. Instead they represent a percent pollution reduction for the area in question. It is not until a Basin Management Action Plan is developed that individual load allocations are assigned to pollution contributors. Therefore, TMDLs in Florida (i.e., those placed in category 4a) should remain on the 303(d) list until a load allocation is established.

- 4b: Contrary to federal regulations and EPA guidance, sections 62-303.600 and 62-303.100(5), F.A.C. do not provide the "technology-based effluent limitations" or "other pollution control programs" that would warrant excluding a waterbody from the 303(d) list. 4b (those waterbodies with a Reasonable Assurance Document) do not coincide with federal regulations and should remain on the 303(d) list until these are met.

- 4c: Category 4c waterbodies should remain on the 303(d) list because their current water quality condition is not meeting state water quality standards. If there is any indication that anthropogenic pollution is or could be present, that waterbody must be listed. EPA guidance shows that unless *all* of the pollutant load can be attributable to natural factors and there are no anthropogenic sources of that pollution, then the waterbody must remain on the 303(d) list and receive a TMDL.

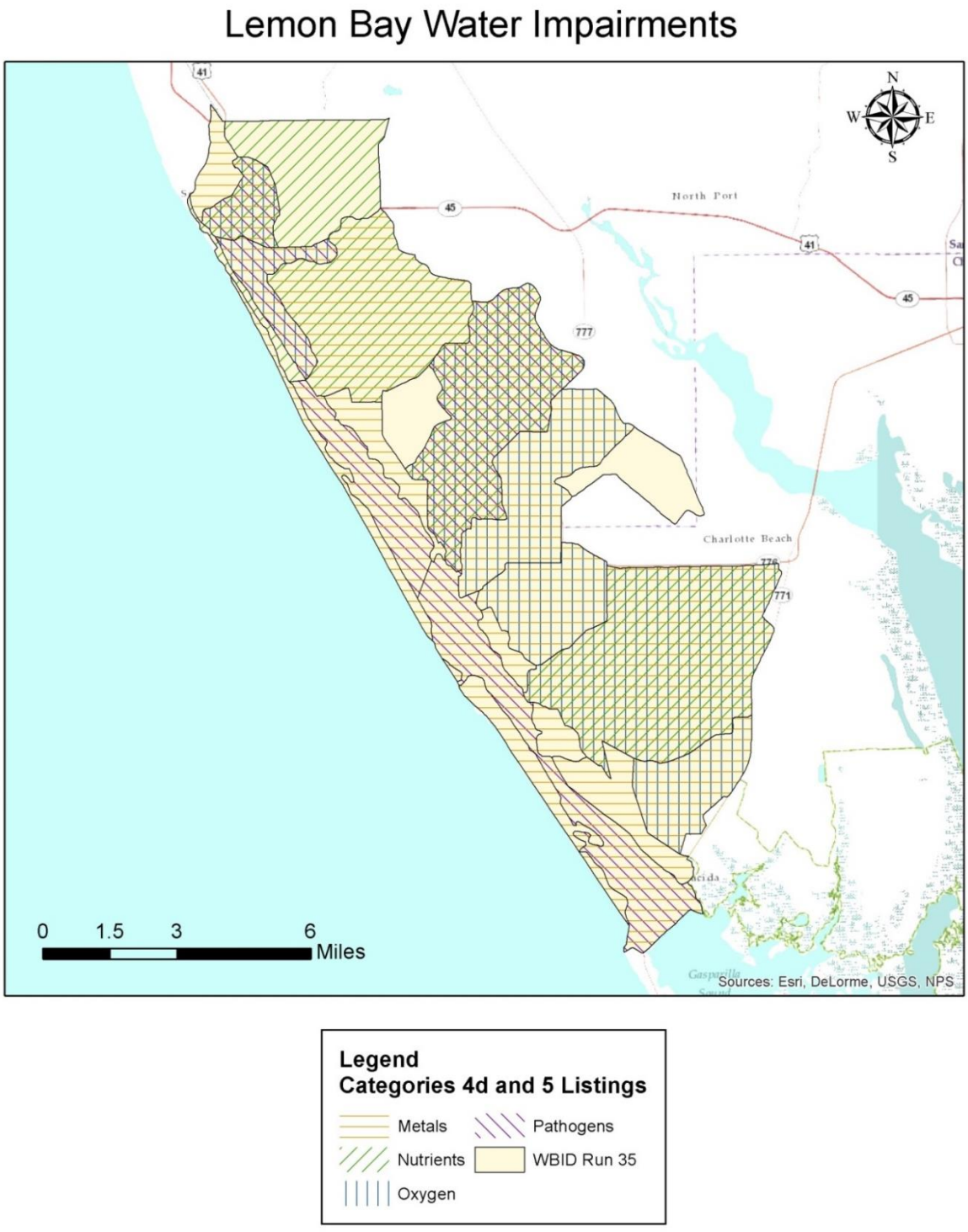
7.2 Categories 4d and 5 Listings and Calculations

7.2.1 Impaired Waters- Maps



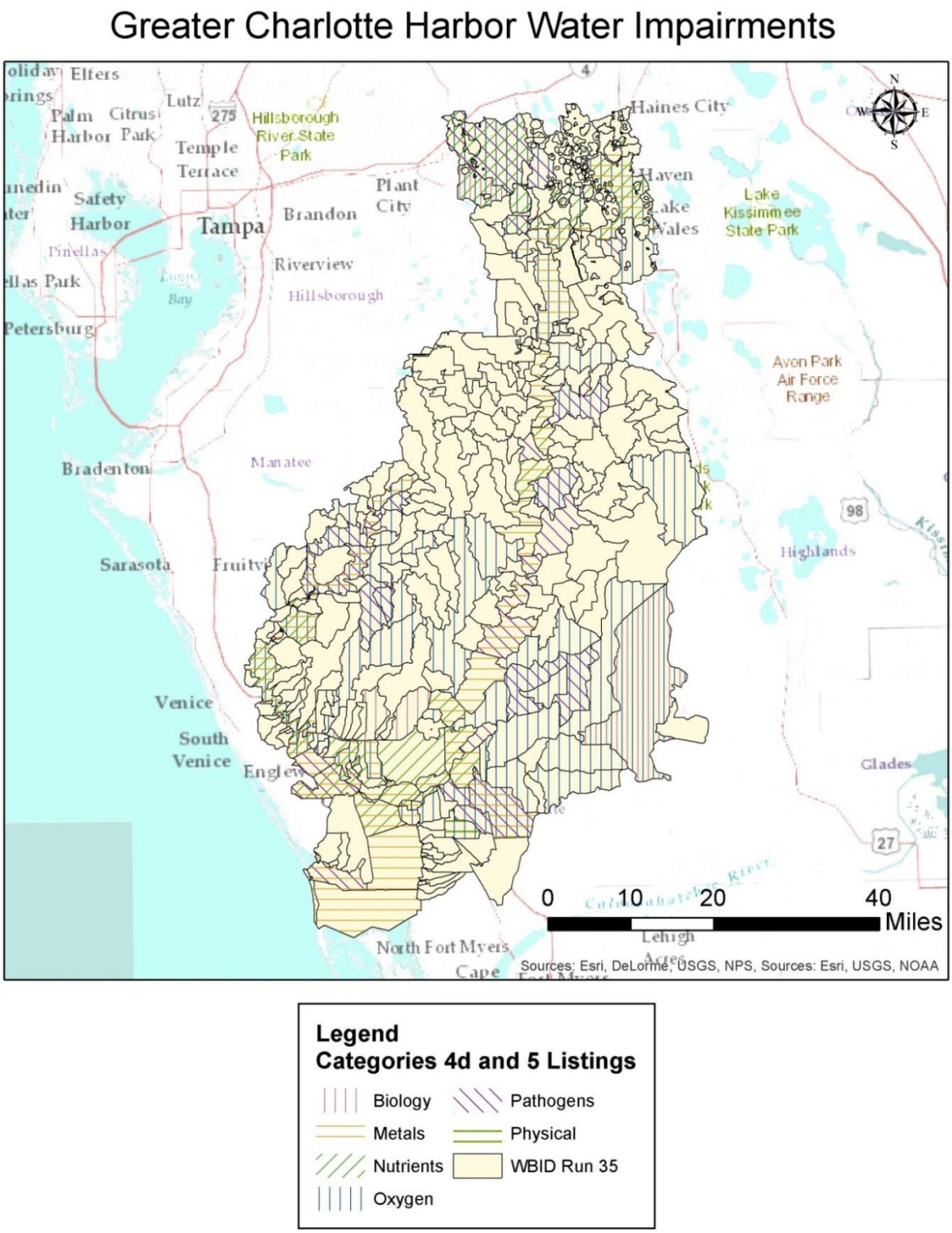
Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-a Impaired Waters- Coastal Venice



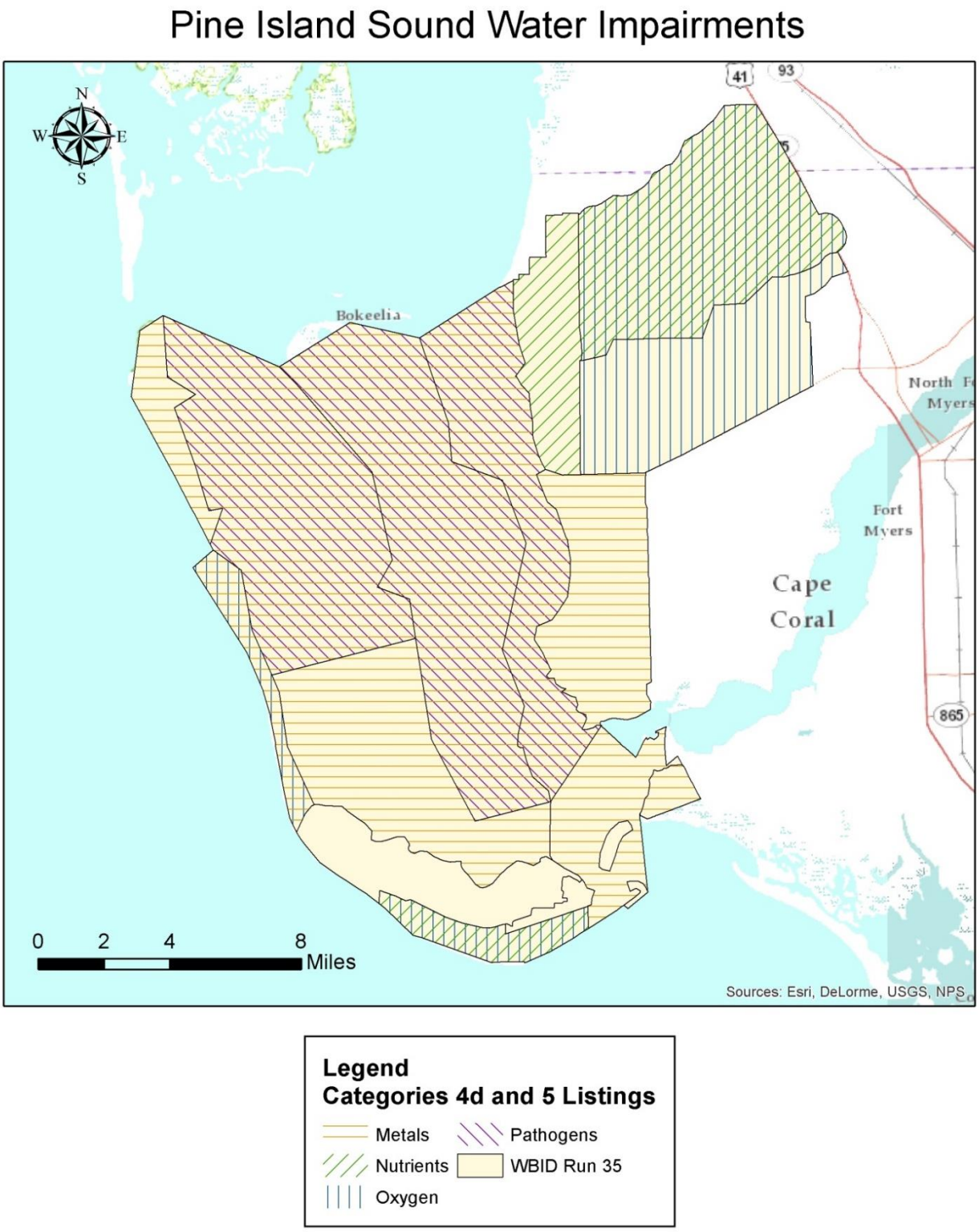
Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-b Impaired Waters- Lemon Bay



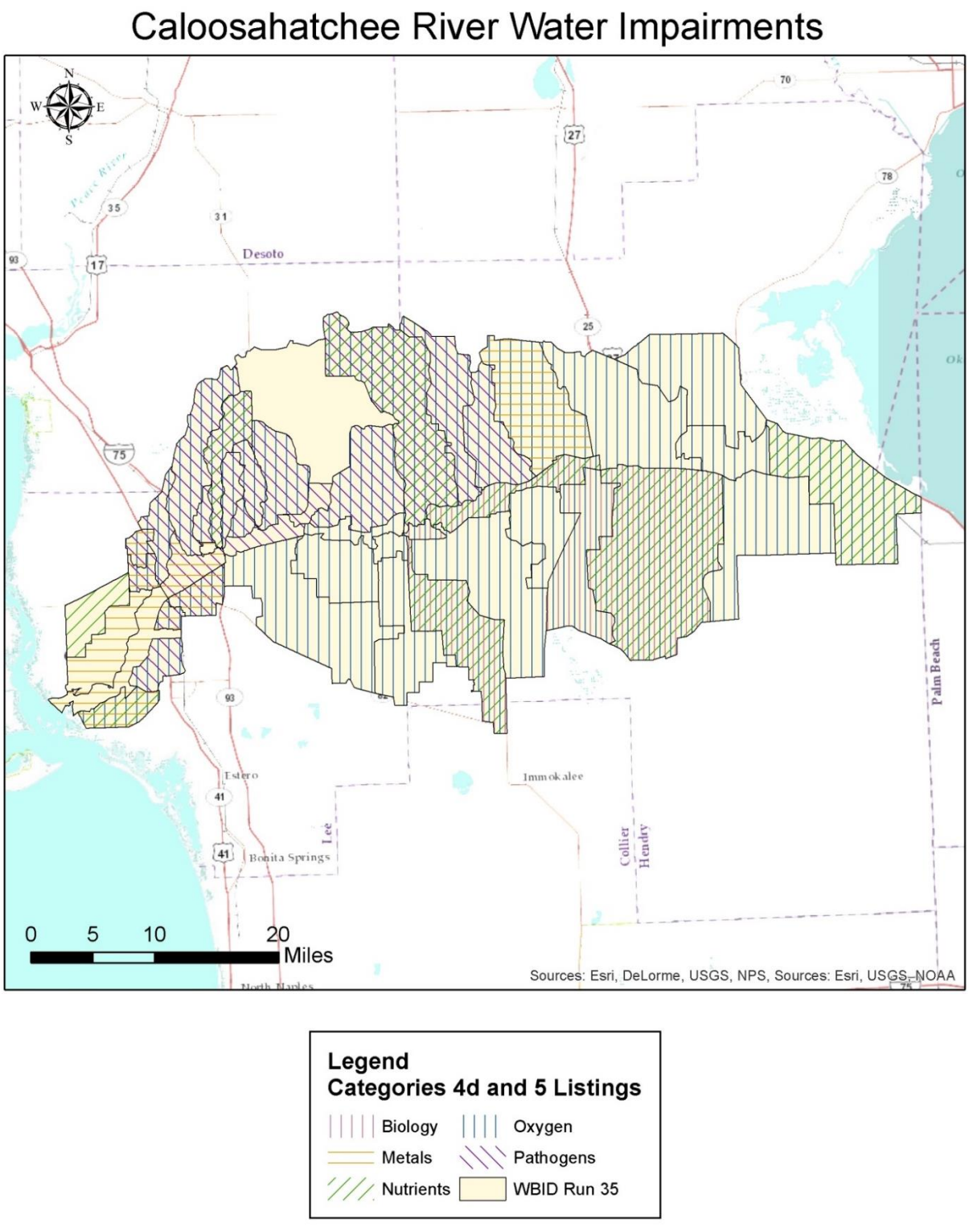
Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-c Impaired Waters- Greater Charlotte Harbor



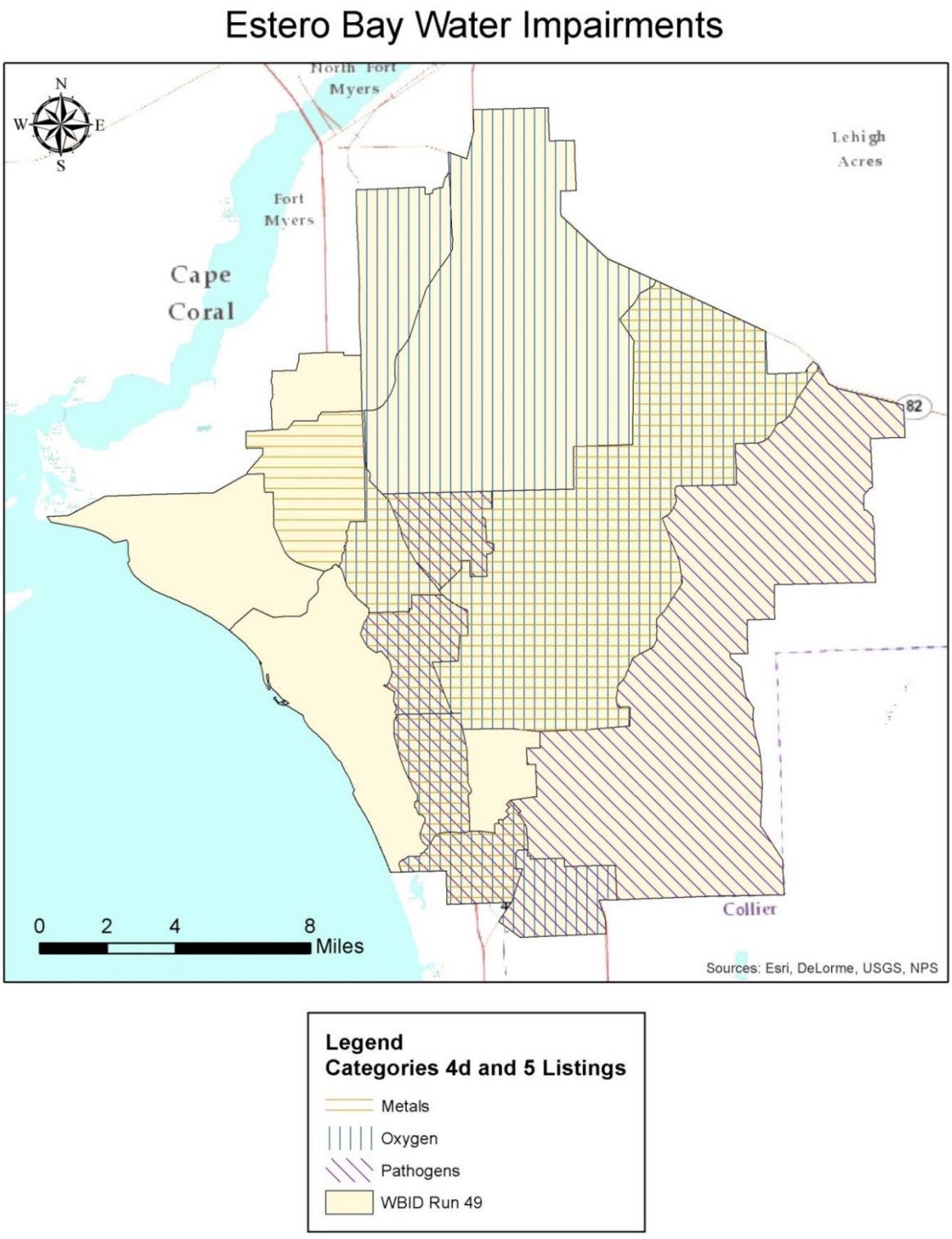
Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-d Impaired Waters- Pine Island Sound



Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 35) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-e Impaired Waters- Caloosahatchee River



Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-f Impaired Waters- Estero Bay

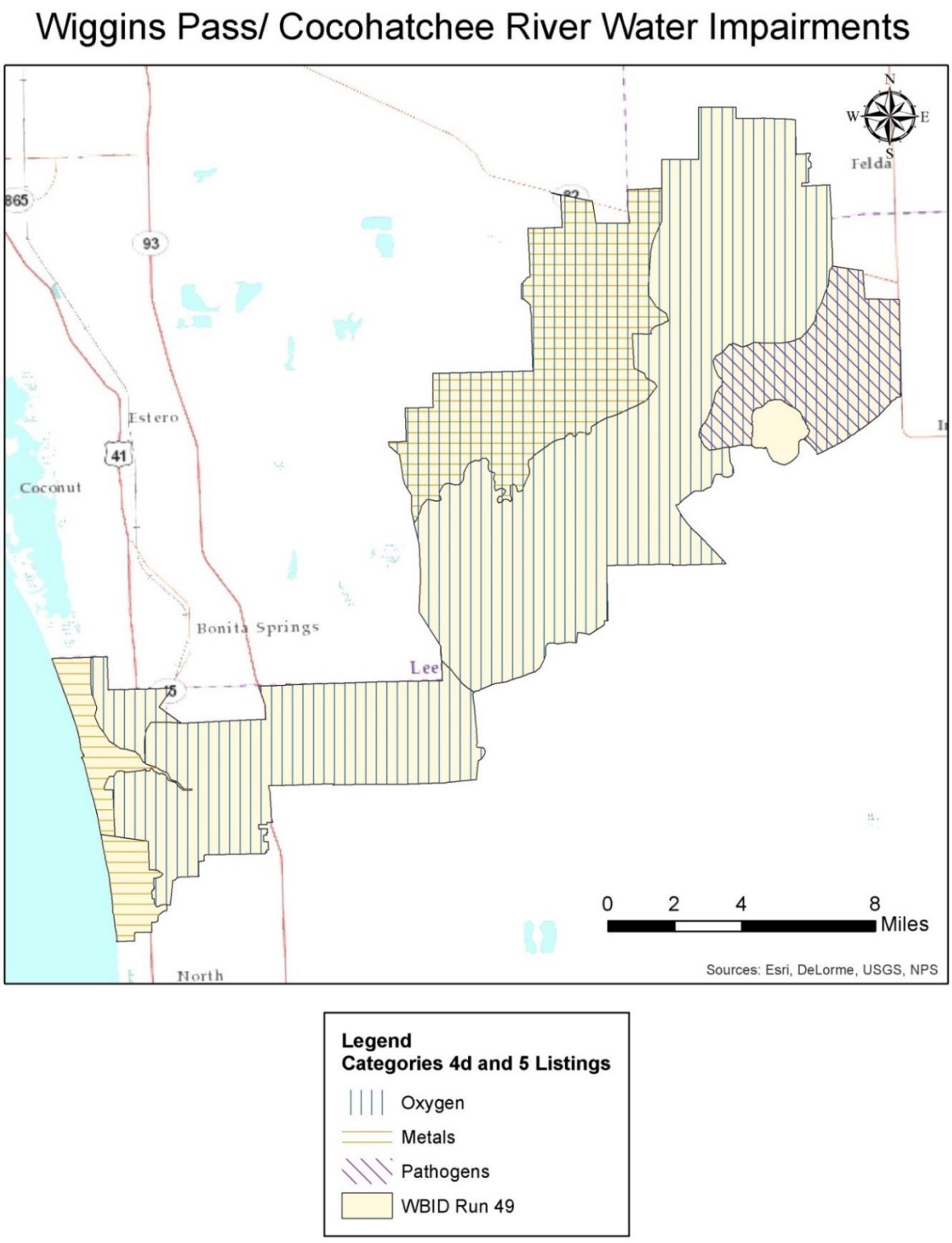
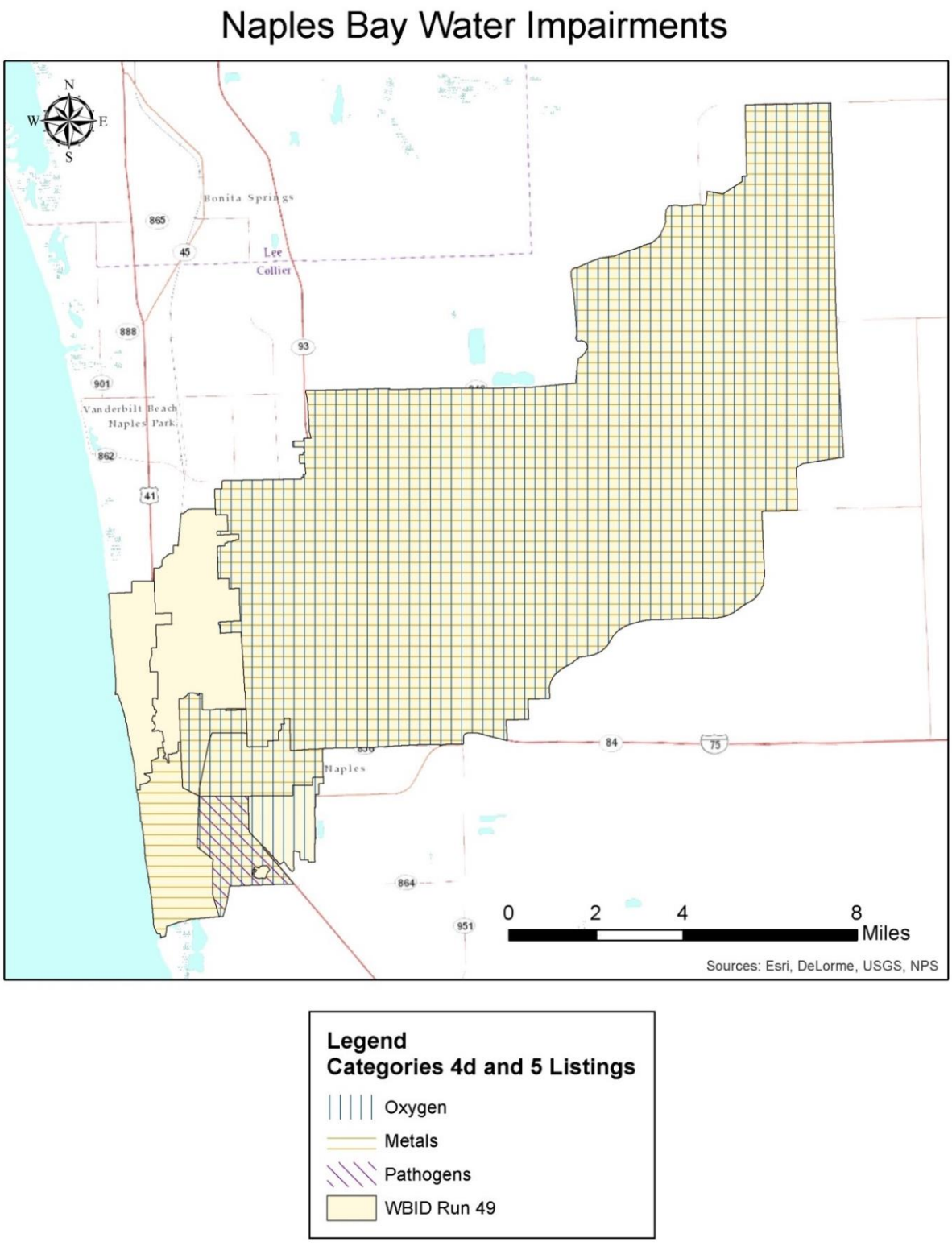
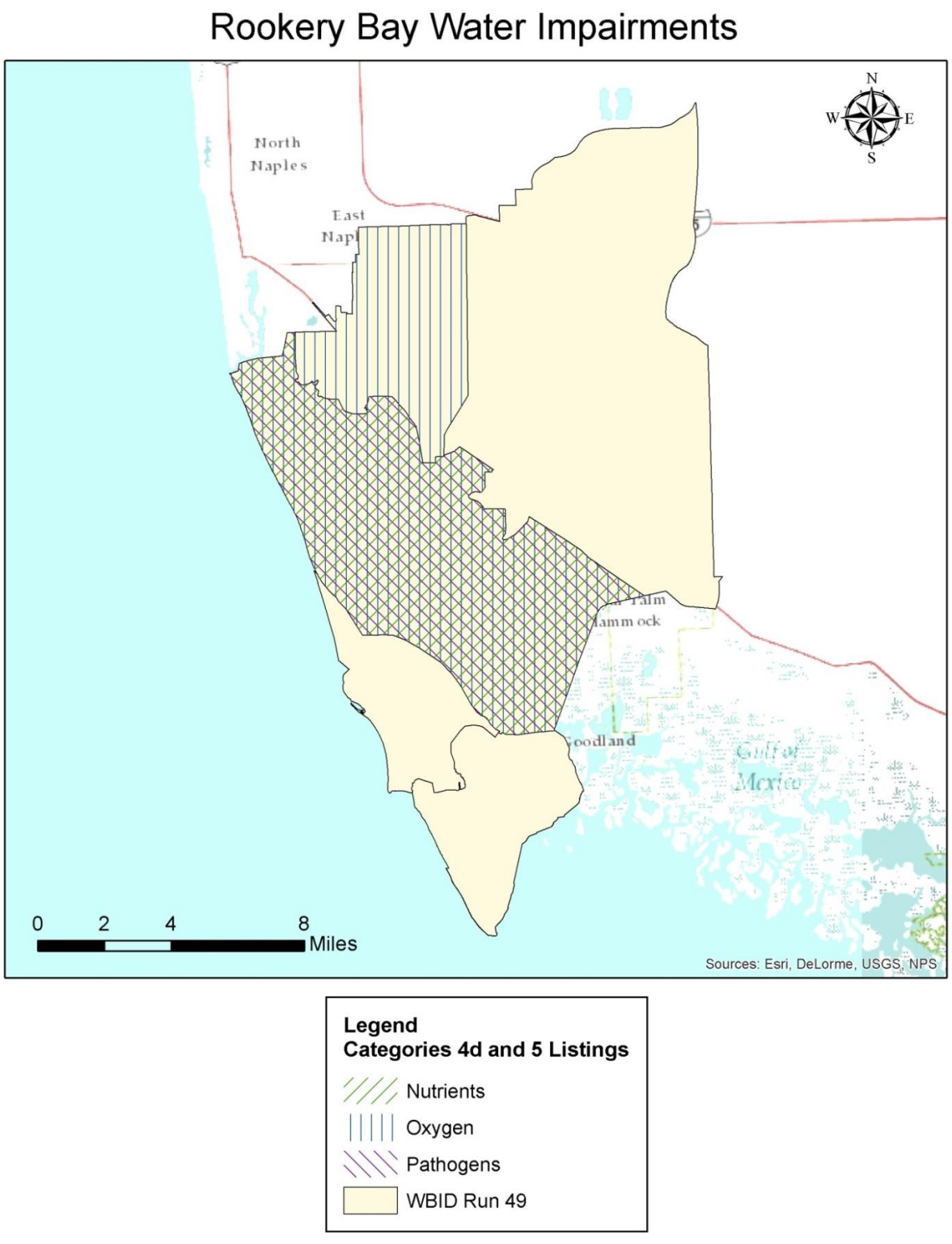


Figure 7.2-g Impaired Waters- Wiggins Pass/Cocohatchee River



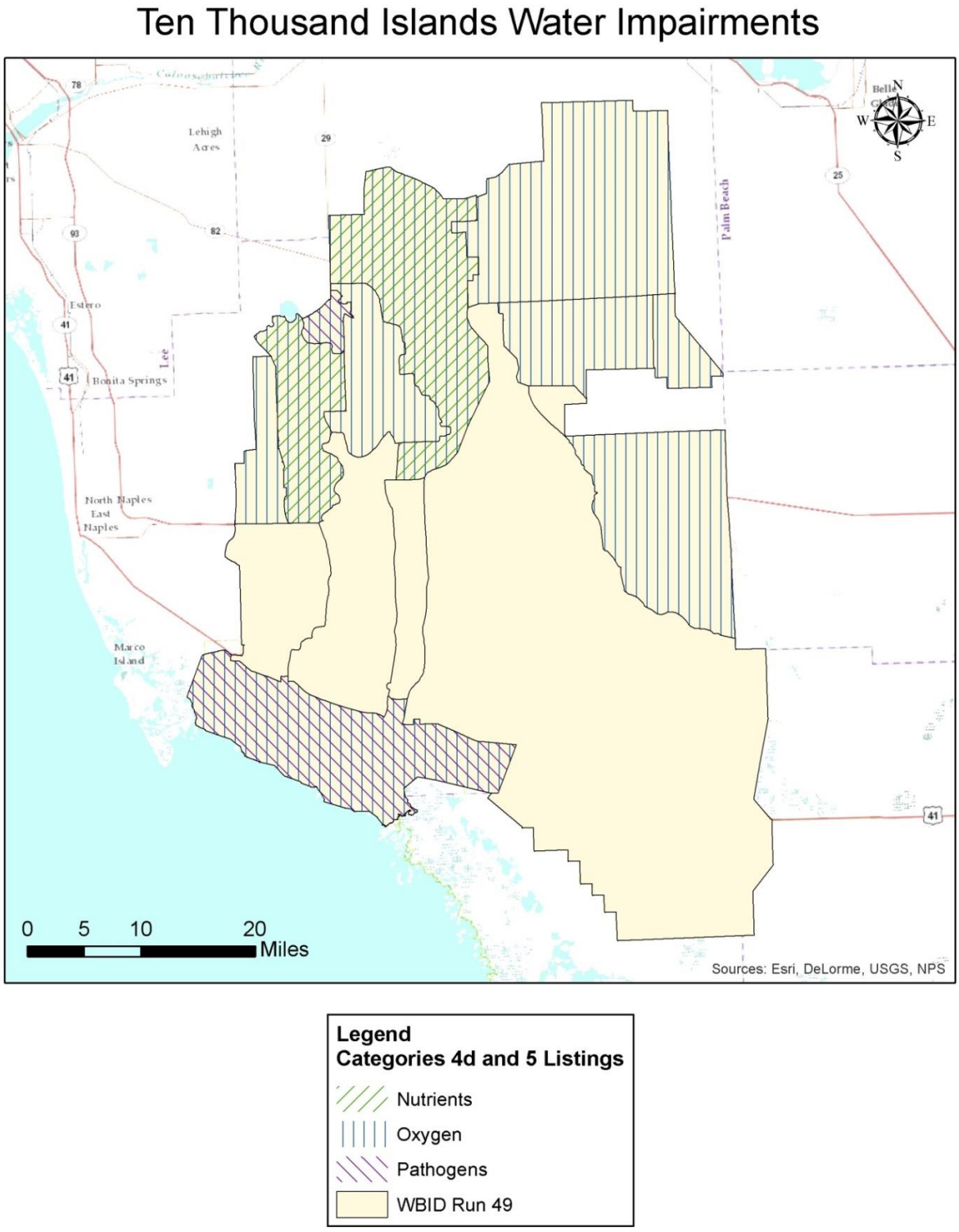
Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-h Impaired Waters- Naples Bay



Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-i Impaired Waters- Rookery Bay



Data Source
WBIDs: WBIDS_APR14, Water Body Identification numbers (WBID - Run 49) for the State of Florida, Florida Department of Environmental Protection
Downloaded from fgdl.org

Figure 7.2-j Impaired Waters- Ten Thousand Islands

7.2.2 Impaired Waters Gradebook

Table 7.2-a Impaired Waters- Gradebook

Coastal Venice

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	44,539	62,961	71%	29%	1.33	2.00	**C**
Severity of Impairment	80,057	377,768	21%	79%	3.33		

Lemon Bay

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	59,153	62,320	95%	5%	0.33	1.11	**D**
Severity of Impairment	136,080	373,923	36%	64%	2.67		

Greater Charlotte Harbor

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	1,113,950	2,075,832	54%	46%	2.00	2.56	**C**
Severity of Impairment	1,817,074	12,454,989	15%	85%	3.67		

Pine Island Sound

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	177,089	187,111	95%	5%	0.33	1.33	**D**
Severity of Impairment	284,324	1,122,665	25%	75%	3.33		

Caloosahatchee River

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	831,659	880,879	94%	6%	0.33	1.22	**D**
Severity of Impairment	1,527,256	5,285,275	5%	71%	3.00		

Estero Bay

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	166,995	198,137	84%	16%	0.67	1.56	**D**
Severity of Impairment	248,745	1,188,823	21%	79%	3.33		

Wiggins Pass/ Cocohatchee River

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	118,120	119,610	99%	1%	0.33	1.33	**D**
Severity of Impairment	152,482	717,657	21%	79%	3.33		

Naples Bay

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	82,409	89,922	92%	8%	0.33	1.22	**D**
Severity of Impairment	162,128	539,529	30%	70%	3.00		

Rookery Bay

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	53,610	127,428	42%	58%	2.33	2.66	**C**
Severity of Impairment	130,721	764,570	17%	83%	3.33		

Ten Thousand Islands

	Impaired Acres	Total Watershed Acreage*	Percent Impaired	Percent Unimpaired	GPA Rank	Combined GPA	Letter Grade
Spatial Impairment	757,880	1,542,441	49%	51%	2.00	2.56	**C**
Severity of Impairment	1,073,645	9,254,647	12%	88%	3.67		

*Total Watershed Acreage for Spatial impairment is the number of acres in the watershed.
Total Watershed Acreage for Severity of Impairment is the number of acres multiplied by 6

7.2.3 Impaired Waters- Complete Lists by Watershed

Table 7.2-b Impaired Waters- Complete Lists by Watershed

Coastal Venice

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
2	3	Sarasota Bay	1924	Cow Pen Slough	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Sarasota Bay	1924	Cow Pen Slough	Dissolved Oxygen	Oxygen	5
2	3	Sarasota Bay	1924A	Cow Pen Slough (Tidal)	Mercury (in fish tissue)	Metals	5
2	3	Sarasota Bay	2002	Dona Bay	Mercury (in fish tissue)	Metals	5
2	3	Sarasota Bay	2009	Curry Creek	Dissolved Oxygen	Oxygen	4d
2	3	Sarasota Bay	2009A	Curry Creek	Mercury (in fish tissue)	Metals	5
2	3	Sarasota Bay	2009A	Curry Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Sarasota Bay	2015	Hatchett Creek (Tidal)	Mercury (in fish tissue)	Metals	5
2	3	Sarasota Bay	2017	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	3	Sarasota Bay	2018	Roberts Bay Venice	Mercury (in fish tissue)	Metals	5

Lemon Bay

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
2	2	Lemon Bay	1983A	Lemon Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	1983A	Lemon Bay	Fecal Coliform	Pathogens	5
2	2	Lemon Bay	1983A	Lemon Bay	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Lemon Bay	1983A1	North Lemon Bay	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	1983B	Lemon Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	1983B	Lemon Bay	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Lemon Bay	2021	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2030	Alligator Creek Tidal	Mercury (in fish tissue)	Metals	5

2	2	Lemon Bay	2030	Alligator Creek Tidal	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	2030	Alligator Creek Tidal	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2030	Alligator Creek Tidal	Fecal Coliform	Pathogens	5
2	2	Lemon Bay	2030A	Alligator Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	2039	Forked Creek	Copper	Metals	5
2	2	Lemon Bay	2039	Forked Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2039	Forked Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	2042	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2042	Direct Runoff to Bay	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2042	Direct Runoff to Bay	Fecal Coliform	Pathogens	5
2	2	Lemon Bay	2049	Gottfried Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2049	Gottfried Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	2049	Gottfried Creek	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2049	Gottfried Creek	Fecal Coliform	Pathogens	5
2	2	Lemon Bay	2051	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2052	Rock Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2052	Rock Creek	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2067	Oyster Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2067	Oyster Creek	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2068	Buck Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2068	Buck Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Lemon Bay	2068	Buck Creek	Dissolved Oxygen	Oxygen	5
2	2	Lemon Bay	2072	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2075A	Manasota Key	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2075B	Barrier Island	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2075C	Barrier Island	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2075D	Barrier Island	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2076	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2078A	Coral Creek	Mercury (in fish tissue)	Metals	5
2	2	Lemon Bay	2078B	Coral Creek (East Branch)	Mercury (in fish tissue)	Metals	5

2	2	Lemon Bay	2078B	Coral Creek (East Branch)	Dissolved Oxygen	Oxygen	5

Greater Charlotte Harbor

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
2	3	Upper Peace River	1488A	Lake Smart	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488B	Lake Rochelle	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488C	Lake Haines	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488D	Lake Alfred	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488G	Sliver Lake (Polk County)	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488P	Lake Martha	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488Q	Lake Maude	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488S	Lake Buckeye	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488U	Lake Conine	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488V	Lake Swoope	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488Y	Lake Pansy	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1488Z	Lake Echo	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	14921	Lake Tracy	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1497	Saddle Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1497	Saddle Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1497	Saddle Creek	Fecal Coliform	Pathogens	5
2	3	Upper Peace River	1497A	Crystal Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1497B	Lake Parker	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1497C	Lake Tenoroc	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1497D	Lake Gibson	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1497E	Lake Bonny	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	15001	Little Lake Hamilton	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	15003	Lake Confusion	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1501	Lake Lena	Nutrients (TSI)	Nutrients	5

2	3	Upper Peace River	1501A	Lake Lena Run	Dissolved Oxygen	Oxygen	4d
2	3	Upper Peace River	1501A	Lake Lena Run	Fecal Coliform	Pathogens	5
2	3	Upper Peace River	1501B	Lake Arianna (North)	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1501W	Sears Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	15041	Lake Hamilton	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	15101	Lake Eva	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1521B	Lake Eloise	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1521C	Lake Lulu Run	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1521C	Lake Lulu Run	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1521C	Lake Lulu Run	Fecal Coliform	Pathogens	5
2	3	Upper Peace River	1521L	Lake Marianna	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1521P	Deer Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1521Q	Lake Blue	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1539	Peace Creek Drainage Canal	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	1539	Peace Creek Drainage Canal	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1539	Peace Creek Drainage Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1539C	Lake Annie	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1539P	Lake Dexter	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	1539Q	Lake Ned	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1539R	Lake Daisy	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1539Z	Lake Menzie	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1548	Lake Elbert	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1549A	Banana Lake Canal	Biology	Biology	4d
2	3	Upper Peace River	1549A	Banana Lake Canal	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1549A	Banana Lake Canal	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1549A	Banana Lake Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1549B	Banana Lake	Nutrients (TSI)	Nutrients	5

2	3	Upper Peace River	1549B1	Lake Stahl	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1549B1	Lake Stahl	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1549X	Hollingsworth Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1580	Wahneta Farms Drainage Canal	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1580	Wahneta Farms Drainage Canal	Dissolved Oxygen	Oxygen	4d
2	3	Upper Peace River	1588A	Lake Mcleod	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1613	Peace Creek Tributary Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1617A	Lake Effie	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	1623A	Peace River Above Thornton Branch	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	1623A	Peace River Above Thornton Branch	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	1623A	Peace River Above Thornton Branch	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Middle Peace River	1623B	Peace River Above Horse Creek	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1623C	Peace River Above Joshua Creek	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1623C	Peace River Above Joshua Creek	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	1623D	Peace River Above Charlie Creek	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1623E	Peace River Above Oak Creek	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1623F	Peace River Above Troublesome Creek	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1623F	Peace River Above Troublesome Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Middle Peace River	1623F	Peace River Above Troublesome Creek	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Middle Peace River	1623G	Peace River Above Little Charlie Creek	Mercury (in fish tissue)	Metals	5

2	3	Upper Peace River	1623H	Peace River Above Payne Creek	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	1623I	Peace River Above Whidden Creek	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	1623J	Peace River Above Bowlegs Creek	Mercury (in fish tissue)	Metals	5
2	3	Upper Peace River	1623J	Peace River Above Bowlegs Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1623K	Saddle Creek Below Lake Hancock	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Upper Peace River	1623K	Saddle Creek Below Lake Hancock	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1623K	Saddle Creek Below Lake Hancock	Fecal Coliform	Pathogens	5
2	3	Upper Peace River	1623L	Lake Hancock	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1623L	Lake Hancock	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1623M	Eagle Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1623M1	Grassy Lake	Nutrients (TSI)	Nutrients	5
2	3	Upper Peace River	1626	West Wales Drainage Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1626	West Wales Drainage Canal	Fecal Coliform	Pathogens	5
2	3	Upper Peace River	1677A	Bowlegs Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Peace River	1677C	Lake Buffum	Mercury (in fish tissue)	Metals	5
2	3	Middle Peace River	1763A	Charlie Creek Above Peace River	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	1774	Little Charlie Creek	Dissolved Oxygen	Oxygen	4d
2	3	Middle Peace River	1774	Little Charlie Creek	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	1787A	Horse Creek Above Peace River	Dissolved Oxygen	Oxygen	4d
2	3	Middle Peace River	1844	Thompson Branch	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	1857	Little Charlie Bowlegs	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1869B	Myakka River (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Upper Myakka River	1869B	Myakka River (Upper Segment)	Fecal Coliform	Pathogens	5

2	3	Upper Myakka River	1869C	Myakka River (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Upper Myakka River	1869C	Myakka River (Upper Segment)	Dissolved Oxygen	Oxygen	4d
2	3	Middle Peace River	1871	Alligator Branch	Dissolved Oxygen	Oxygen	4d
2	3	Middle Peace River	1871	Alligator Branch	Fecal Coliform	Pathogens	5
2	3	Upper Myakka River	1877A	Myakka River (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Upper Myakka River	1877A	Myakka River (Upper Segment)	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1877A	Myakka River (Upper Segment)	Fecal Coliform	Pathogens	5
2	3	Upper Myakka River	1877B	Myakka River (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1877C	Myakka River (North Fork)	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1877C	Myakka River (North Fork)	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1894	Young Creek	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1894	Young Creek	Fecal Coliform	Pathogens	5
2	3	Upper Myakka River	1908	Coker Creek	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1917	Long Creek	Dissolved Oxygen	Oxygen	5
2	3	Middle Peace River	1921	Limestone Creek	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1927	Ogleby Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Upper Myakka River	1927	Ogleby Creek	Fecal Coliform	Pathogens	5
2	3	Upper Myakka River	1933	Owen Creek	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1935	Maple Creek	Dissolved Oxygen	Oxygen	4d
2	3	Upper Myakka River	1940	Howard Creek	Dissolved Oxygen	Oxygen	4d

2	3	Middle Peace River	1950A	Joshua Creek Above Peace River	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1955	Wildcat Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1958	Mud Lake Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1958	Mud Lake Slough	Fecal Coliform	Pathogens	5
2	3	Lower Peace River	1962	Prairie Creek	Dissolved Oxygen	Oxygen	5
2	3	Lower Peace River	1964	Cow Slough	Biology	Biology	4d
2	3	Lower Peace River	1964	Cow Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1967	Bud Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1967	Bud Slough	Fecal Coliform	Pathogens	5
2	3	Lower Myakka River	1972	Myakka River at Clay Gully	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1972	Myakka River at Clay Gully	Dissolved Oxygen	Oxygen	5
2	3	Lower Myakka River	1976	Big Slough Canal	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1981	Lake Myakka (Lower Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1981B	Myakka River	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1981B	Myakka River	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	1981B	Myakka River	Dissolved Oxygen	Oxygen	5
2	3	Lower Myakka River	1981C	Lake Myakka (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1981C	Lake Myakka (Upper Segment)	Nutrients (TSI)	Nutrients	5
2	3	Lower Myakka River	1991A	Myakka River	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1991A	Myakka River	Nutrients (Chlorophyll-a)	Nutrients	5

2	3	Lower Myakka River	1991A	Myakka River	Fecal Coliform (SEAS Classification)	Pathogens	5
2	3	Lower Myakka River	1991B	Myakka River	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1991B	Myakka River	Fecal Coliform	Pathogens	5
2	3	Lower Myakka River	1991B	Myakka River	Fecal Coliform (SEAS Classification)	Pathogens	5
2	3	Lower Myakka River	1991C	Myakka River	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1991C	Myakka River	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	1991C	Myakka River	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Myakka River	1991D	Myakka River	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	1991D	Myakka River	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	1991D	Myakka River	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	1991E	Myakka River (Tidal Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	1991E	Myakka River (Tidal Segment)	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	1991E	Myakka River (Tidal Segment)	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	1995	Myrtle Slough	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	1995	Myrtle Slough	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	1997	Hawthorne Creek	Dissolved Oxygen	Oxygen	4d
2	3	Middle Peace River	1997	Hawthorne Creek	Fecal Coliform	Pathogens	5
2	3	Middle Peace River	2001	Hog Bay	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	2008	Thornton Branch	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	2010	Cocoplum Waterway	Biology	Biology	4d
2	3	Lower Myakka River	2026	Little Salt Creek (Warm Mineral Spring)	Mercury (in fish tissue)	Metals	5

2	3	Lower Myakka River	2026	Little Salt Creek (Warm Mineral Spring)	Dissolved Oxygen	Oxygen	4d
2	3	Lower Peace River	2028	Unnamed Ditches	Dissolved Oxygen	Oxygen	5
2	3	Lower Peace River	2035	Lee Branch	Fecal Coliform	Pathogens	5
2	3	Lower Peace River	2040	Myrtle Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Peace River	2041	Shell Creek	Dissolved Oxygen	Oxygen	4d
2	3	Lower Peace River	2041A	Shell Creek Below Hendrickson Dam	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2041A	Shell Creek Below Hendrickson Dam	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2041B	Shell Creek Reservoir (Hamilton Reservoir)	Dissolved Oxygen	Oxygen	4d
2	3	Lower Myakka River	2043	Apollo Waterway	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	2045	Rock Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	2046	Little Alligator Creek	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2046	Little Alligator Creek	Dissolved Oxygen	Oxygen	5
2	3	Lower Peace River	2047	Manchester Way	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	2048A	Sam Knight Creek	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	2048A	Sam Knight Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	2048A	Sam Knight Creek	Dissolved Oxygen	Oxygen	5
2	3	Lower Peace River	2048B	Huckaby Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2048B	Huckaby Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	2048C	Flopbuck Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	2053	Trailer Park Canal	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2054	Myrtle Slough	Iron	Metals	5
2	3	Lower Peace River	2054	Myrtle Slough	Mercury (in fish tissue)	Metals	5

2	3	Lower Peace River	2054	Myrtle Slough	Dissolved Oxygen	Oxygen	4d
2	3	Lower Peace River	2054	Myrtle Slough	Fecal Coliform	Pathogens	5
2	3	Lower Myakka River	2055	Tippecanoe Bay	Mercury (in fish tissue)	Metals	5
2	3	Lower Myakka River	2055	Tippecanoe Bay	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Myakka River	2055	Tippecanoe Bay	Fecal Coliform	Pathogens	5
2	3	Lower Myakka River	2055	Tippecanoe Bay	Fecal Coliform (SEAS Classification)	Pathogens	5
2	3	Lower Peace River	2056A	Peace River Estuary (Lower Segment)	Iron	Metals	5
2	3	Lower Peace River	2056A	Peace River Estuary (Lower Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2056A	Peace River Estuary (Lower Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2056B	Middle Peace River Estuary (Middle Segment)	Iron	Metals	5
2	3	Lower Peace River	2056B	Middle Peace River Estuary (Middle Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2056B	Middle Peace River Estuary (Middle Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2056C	Peace River Estuary(Upper Segment)	Iron	Metals	5
2	3	Lower Peace River	2056C	Peace River Estuary(Upper Segment)	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2056C	Peace River Estuary(Upper Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2056D	Alligator Bay	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2056D	Alligator Bay	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2056E	Sunrise Waterways	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2059	Cleveland Cemetery Ditch	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	2059	Cleveland Cemetery Ditch	Fecal Coliform	Pathogens	5

2	3	Lower Peace River	2060	Myakka Cutoff	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2061	Direct Runoff to Stream	Iron	Metals	5
2	3	Lower Peace River	2061	Direct Runoff to Stream	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2061	Direct Runoff to Stream	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2061	Direct Runoff to Stream	Dissolved Oxygen (Nutrients)	Oxygen	5
2	2	Charlotte Harbor Proper	2063	Alligator Creek (North Fork)	Dissolved Oxygen	Oxygen	5
2	3	Lower Peace River	2064	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2065A	Charlotte Harbor (Upper Segment)	Iron	Metals	5
2	2	Charlotte Harbor Proper	2065A	Charlotte Harbor (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2065A	Charlotte Harbor (Upper Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Charlotte Harbor Proper	2065B	Charlotte Harbor (Middle Segment)	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2065C	Charlotte Harbor (Middle Segment 2)	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2065C	Charlotte Harbor (Middle Segment 2)	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Charlotte Harbor Proper	2065D	Charlotte Harbor (Lower Segment 1)	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2069	Punta Gorda Isles Canal	Mercury (in fish tissue)	Metals	5
2	3	Lower Peace River	2069	Punta Gorda Isles Canal	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Lower Peace River	2069	Punta Gorda Isles Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Lower Peace River	2070	Punta Gorda Isles 2 Canal	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2071	No. Prong Alligator Cr	Dissolved Oxygen	Oxygen	4d
2	2	Charlotte Harbor Proper	2071	No. Prong Alligator Cr	Fecal Coliform	Pathogens	5
2	2	Charlotte Harbor Proper	2073	Mangrove Point Canal	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2073	Mangrove Point Canal	Dissolved Oxygen	Oxygen	5

2	2	Charlotte Harbor Proper	2074	Alligator Creek	Dissolved Oxygen	Oxygen	4d
2	2	Charlotte Harbor Proper	2074	Alligator Creek	Dissolved Solids	Physical	5
2	2	Charlotte Harbor Proper	2087	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2090	Direct Runoff to Bay	Mercury (in fish tissue)	Metals	5
2	2	Charlotte Harbor Proper	2092B	Gasparilla Island	Mercury (in fish tissue)	Metals	5

Pine Island Sound

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
2	2	Pine Island	2065E	Pine Island Sound (Upper Segment)	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2065E	Pine Island Sound (Upper Segment)	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Pine Island	2065F	Matlacha Pass	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2065F	Matlacha Pass	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Pine Island	2065G	Pine Island Sound Lowr	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2065H	San Carlos Bay	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2082C	Gator Slough Canal	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	2	Pine Island	2082C	Gator Slough Canal	Dissolved Oxygen	Oxygen	5
2	2	Pine Island	2082C1	West Urban Cape Coral	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	2	Pine Island	2092C	North Captiva Island	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2092D	Captiva Island	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2092D	Captiva Island	Dissolved Oxygen	Oxygen	4d
2	2	Pine Island	2092E	Pine Island	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	2092E	Pine Island	Fecal Coliform (3)	Pathogens	5

2	2	Pine Island	2092E	Pine Island	Fecal Coliform (SEAS Classification)	Pathogens	5
2	2	Pine Island	2092F	Sanibel River Basin (Formerly Sanibel Island)	Nutrients (Chlorophyll-a)	Nutrients	5
2	2	Pine Island	2092F	Sanibel River Basin (Formerly Sanibel Island)	Dissolved Oxygen	Oxygen	5
2	2	Pine Island	3240A3	Horseshoe Hermosa Canals	Dissolved Oxygen	Oxygen	5
2	2	Pine Island	3240O	Punta Rasa Cove	Mercury (in fish tissue)	Metals	5
2	2	Pine Island	3240S	South Urban Cape Coral	Mercury (in fish tissue)	Metals	5

Caloosahatchee River

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
2	3	West Caloosahatchee	3235A	Caloosahatchee River (Above S-79)	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235B	Caloosahatchee River Between S-79 And S-78	Biology	Biology	4d
2	3	West Caloosahatchee	3235B	Caloosahatchee River Between S-79 And S-78	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	West Caloosahatchee	3235B	Caloosahatchee River Between S-79 And S-78	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235C	Cypress Creek	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235C	Cypress Creek	Fecal Coliform	Pathogens	5
2	3	West Caloosahatchee	3235D	Jacks Branch	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	West Caloosahatchee	3235D	Jacks Branch	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235D	Jacks Branch	Fecal Coliform	Pathogens	5
2	3	West Caloosahatchee	3235E	Bee Branch	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235E	Bee Branch	Fecal Coliform	Pathogens	5
2	3	West Caloosahatchee	3235F	Pollywog Creek	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235F	Pollywog Creek	Fecal Coliform	Pathogens	5
2	3	West Caloosahatchee	3235G	Cypress Branch	Lead	Metals	5

2	3	West Caloosahatchee	3235G	Cypress Branch	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	West Caloosahatchee	3235H	Hickey Creek	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235I	Bedman Creek	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235J	Dog Canal	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235K	Fort Simmons Branch	Biology	Biology	4d
2	3	West Caloosahatchee	3235K	Fort Simmons Branch	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235L	Townsend Canal	Biology	Biology	4d
2	3	West Caloosahatchee	3235L	Townsend Canal	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	West Caloosahatchee	3235L	Townsend Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	West Caloosahatchee	3235 M	Goodno Canal	Biology	Biology	4d
2	3	West Caloosahatchee	3235 M	Goodno Canal	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235N	Roberts Canal	Dissolved Oxygen	Oxygen	4d
2	3	West Caloosahatchee	3235O	Okaloacoochee Branch	Dissolved Oxygen	Oxygen	4d
2	3	Telegraph Swamp	3236A	Telegraph Creek	Fecal Coliform	Pathogens	5
2	3	East Caloosahatchee	3237A	Caloosahatchee River Above S-78	Dissolved Oxygen	Oxygen	4d
2	3	East Caloosahatchee	3237B	Long Hammock Creek	Biology	Biology	4d
2	3	East Caloosahatchee	3237B	Long Hammock Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	East Caloosahatchee	3237B	Long Hammock Creek	Dissolved Oxygen	Oxygen	4d
2	3	East Caloosahatchee	3237C	Lake Hicpochee	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	East Caloosahatchee	3237D	Ninemile Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	East Caloosahatchee	3237E	C-19 Canal	Dissolved Oxygen (Nutrients)	Oxygen	4d
2	3	Caloosahatchee Estuary	3240A	Caloosahatchee Estuary (Tidal Segment1)	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240A 1	Cape Coral (Tidal Segment)	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240A 2	Cape Coral	Nutrients (Historic Chlorophyll-a)	Nutrients	5
2	3	Caloosahatchee Estuary	3240A 4	Deep Lagoon Canal	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240A 4	Deep Lagoon Canal	Nutrients (Chlorophyll-a)	Nutrients	5

2	3	Caloosahatchee Estuary	3240A 4	Deep Lagoon Canal	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Caloosahatchee Estuary	3240B	Caloosahatchee Estuary (Tidal Segment2)	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240B	Caloosahatchee Estuary (Tidal Segment2)	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240B 1	Chapel Creek / Bayshore Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240B 1	Chapel Creek / Bayshore Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240B 2	Chapel Creek / Bayshore Creek (Marine Segments)	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240C	Caloosahatchee Estuary (Tidal Segment3)	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240C 1	Palm Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240C 1	Palm Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240E	Yellow Fever Creek	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240E	Yellow Fever Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240E	Yellow Fever Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240E 1	Hancock Creek	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240E 1	Hancock Creek	Dissolved Oxygen	Oxygen	5
2	3	Caloosahatchee Estuary	3240E 1	Hancock Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240F	Daughtrey Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240F	Daughtrey Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240G	Trout Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240G	Trout Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240H	Whiskey Creek (Wyoua Creek)	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240H	Whiskey Creek (Wyoua Creek)	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240I	Manuel Branch	Mercury (in fish tissue)	Metals	5
2	3	Caloosahatchee Estuary	3240I	Manuel Branch	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240I	Manuel Branch	Fecal Coliform	Pathogens	5
2	3	Orange River	3240J	Billy Creek	Mercury (in fish tissue)	Metals	5

2	3	Orange River	3240J	Billy Creek	Dissolved Oxygen (Nutrients)	Oxygen	5
2	3	Orange River	3240J	Billy Creek	Fecal Coliform	Pathogens	5
2	3	Orange River	3240K	Orange River	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240L	Powell Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240L	Powell Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240 M	Stroud Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240 M	Stroud Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240N	Owl Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240N	Owl Creek	Fecal Coliform	Pathogens	5
2	3	Caloosahatchee Estuary	3240Q	Popash Creek	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	Caloosahatchee Estuary	3240Q	Popash Creek	Dissolved Oxygen	Oxygen	4d
2	3	Caloosahatchee Estuary	3240Q	Popash Creek	Fecal Coliform	Pathogens	5
2	3	East Caloosahatchee	3246	S-4 Basin	Nutrients (Chlorophyll-a)	Nutrients	5
2	3	East Caloosahatchee	3246	S-4 Basin	Dissolved Oxygen (Nutrients)	Oxygen	5

Estero Bay

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
3	1	Estero Bay	3258B 2	Hendry Creek	Iron	Metals	5
3	1	Estero Bay	3258C 2	Mullock Creek	Iron	Metals	5
3	1	Estero Bay	3258C 2	Mullock Creek	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258C 2	Mullock Creek	Fecal Coliform	Pathogens	5
3	1	Estero Bay	3258C 3	Six Mile Cypress Slough	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258C 4	Mullock Creek (Marine Segment)	Iron	Metals	5
3	1	Estero Bay	3258C 4	Mullock Creek (Marine Segment)	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258D 1	Estero River (Marine Segment)	Iron	Metals	5

3	1	Estero Bay	3258D 1	Estero River (Marine Segment)	Dissolved Oxygen	Oxygen	5
3	1	Estero Bay	3258D 1	Estero River (Marine Segment)	Fecal Coliform	Pathogens	5
3	1	Estero Bay	3258D 2	Estero River	Iron	Metals	5
3	1	Estero Bay	3258D 2	Estero River	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258E A	Imperial River	Fecal Coliform	Pathogens	5
3	1	Estero Bay	3258E B	Imperial River (Marine Segment)	Iron	Metals	5
3	1	Estero Bay	3258E B	Imperial River (Marine Segment)	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258E B	Imperial River (Marine Segment)	Fecal Coliform	Pathogens	5
3	1	Estero Bay	3258F	Oak Creek	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258F	Oak Creek	Fecal Coliform	Pathogens	5
3	1	Estero Bay	3258G 1	Ten Mile Canal	Dissolved Oxygen	Oxygen	4d
3	1	Estero Bay	3258H 2	Spring Creek (Marine Segment)	Iron	Metals	5
3	1	Estero Bay	3258H 2	Spring Creek (Marine Segment)	Dissolved Oxygen (Nutrients)	Oxygen	5
3	1	Estero Bay	3258H 2	Spring Creek (Marine Segment)	Fecal Coliform	Pathogens	5

Wiggins Pass/ Cocohatchee River

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
3	1	Southwest Coast	3259A	Cocohatchee River	Iron	Metals	5
3	1	Southwest Coast	3259B1	Drainage to Corkscrew Swamp	Iron	Metals	5
3	1	Southwest Coast	3259B1	Drainage to Corkscrew Swamp	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278C	Cocohatchee Golf Course Discharge	Dissolved Oxygen	Oxygen	4d

3	1	Southwest Coast	3278D	Cocohatchee (Inland Segment)	Dissolved Oxygen	Oxygen	5
3	1	Southwest Coast	3278E	Cow Slough	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278E	Cow Slough	Fecal Coliform	Pathogens	5
3	1	Southwest Coast	3278F	Corkscrew Swamp	Dissolved Oxygen	Oxygen	5
3	1	Southwest Coast	3278Q1	Clam Bay	Copper	Metals	5

Naples Bay

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
3	1	Southwest Coast	3278R1	Haldeman Creek (Lower)	Copper	Metals	5
3	1	Southwest Coast	3278R1	Haldeman Creek (Lower)	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278R1	Haldeman Creek (Lower)	Fecal Coliform	Pathogens	5
3	1	Southwest Coast	3278R2	Haldeman Creek (Upper)	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278R3	Rock Creek	Copper	Metals	5
3	1	Southwest Coast	3278R3	Rock Creek	Iron	Metals	5
3	1	Southwest Coast	3278R3	Rock Creek	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278R4	Naples Bay (Coastal Segment)	Copper	Metals	5
3	1	Southwest Coast	3278R4	Naples Bay (Coastal Segment)	Iron	Metals	5
3	1	Southwest Coast	3278R5	Gordon River (Marine Segment)	Copper	Metals	5
3	1	Southwest Coast	3278R5	Gordon River (Marine Segment)	Iron	Metals	5
3	1	Southwest Coast	3278R5	Gordon River (Marine Segment)	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278S	North Golden Gate	Iron	Metals	5
3	1	Southwest Coast	3278S	North Golden Gate	Dissolved Oxygen (Nutrients)	Oxygen	5

Rookery Bay

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
3	1	Southwest Coast	3278U	Rookery Bay (Coastal Segment)	Nutrients (Chlorophyll-a)	Nutrients	5
3	1	Southwest Coast	3278U	Rookery Bay (Coastal Segment)	Nutrients (Historic Chlorophyll-a)	Nutrients	5
3	1	Southwest Coast	3278U	Rookery Bay (Coastal Segment)	Dissolved Oxygen (BOD)	Oxygen	5
3	1	Southwest Coast	3278U	Rookery Bay (Coastal Segment)	Fecal Coliform	Pathogens	5
3	1	Southwest Coast	3278Y	Rookery Bay (Inland West Segment)	Dissolved Oxygen	Oxygen	4d

Ten Thousand Islands

Cycle	Group	Planning Unit Name	WBID	Water Segment Name	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)	Parameter Category	Integrated FINAL Assessment Category
3	1	Interdrainage Area	3255	C-139	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3259I	Camp Keais	Nutrients (Chlorophyll-a)	Nutrients	5
3	1	Southwest Coast	3259I	Camp Keais	Nutrients (Historic Chlorophyll-a)	Nutrients	5
3	1	Southwest Coast	3259I	Camp Keais	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3259M	Ten Thousand Islands	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3259M	Ten Thousand Islands	Fecal Coliform (SEAS Classification)	Pathogens	5
3	1	Interdrainage Area	3266A	C-139 Annex Basin (L3 Canal)	Dissolved Oxygen	Oxygen	4d
3	1	Interdrainage Area	3267	Feeder Canal	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278H	Faka Union (North Segment)	Dissolved Oxygen	Oxygen	4d
3	1	Southwest Coast	3278L	Immokalee Basin	Dissolved Oxygen (Nutrients)	Oxygen	5

3	1	Southwest Coast	3278L	Immokalee Basin	Fecal Coliform	Pathogens	5
3	1	Interdrainage Area	3278M	L-28 Tieback	Dissolved Oxygen	Oxygen	4d
3	1	Interdrainage Area	3278T	Okaloacoochee Slough	Nutrients (Chlorophyll-a)	Nutrients	5
3	1	Interdrainage Area	3278T	Okaloacoochee Slough	Dissolved Oxygen (Nutrients)	Oxygen	5
3	1	Interdrainage Area	3278W	Silver Strand	Dissolved Oxygen (Nutrients)	Oxygen	5

7.3 Hydrology

7.3.1 Narrative Hydrology and Impervious Surface Grades by Watershed

Coastal Venice

The Coastal Venice watershed historically covered only 10,240 acres of water that flowed into Lyons, Dona, and Roberts Bays before reaching the Gulf of Mexico. However, in an effort to drain the land in the 20th century for agricultural use, Cow Pen Slough and Blackburn Canal were constructed and diverted a significant amount of water from the Greater Charlotte Harbor watershed into the Bays. As a result, the watershed now spans over 62,336 acres, and its tidal creeks now receive more freshwater than under historical conditions.[191] The southern portion of Coastal Venice is affected by major boat traffic and dredging projects in large channels along the coast.[191] One of the most significant alterations has been the Intracoastal Waterway, a trade route that began construction in the late 1890s, that now connects Tampa Bay to Charlotte Harbor.[192] The canal in Venice, built in the 1960s, connects Hatchett Creek to Alligator Creek and forms the island of Venice.[193] Throughout the watershed, ditches to control mosquitos and water level control structures have also altered freshwater flows, and urban impervious surfaces has increased rates of discharge into the Bay during the rainy season.[191] The pumping of groundwater throughout the region also reduces the contribution of groundwater to rivers and estuaries, and put aquifers at risk of saltwater intrusion.[7]

Although Coastal Venice hydrology has been dramatically altered, Sarasota County is developing ongoing projects that restore natural flow processes for stormwater runoff such as pervious pavement and cisterns.[194] One project of particular importance is the Dona Bay Conveyance Improvement Project that will direct water into rehydration areas that treat runoff by reducing nutrient levels, peak flows, and regulate freshwater discharge. The final treatment system will provide regional storage and improve flow patterns for the Cow Pen Slough and Saltwater Creek that currently flow south into Dona Bay. Currently, Phase 1 is under construction, and the project is expected to be completed in spring 2017.[195] The Charlotte Harbor National Estuary Program (CHNEP) is also working to restore and improve the historic hydrology of the watershed, where practical, by 2020.[7]

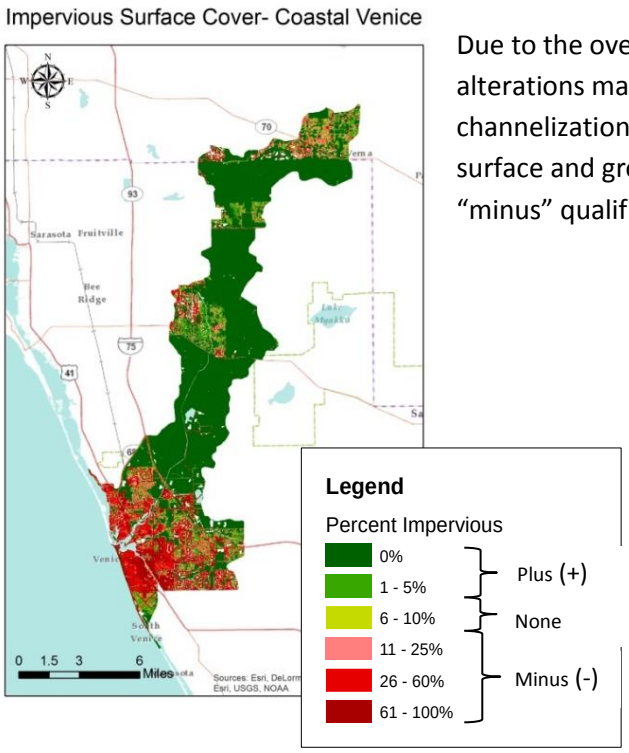


Figure 7.3-a Impervious Surface Cover- Coastal Venice

Due to the overall impervious cover of 11.2%, the severe alterations made to the watershed through dredging, channelization of natural flow systems, and the pumping of surface and groundwater resources, Coastal Venice received a "minus" qualifier for hydrology (Figure 7.3-a).

Total Impervious Acres	6,801
Total Watershed Area	60,556
Overall Percent Impervious	11.2%
ISC Qualifier	Minus
Narrative Qualifier	Minus
Overall Qualifier	Minus

Lemon Bay

In the Lemon Bay watershed, water travels through Ainger, Alligator, Forked, Gottfried, and Woodmere Creeks into Lemon Bay. The bay is affected by tidal flows that travel through two inlets from the Gulf of Mexico. In recent years, land development activities have contributed to the overall degradation of water quality in the watershed. There has been extensive destruction of wetlands and sloughs, along with construction of dead-end finger canals, culverts, interceptor waterways, salinity barriers, and mosquito ditches.[196] This watershed has experienced over-pumping of groundwater and the channelization of the majority of its coastal creeks.[197] Many of these streams have been deepened for navigation purposes, allowing for increased inland intrusion of saltwater.[198] For example, the Intracoastal Waterway, constructed in the 1960s, connects the Coastal Venice watershed to Lemon Bay.[199] Lastly, the pumping of groundwater throughout the region also reduces the contribution of groundwater to rivers and estuaries, and put aquifers at risk of saltwater intrusion.[7]

Several entities have made efforts to improve the local hydrology. Sarasota County and SWFWMD created a Lemon Bay watershed Management Plan in 2010 that outlined several projects to restore wildlife habitat, water quality, and stormwater management.[200] Sarasota County has completed a $2 million hydrologic restoration project along Alligator Creek. Projects were also completed in the Myakka State Forest in 2011 that restored 122 acres of wetlands.[201] The downtown district of Englewood completed a Low Impact Development stormwater infrastructure project in 2014.[202] Lemon Bay is a part of the Charlotte Harbor National Estuary Program (CHNEP) that is working to restore, enhance, and improve the historic hydrology of the watershed boundaries, where practical, by 2020.[7]

Impervious Surface Cover- Lemon Bay

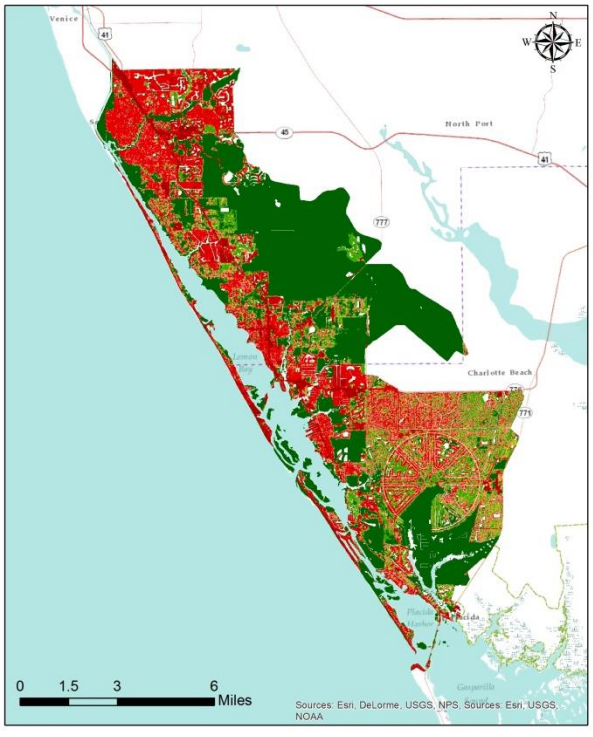
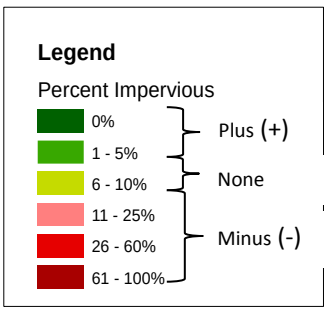


Figure 7.3-b Impervious Surface Cover- Lemon Bay

Due to the overall impervious cover of 15.9%, the lingering effects of development, the destruction of wetlands, and alterations to natural flow, Lemon Bay received a “minus” qualifier for hydrology (Figure 7.3-b).

Total Impervious Acres	8,153
Total Watershed Area	51,186
Overall Percent Impervious	15.9%
ISC Qualifier	Minus
Narrative Qualifier	Minus
Overall Qualifier	Minus



Greater Charlotte Harbor

In the Greater Charlotte Harbor watershed, the Peace and Myakka River basins bring water southwest into Gasparilla Sound and the Charlotte Harbor estuary. The Peace River headwaters begin in Lake Hancock and collect water from several tributaries including Horse Creek, Prairie Creek, and Shell Creek, and the Myakka has several of its own tributaries including Big Slough, Curry Creek, Deer Prairie Creek, and Maple Creek.

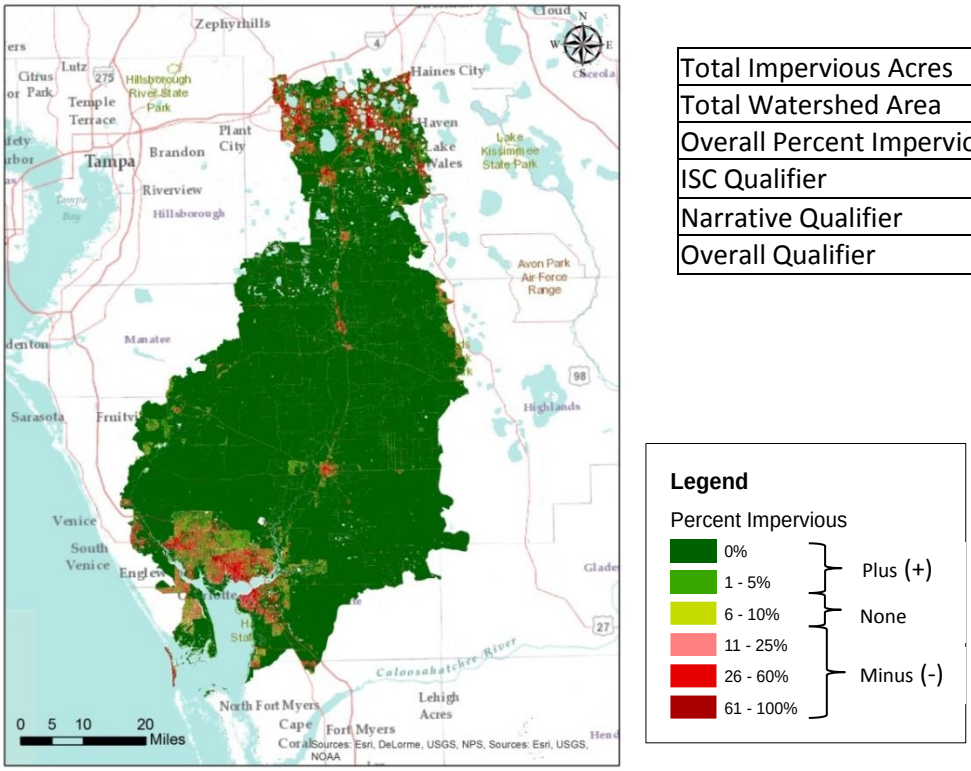
Despite containing significant protected areas, the Charlotte Harbor watershed still experiences major stress. The upper Peace River basin is drained by large-scale phosphate mining, agricultural operations, and local freshwater demand, which is increasing saltwater intrusion in the regional groundwater aquifer. As a result, the Peace River often misses its Minimum Flows and Levels (MFL) requirements. Land use impacts have, on the other hand, inundated the upper Myakka River basin with freshwater discharges. The southern portion of the watershed is experiencing the damaging effects of urban development downstream, including polarized discharge patterns.[203] Canals transport saltwater inland and cause existing freshwater in the surficial aquifer to drain off into the canals, which has led to saltwater intrusion in the surficial aquifer system in Charlotte County.[204] The pumping of groundwater throughout the region also reduces the contribution of groundwater to rivers and estuaries, and put aquifers at risk of saltwater intrusion.[7]

Many programs are facing the challenge to help restore the watershed's hydrology. Upstream, the Southern Water Use Conservation Area Recovery Strategy has made progress in water conservation and restoration projects to increase surficial and groundwater levels in the Peace River basin. The Southwest Florida Water Management District (SWFWMD) created the Upper Peace River watershed Management Plan to oversee the program's work. From 2006–2011, the program had 43 completed, ongoing, or planned water conservation projects with agricultural landowners in the Shell, Prairie, and Joshua Creeks, saving 7.75 million gallons per day (mgd) of water. The program also completed a project to raise water levels in Lake Hancock in 2014. A feasibility study was completed in 2016 to restore Flatford Swamp and reduce water levels in the Upper Myakka Basin. Lastly, four Aquifer Storage and Recovery (ASR) projects are under development in the Charlotte Harbor estuary to store excess water from the wet season.[205]

Throughout the Charlotte Harbor watershed, Florida's Surface Water Improvement and Management program (SWIM) completed 14 of 18 restoration projects between 1989 and 2014, spanning 4,412 acres of coastal habitat. Three of these projects were completed in the past few years: Alligator Creek In-stream Restoration, Lake Hancock Outfall Treatment System, and Lake Gwyn Surface Water Restoration. Ongoing restoration projects are at Alligator Creek, Coral Creek, and Lemon Bay Wildflower Preserve.[206] The SFWMD is also collaborating with fourteen government agencies on the Charlotte Harbor Flatwoods Initiative that will restore sheet flow on publicly owned land, reduce flooding, and enhance ground water recharge in five sub-basins, totaling 90 square miles.[207] Lastly, Charlotte Harbor is also managed under the Charlotte Harbor National Estuary Program (CHNEP) that aims to restore hydrologic alterations, where practical, by 2020.[7]

The overall impervious surface cover in the Greater Charlotte Harbor watershed is 2.8%, receiving a "plus" qualifier, which is supported by several ongoing restoration initiatives (Figure 7.3-c).

Impervious Surface Cover- Greater Charlotte Harbor



Total Impervious Acres	54,242
Total Watershed Area	1,904,750
Overall Percent Impervious	2.8%
ISC Qualifier	Plus
Narrative Qualifier	Plus
Overall Qualifier	Plus

Figure 7.3-c Impervious Surface Cover- Greater Charlotte Harbor

Pine Island Sound

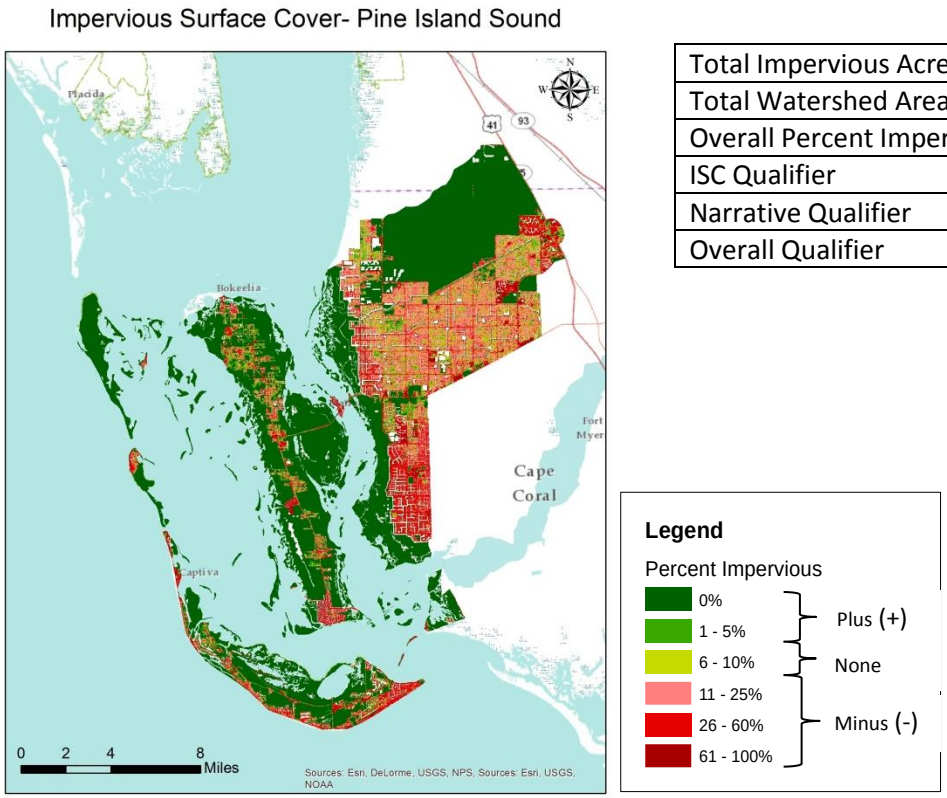
The Pine Island Sound watershed is influenced from water discharging from the Caloosahatchee River into San Carlos Bay, southern Matlacha Pass and southern Pine Island Sound; runoff and drainage from the land north of the river (Cape Coral) flowing into Matlacha Pass; runoff from Pine Island and other smaller islands into the adjacent waters; and water from the Charlotte Harbor watershed in the northern portions of the Pine Island Sound and Matlacha Pass. The Sound is protected by the barrier islands of Sanibel, Captiva, North Captiva and Cayo Costa.

Although much of this watershed lies within preserve areas, the historic flowways in portions of the watershed have been altered. Today, water is transported on the mainland through the freshwater canals of Cape Coral and into culverts and ditches that drain into Matlacha Pass.[208] The Cape Coral Canal and Drainage System consists of 404 miles of canals that have significantly modified flows of freshwater.[209] Stormwater runoff, which continues to increase as the population increases, is collected by these canals.[210,208] The navigation channel through Matlacha Pass has also made the area significantly deeper.[211] To the south, San Carlos Bay is channelized to receive freshwater releases from the Caloosahatchee River that affect the bay's salinity and water quality.[212] To the east, Pine Island has added enhanced drainage due to the expansion of agriculture.[211] Major structures, including the Intracoastal Waterway (ICW) channel, the Sanibel Causeway, deep tidal canals, and small finger-fill canal systems, alter the water flows around Pine Island and the other barrier islands. The pumping of groundwater throughout the region also reduces the contribution of groundwater to rivers and estuaries, and puts aquifers at risk of saltwater intrusion.[7]

In addition to these changes, controversy has surrounded the North Spreader Canal System (NCS) in the past few years. After the removal of the Ceitus barrier in 2008, urban runoff and nutrient pollution from NCS began to funnel out from the new gap into the Matlacha Pass Aquatic Preserve. The City of Cape Coral has not yet taken steps to address the pollution discharge and, as a result, a lawsuit was filed in 2014 by several environmental groups and local stakeholders to press the City to stop the discharges.[213] The lawsuit is on hold, however, as the City is now conducting research on possible alternatives to a new barrier.

The City of Cape Coral and Lee County have two hydrologic projects included under the SFWMD's Caloosahatchee watershed Protection Plan within the Pine Island Sound watershed. The final phase of construction for three aquifer storage and recovery (ASR) wells was completed in 2015. The Yellow Fever Creek/Gator Slough Transfer Facility Project will redirect high flows from Gator Slough Canal and Matlacha Pass to their historic path through Yellow Creek. Permitting for the project began in 2015.[214] The watershed is also within the Charlotte Harbor National Estuary Program (CHNEP) that has made hydrologic restoration a top priority. The completion of the C-43 Reservoir and other hydrologic projects on the Caloosahatchee River will also help moderate the harmful volume of freshwater discharges into San Carlos Bay.[215]

The overall impervious cover in the Pine Island Sound watershed is 9.3% and received no qualifier. This finding is supported by several ongoing hydrologic restoration activities to this moderately altered watershed (Figure 7.3-d).



Total Impervious Acres	9,624
Total Watershed Area	103,369
Overall Percent Impervious	9.3%
ISC Qualifier	None
Narrative Qualifier	None
Overall Qualifier	None

Figure 7.3-d Impervious Surface Cover- Pine Island Sound

Caloosahatchee River

The Caloosahatchee River is the main body of water in the watershed and flows into the Caloosahatchee River estuary. Historically, the Caloosahatchee River meandered from its headwaters at Lake Flirt, westward through swamp forests and marshes, to San Carlos Bay and Matlacha Pass.[216]

However, since the 1880s, the river has been transformed into a channel connecting Lake Okeechobee to the Gulf of Mexico. Continuous dredging, deepening, and widening of the river has produced long-lasting effects on the watershed. Canals and dam/lock structures regulate freshwater flows in order to benefit navigation, flood control, and land use.[7] The timing and amount of discharge is largely determined by Lake Okeechobee's flood control and water supply projects.[217] During the rainy season, high levels of freshwater are released from Lake Okeechobee, significantly increasing the volume of freshwater and decreasing salinity in the river.[218] Conversely, during the dry season, the combination of the increased demand for water in agricultural and urban areas and the lack of rainfall results in significant stress on water in the region and in Lake Okeechobee.[219] Regulatory releases are extremely limited, and Minimum Flows and Levels (MFLs) are often violated.[220] The quality of the water in the watershed has also been significantly compromised because Lake Okeechobee and surrounding lands discharge significant amounts of agricultural and stormwater runoff, sewage, and thermal effluent into the river.[7] Rather than slowly filtering down the river, these nutrients and toxic algae blooms now flush down to the coastal waterways, thus impacting water quality over the entire region.

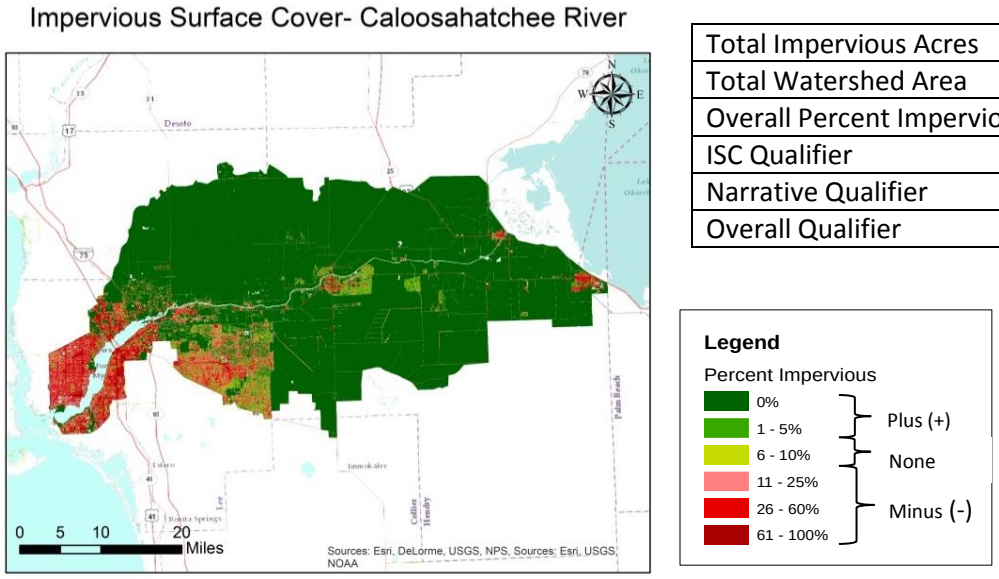
Given the extent and severity of alterations, the watershed has received special priority by federal, state, and local agencies for hydrologic restoration. The most significant project is the Caloosahatchee River (C-43) West Basin Storage Reservoir Project, managed under the Comprehensive Everglades Restoration Plan (CERP).[221] The project is a 170,000 acre-ft reservoir that will capture runoff from C-43 and Lake Okeechobee freshwater. The project currently lacks a specific water quality treatment component. A water quality treatment feature needs to be developed in order to ensure the water released from the reservoir does not contribute to the existing nutrient pollution problems in the river and estuary. The project also intends to reduce salinity and provide flood control.[222] SFWMD has completed testing the reservoir test cells[223] and hopes to complete Cell 1 by 2018 and Cell 2 by 2022.[224,103,225]

In 2017, the Florida legislature passed Senate Bill 10 which will expedite the planning and construction of the Everglades Agricultural Area (EAA) Reservoir CERP project. The EAA Reservoir will benefit the Caloosahatchee during high flow times, by allowing more Lake Okeechobee water to be sent south towards the Everglades and Florida Bay.

The Caloosahatchee watershed is also under the State's Northern Everglades and Estuaries Protection Plan, giving the watershed expedited feasibility studies and restoration projects in the region. There are currently 15 state-led and 28 local hydrologic restoration projects in the watershed that are being constructed, awaiting funding, or are in the design phase. More information about these projects can be found in the South Florida Water Management District (SFWMD) 2015 South Florida Environmental Report and updated Caloosahatchee watershed Protection Plan.[226,221] In addition, although a TMDL and

Basin Management Action Plan (BMAP) already exist for the tidal Caloosahatchee, the Florida Department of Environmental Protection (FDEP) and SFWMD are working on developing a TMDL for its upstream tributaries using several ecological and physical indicators.[227] Lastly, Lee County's Greenbriar Swamp's Pollution Prevention Project, which restored an illegal dumping ground into a wildlife area, received the P2 Award for pollution prevention at the 2015 North American Hazardous Material Management Association conference.

Although overall impervious cover within the Caloosahatchee watershed is relatively low, at 4.2%, the significant hydrologic alterations to the river, including the connection to Lake Okeechobee, the multiple control structures, and the river's dredging, widening, and straightening, have resulted in documented and ongoing ecological degradation. As a result, the Caloosahatchee watershed has received a "minus" qualifier for hydrology (Figure 7.3-e).



Total Impervious Acres	35,846
Total Watershed Area	851,048
Overall Percent Impervious	4.2%
ISC Qualifier	Plus
Narrative Qualifier	Minus
Overall Qualifier	Minus

Figure 7.3-e Impervious Surface Cover- Caloosahatchee River

Estero Bay

The Estero Bay watershed has five main basins that bring water to the bay: Hendry Creek, Mullock Creek, Estero River, Spring Creek, and the Imperial River. Water flows in and out through Matanzas Pass, Big Carlos Pass, New Pass, and Big Hickory Pass, the water moves around several barrier islands and flushes between the estuary and the Gulf of Mexico.[228]

Despite its recognition as an Outstanding Florida Water (OFW), [228] the hydrology of Estero Bay has been significantly altered as a result of rapid urbanization, roadway construction, and upstream mining operations. The creation of the Ten Mile Canal in the 1920s severed hydrologic connection between Six-Mile Cypress Strand and Hendry Creek. Throughout the watershed, drainage culverts, salinity barriers, and interceptor waterways have changed the timing of flows. Significant developments that have increased run-off include the Southwest Florida International Airport and Florida Gulf Coast University.[229] Increased surface water run-off has increased freshwater discharges and prevents groundwater aquifers from recharging.[230,231]

In response to these critical hydrologic issues, several restoration projects are underway to improve water flow into Estero Bay's estuarine environment. In 2012, Lee County's Conservation 20/20 program purchased an additional 43 acres for the Pine Lake Preserve, located within the Imperial River watershed. The now 174-acre preserve borders the Corkscrew Regional Ecosystem Watershed (CREW), an important area for groundwater recharge in the watershed. In 2016, the City of Bonita Springs and Lee County entered into an agreement to restore the preserve's hydrology.[232] The Southern CREW Restoration Project, included in the Comprehensive Everglades Restoration Plan (CERP), will restore 2,880 acres to wetlands in the CREW. Groundwork on the project began in 2016.[232]

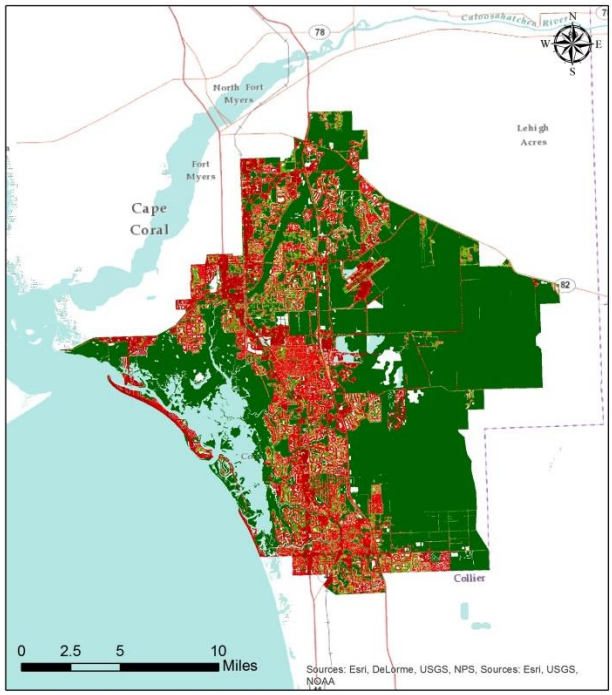
To protect the region's drinking water supply, the City of Bonita Springs and Lee County have maintained separate Density Reduction/Groundwater Resource (DRGR) areas. These areas maintain a relatively low percentage of impervious surface cover to allow freshwater to drain into the surficial aquifers. The Bonita Springs DRGR covers 4,700 acres and was designated three decades ago.[233] The Lee County DR/GR was designated in 1990 and covers approximately 82,500 acres.[234] Their density restrictions also benefit the watershed's hydrology by slowing freshwater discharges into the tributaries. However, with increasing demand for development, the DR/GRs have been under threat for the past several years. Today, 30% of the Bonita Springs DR/GR area is now developed. To address this concern, the city of Bonita Springs created a Citizens Water Task Force in 2014 to evaluate the amount of development that could be allowed in the area without damaging its hydrologic function. The Council unanimously supported the Task Force's recommendations that would help protect and restore the area's hydrology, and projects are currently underway.[233]

Several other local projects also focus on hydrologic restoration. Lee County restored wetlands and constructed a filter marsh in Lakes Park.[235] New residential developments in Bonita Bay incorporate natural buffers to treat stormwater runoff. The Town of Fort Myers Beach has planned eleven drainage projects to address flooding and water quality issues associated with stormwater.[228236] The town is also looking to implement Best Management Practices (BMPs) in three problem areas as well as new

alternatives to improve drainage into Estero Bay.[237] The Estero Boulevard Improvement Project will install new waterlines to enhance the connectivity of the stormwater system, improve drainage off of Estero Boulevard, and enhance water quality.[238] Lastly, in 2015 the Bonita Springs Council approved a plan to restore Spring Creek, which has been altered as a result of its location between I-75 and US-41.[239,240]

Overall impervious cover in Estero Bay watershed is 12.4%, and significant alterations have occurred. However, there are many ongoing restoration projects in the watershed that are in the process of improving hydrologic function. Consequently, the Estero Bay watershed received no qualifier for hydrology (Figure 7.3-f).

Impervious Surface Cover- Estero Bay



Total Impervious Acres	21,873
Total Watershed Area	176,507
Overall Percent Impervious	12.4%
ISC Qualifier	Minus
Narrative Qualifier	None
Overall Qualifier	None

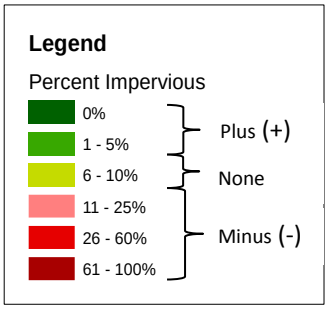


Figure 7.3-f Impervious Surface Cover- Estero Bay

Wiggins Pass/ Cocohatchee River

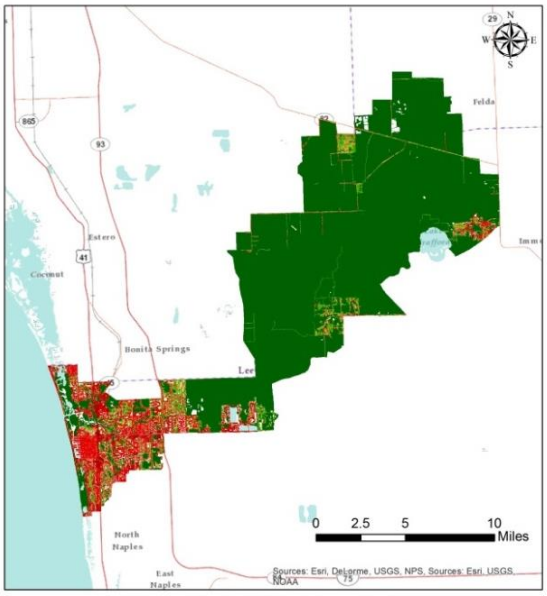
Historically in the Wiggins Pass/Cocohatchee watershed, water from the Immokalee ridge, the Corkscrew Regional Ecosystem Watershed (CREW), and western Lake Trafford flowed southwest into the Cocohatchee River and then to Wiggins Pass.[241,211]

However, a number of alterations in the watershed, including the construction of the Cocohatchee Canal, the encroachment of agriculture and urban development (including Vanderbilt Beach properties) into former wetlands, and the continued dredging of Wiggins Pass since the 1950s, have affected the historic flowways.[242,243] Like other interior portions of the watershed, sheetflows vary with the magnitude of storm events. Due to flood protection releases through the gated water control structures on the Cocohatchee Canal, reduced salinities often occur in the watershed during storm events. Similar to other estuaries, a major issue facing the watershed is the spike in freshwater discharges and stormwater pollution during the wet season.[244,245]

A few hydrologic restoration projects have been ongoing in the Wiggins Pass/Cocohatchee River watershed. The South Florida Water Management District (SFWMD) completed restoration activities in Lake Trafford in 2010. Water quality has significantly improved, thereby improving water quality moving downstream and enhancing fishing on the lake.[246] A very small portion of the Southern CREW Restoration Project is in the watershed and will restore 2,880 acres overall to wetlands in the CREW. Groundwork on the project began in 2016 as a part of the Comprehensive Everglades Restoration Plan (CERP).[232] Collier County's separate proposed hydrologic restoration project in the CREW will also improve the timing of freshwater flow into Wiggins Pass.[247]

Overall impervious cover in the Wiggins Pass/Cocohatchee watershed is 5.3%, which would receive no qualifier. However, due to the significant hydrologic alterations and minimal restoration activities, the hydrology qualifier has been modified to "minus" (Figure 7.3-g).

Impervious Surface Cover- Wiggins Pass/ Cocohatchee RIver



Total Impervious Acres	6,098
Total Watershed Area	114,294
Overall Percent Impervious	5.3%
ISC Qualifier	None
Narrative Qualifier	Minus
Overall Qualifier	Minus

Figure 7.3-g Impervious Surface Cover- Wiggins Pass/ Cocohatchee River

Naples Bay

In the Naples Bay watershed, water from the Gordon River, Haldeman Creek, Rock Creek, and Golden Gate Canal flow into Naples Bay. The water then leaves either to Gordon Pass and the Gulf of Mexico, or to Dollar Bay and the Rookery Bay estuary. The Gordon River watershed historically extended over 16,000 acres, and Naples Bay covered 12,800 acres.

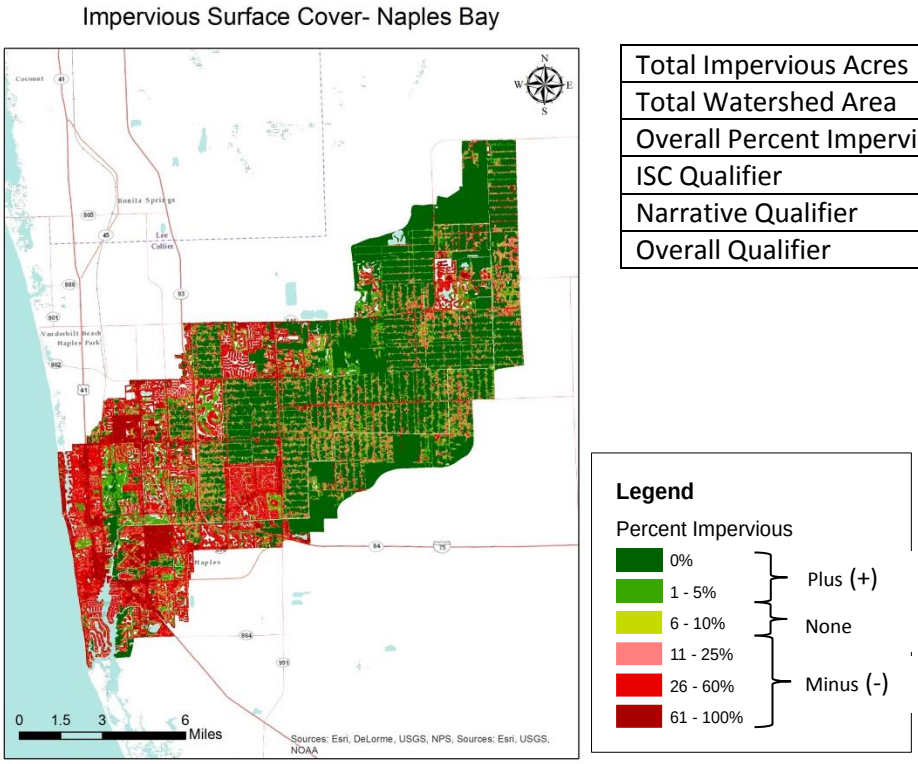
The watershed, however, has been drastically altered as a result of the loss of wetlands, the creation of the Golden Gate Canal system, continuous dredging, and the onslaught of urbanization. Development has led to the over-drainage of surface waters, polarized hydroperiods, and altered salinity regimes in coastal areas. Although the Gordon River watershed has shrunk to 5,440 acres, the Naples Bay watershed has expanded more than tenfold to 83,200 acres.[248] Development has also lowered ground water to the point where saltwater intrusion has become problematic.[243],[249] The continued expansion of the North Golden Gate Estates (GGE) area is of concern, as new homes with impermeable surfaces continue to replace wetlands.[243] Development has picked up in recent years, and there are a number of permitted and proposed developments expanding inland through the watershed.

Although completely restoring the watershed's hydrology to its historic flowways is financially and practically infeasible, Collier County has been working on several projects to reduce peak freshwater discharges and to store excess stormwater. A new outfall structure on Gordon River has decreased the harmful volume of freshwater reaching the bay. The new Freedom Park restored wetlands and added filter marshes to manage urban runoff from the Gordon River extension basin to Naples Bay.[250] Further, the City of Naples completed a project using stormwater aquifer storage and recovery (ASR) that stores excess water in wells for recovery during periods of high water use. The wells can reduce up to 10 mgd of freshwater outflow to Naples Bay.[251]

Collier County's Lely Area Stormwater Improvement Plan (LASIP), which is now over 90% complete,[252] and improvements on the Gateway Triangle area drainage will dissipate the channelized flow of Lely Canal as stormwater runoff drains through wetlands.[251] Collier County also devised the Golden Gate Watershed Improvement Program (GGWIP) to study potential water storage projects in Northern GGE. In 2015, the County created the Comprehensive Watershed Improvement Program Committee, comprised of representatives from several different state and local government agencies, to advise the County on the GGWIP.[253]

Lastly, the North GGE Flowway Restoration Project is a significant project under consideration to restore hydrologic flowways. The project would use RESTORE Act funds to reconnect the wetland systems in the Northern Golden Gate Estates, divert flows from Naples Bay, and send water south towards Rookery Bay. However, even this project will only divert a small fraction of the water and is estimated to cost $30 million to complete.[254]

The overall impervious cover in the Naples Bay watershed is 16.4%, and the hydrology has been significantly altered by development, canals, and the destruction of wetlands, resulting in ongoing documented ecological degradation in Naples Bay. Therefore, the hydrology qualifier is a "minus" (Figure 7.3-h).



Total Impervious Acres	13,878
Total Watershed Area	84,758
Overall Percent Impervious	16.4%
ISC Qualifier	Minus
Narrative Qualifier	Minus
Overall Qualifier	Minus

Figure 7.3-h Impervious Surface Cover- Naples Bay

Rookery Bay

Water historically travelled through the Rookery Bay watershed via gradual sheetflow, with only Henderson Creek and Stopper Creek as the main tributaries. Today, the flowway has been channelized into ten discharge points across the bay and diverted for other uses. Overall, the watershed has shrunk 51,200 acres from its historical size.

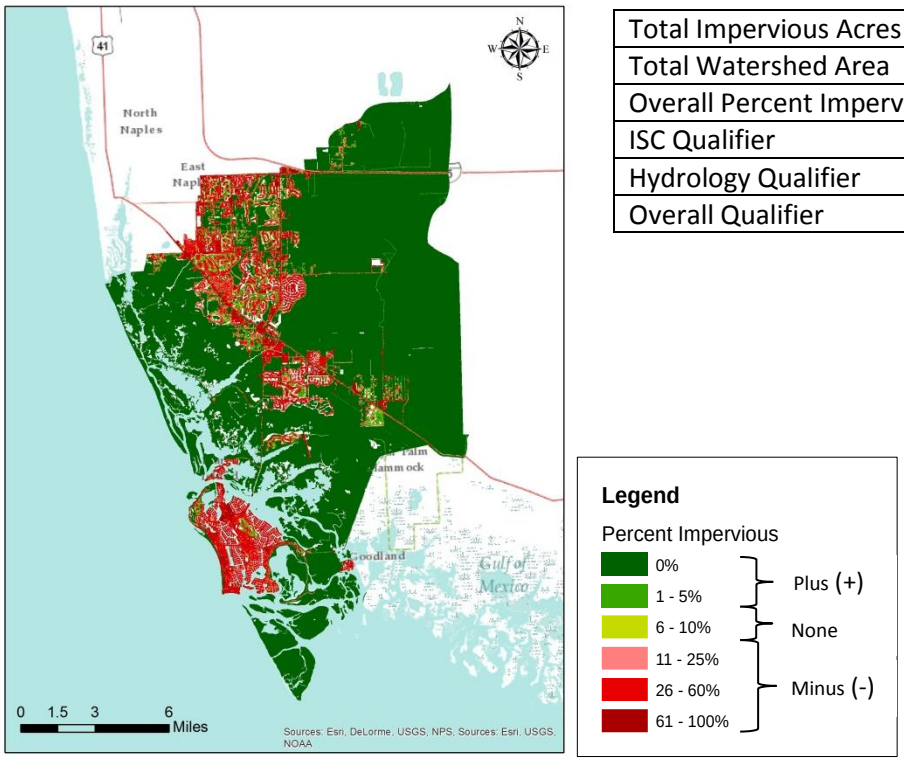
Although most of the southern part of the watershed is protected, large developments constructed in recent years to the north, including Sabal Bay, Wentworth Estates/Treviso Bay, and Artesia Naples, as well as Marco Island to the south, have increased impervious surface coverage and stormwater runoff.[255,256] Similar to the other estuaries, Rookery Bay experiences polarizing freshwater discharges and fluctuating salinity throughout the year.[257] The Comprehensive Everglades Restoration Plan (CERP) originally included a restoration project in Henderson Creek and Belle Meade, but the project is no longer included in the U.S. Army Corp of Engineers (USACE) Integrated Delivery Schedule.[258,259]

Fortunately, several local entities have recently stepped in to restore Rookery Bay's hydrology to historic patterns. In 2012, the Rookery Bay National Estuarine Research Reserve (NERR) received an $815,000 grant for a three-year project to help the local community manage the Rookery Bay watershed. Part of the funding was directed towards studies to enhance knowledge of Rookery Bay's hydrology, to establish restoration goals, simulate projects that would improve local hydrology, and compile a list of proposed projects in the watershed.[260]

There are still 25 conceptualized or ongoing watershed improvement projects within Rookery Bay's watershed, which can be found in the 2011 Collier County Watershed Plan, the 2006 Belle Meade Stormwater Master Plan, and the Southwest Florida Comprehensive Watershed Plan (SWFCWP). Current projects include a 66-acre wetland stormwater treatment area near US 41, the redirection of stormwater runoff on Manatee Road from Henderson Creek, and the installation of overflow weirs near Fiddler's Creek.[261,257] Gate operations have also changed to more closely mimic historic flow patterns. The largest ongoing project is the Lely Area Stormwater Treatment Project (LASIP) that is over 90% complete and will improve discharges into Rookery Bay through the Lely Manor Canal.[252,262] The conceptualized projects will use various methods of restoration, including culverts, filter marshes, spreader systems, Best Management Practices (BMPs), reservoirs, wetland areas, berms, pump stations and flowways.[263]

Overall impervious cover in the Rookery Bay watershed is 6.9%, and there are planned and ongoing restoration projects to improve hydrologic function. Therefore, no hydrology qualifier is assigned (Figure 7.3-i).

Impervious Surface Cover- Rookery Bay



Total Impervious Acres	74,76
Total Watershed Area	108,840
Overall Percent Impervious	6.9%
ISC Qualifier	None
Hydrology Qualifier	None
Overall Qualifier	None

Figure 7.3-i Impervious Surface Cover- Rookery Bay

Ten Thousand Islands

The Ten Thousand Islands watershed is comprised of the Faka Union, Okaloacoochee, and Fakahatchee basins, bringing in water through various tributaries and Lake Trafford into the bays in the Ten Thousand Islands National Wildlife Refuge. Tributaries include Blackwater River, Faka Union Canal and River, and the Barron Canal and River; bays include Pumpkin Bay, Faka Union Bay, and Fakahatchee Bay.[159]

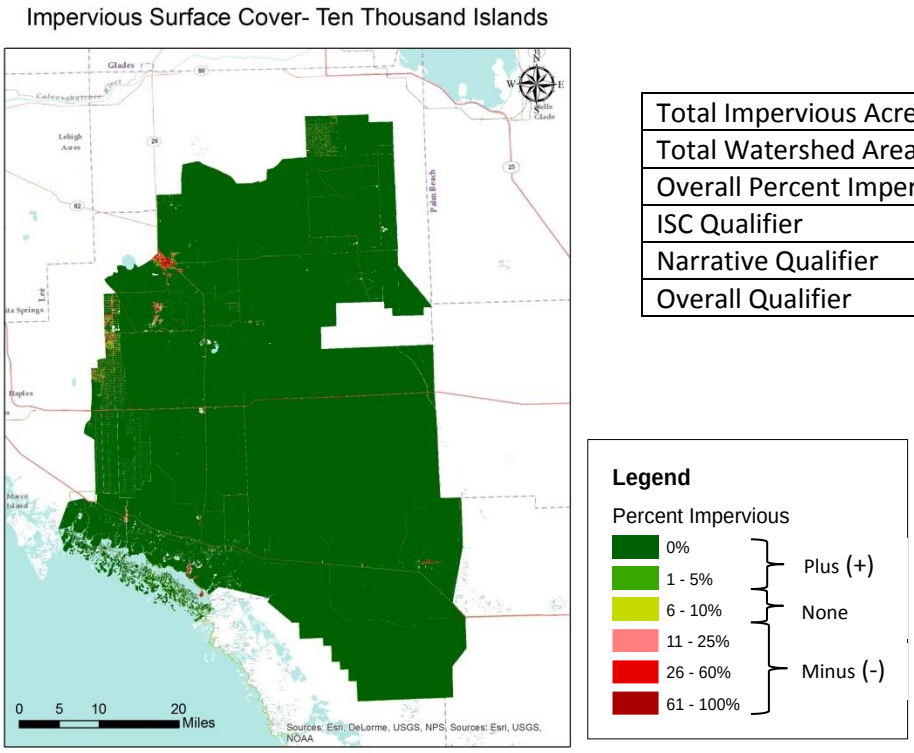
Despite the fact that the majority of the watershed is protected under conservation, large portions of the watershed upstream have been hydrologically altered by drainage, channelization, and development. The Faka Union Canal system drains almost 150,000 acres and discharges into Faka Union Bay in the Ten Thousand Islands refuge.[264] Efforts have been made to mitigate the canal's hydrologic impacts by installing culverts to improve water distribution.[243] The town of Ave Maria, founded in 2005, continues to grow, with its university now enrolling over 1,000 students.[243,265] Agricultural production has expanded in the north, and Lipman Farms in Immokalee is now the nation's largest tomato farm.[266] The planned town of Rural Lands West and the active Sunniland mine are also located upstream. To the south, the proposed River of Grass Greenway would follow U.S. 41 South from Miami to the outskirts of East Naples. Despite opposition from the Seminole Tribe,[267] its feasibility study and master plan were completed in 2016.[268] A significant threat to the watershed's hydrology downstream is the presence of oil in the Big Cypress National Preserve. There are active drilling operations in Bear Island and Raccoon Point.[269] Additionally, there is an approved seismic exploration project intended to determine the presence of oil and gas inside of the Preserve; if found, this would eventually lead to drilling. A coalition of environmental groups filed a lawsuit against this plan in 2016, requesting it to go through a full environmental impact assessment.[270]

Fortunately, there have been several successful ongoing projects to restore the watershed's hydrology. CERP includes two projects in the Ten Thousand Islands watershed. The Seminole Tribe Big Cypress Water Conservation Plan, covering tribal lands north of Big Cypress National Preserve, will rectify hydrologic alterations resulting from the L-28 and L-29 Canals. The last basin to be completed for the project is currently under construction.[271] The Picayune Strand Restoration Project will restore over 55,000 acres of former wetlands that were drained and abandoned by a developer.[272] The project will create three water pumping stations, plug 48 miles of canals, and remove 260 miles of roads.[273] By 2014, the first water pumping station was completed, and 25 miles of canals and 195 miles of roadways were removed. Within the following year, wildlife was returning to the area in increasing numbers and water levels were rising in the Fakahatchee Strand State Preserve to natural levels. The two other pumps are still currently under construction, with the entire project set to be completed by 2019.[274] Additional modelling is underway to identify restoration opportunities west of the project.[275,276]

There are other hydrologic restoration efforts in progress at the Big Cypress National Preserve. One project will prevent water from moving directly down the Turner River and Birdon Road canals and instead spread it out over the swamp. The Preserve is also in the initial stages of developing a Hydrologic Restoration Master Plan.[269] Finally, the Army Corps of Engineers kicked off the Western Everglades Restoration Project planning process in 2016 that aims "to reestablish sheetflow from the West Feeder Canal across the Big Cypress Seminole Indian Reservation and into BCNP, maintain flood

protection on Seminole Tribal lands, and ensure that inflows to the North and West Feeder Canals meet applicable water quality standards."[277]

The Ten Thousand Islands watershed has the lowest percentage of impervious cover at 0.3%. The significant alterations caused by the Southern Golden Gate Estates are being rectified by the Picayune Strand Restoration Project, and supports the "plus" qualifier for hydrology (Figure 7.3-j).



Total Impervious Acres	4,295
Total Watershed Area	1,521,889
Overall Percent Impervious	0.3%
ISC Qualifier	Plus
Narrative Qualifier	Plus
Overall Qualifier	Plus

Figure 7.3-j Impervious Surface Cover- Ten Thousand Islands

7.3.2 Blank Interview Questionaire

2016 Estuaries Report Card Questionnaire

Name: Click here to enter text.

Date: Click here to enter a date.

Watershed(s) Discussed (*if more than one, please differentiate answers in text boxes*): Click here to enter text.

Professional affiliation and/or expertise: Click here to enter text.

Hydrology:

1. Have any natural flowways in this watershed been channelized or diverted within the past five years?
   Click here to enter text.
2. Are there any notable changes to hydrology or recharge capacity within the watershed in the past five years?
   Click here to enter text.
3. Are there hydrologic restoration efforts that have been completed or begun within the watershed in the past five years?
   Click here to enter text.
4. Are there plans for hydrologic restoration in the watershed which have not been implemented?
   Click here to enter text.

Water Quality:

1. Have there been any documented water quality trends in the watershed within the past five years, either positive or negative?
   Click here to enter text.
2. Is there an adequate amount of sampling stations and data for the watershed to reasonably determine water quality?
   Click here to enter text.
3. Are there documented signs of water quality degradation in the watershed, i.e., fish kills, harmful algal blooms, etc. which have occurred in the past five years?
   Click here to enter text.
4. Are there water quality restoration efforts planned or ongoing in the watershed?
   Click here to enter text.

Miscellaneous:

1. Are there any current or proposed large scale developments or mining activities in the watershed?
   Click here to enter text.
2. Are there any current or proposed oil drilling activities in the watershed?
   Click here to enter text.
3. Have there been documented impacts to coastal ecosystems due to sea level rise in the watershed?
   Click here to enter text.
4. Have there been any significant conservation land purchases or other land preservation (easements, donations) achieved in the watershed within the last five years?
   Click here to enter text.
5. Is there any notable change in the species present (i.e., extinction of natives and/or presence of exotics) that have been documented within the past five years?
   Click here to enter text.
6. Can you recommend other experts in southwest Florida watersheds and estuaries who we should contact?
   Click here to enter text.

Figure 7.3-k Blank Interview Questionnaire

7.4 Changes in Water Quality Standards and Assessment

According to the federal Clean Water Act (CWA), states are required to adopt a set of water quality standards for surface waters that will ensure that waterways can support the use for which they are designated, such as swimming, fishing, or drinking. Designated uses in Florida are divided into six classifications, and each use classification has a specified set of water quality criteria or standards to protect human health and aquatic life.[190] To determine whether a water body is meeting the applicable water quality standards, the Florida Department of Environmental Protection (FDEP) conducts watershed assessments using collected water quality sampling data.[278] FDEP reviews each waterbody for compliance with water quality standards using the Impaired Waters Rule (IWR) in Chapter 62-303 of Florida Statutes and determines whether it is polluted and should be placed on the impaired waters list, whether it should be on the planning or study lists, or whether the data collected is insufficient to determine compliance. These standards are periodically reviewed and updated. The applicable standards in place at the time the data in this Report Card was collected and assessed by FDEP were current through the Group 1 Cycle 3 assessment completed in 2013. Since then, FDEP has adopted new standards for some of the parameters (i.e., nutrients and dissolved oxygen), and those changes are discussed in more detail in section 7.5. To differentiate, any change in standards since 2013 are designated as "new."

1) Nutrients

New Water Quality Standards

FDEP uses both numeric and narrative data to determine nutrient levels. Parameters that are quantified are Total Nitrogen (TN), Total Phosphorus (TP), and Chlorophyll-a (Chl-a). Chl-a is a measure of phytoplankton biomass and plant abundance in the water. Phytoplankton is a direct and indirect source of food for many marine animals and depends on certain conditions for growth; hence, they are a good indicator of environmental change. More information on the update is available in section 7.5.

For all surface waters: Nutrients discharges will be limited when necessary to prevent violations of other water quality standards and to prevent an imbalance in natural populations of aquatic flora or fauna. Additional criteria are included based on three types of waterbodies: lakes, streams, and estuaries.

For lakes: Lake nutrient criteria are classified by lake color and alkalinity. Based on the measurement of color through platinum cobalt units and the alkalinity measurement in the below lefthand column, lakes are divided into three different categories with an associated chl-a annual geometric mean (AGM) and a minimum/maximum range for total nitrogen and total phosphorus levels (Table 7.4-a).

Table 7.4-a 2015 Lake Nutrient Criteria

Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean (AGM) Chl-a	Minimum calculated numeric interpretation		Maximum calculated numeric interpretation	
		AGM TP	AGM TN	AGM TP	AGM TN

> 40 Platinum Cobalt Units	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L	2.23 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93g/L

For streams: FDEP divides streams, rivers, and canals into six Nutrient watershed Regions, three of which cover the estuaries in the Report Card (Figure 7.4-a). These criteria do not apply to ditches or canals used for water conveyance, wetlands, non-perennial streams, or tidal creeks. The nutrient standards in Table 7.4-b are used as thresholds and not strict criteria for determining impairment. If a threshold is exceeded, then floral evidentiary thresholds including chl-a, Rapid Periphyton Survey, algal community composition (autecological), and Linear Vegetation Survey are used to verify impairment.

Figure 7.4-a 2015 Florida Stream Nutrient Regions

Table 7.4-b 2015 Stream Nutrient Criteria

Nutrient Watershed Region	TP Nutrient Threshold	TN Nutrient Threshold
Peninsular	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	None	None

For estuaries: All estuaries were assigned a nutrient region with site-specific criteria. Table 7.4-c lists all of the estuaries included in this Report Card.

Table 7.4-c 2015 Estuarine Nutrient Criteria

Estuary	Total Phosphorus (TP) Criterion	Total Nitrogen (TN) Criterion	Chlorophyll-a Criterion
Charlotte Harbor/ Estero Bay	Criteria expressed as annual means are arithmetic means and are not to be exceeded more than once in a three-year period. For criteria expressed as long-term averages, the long-term average shall be based on data from the most recent seven-year period and shall not be exceeded. Criteria expressed as annual geometric means (AGM) are not be exceeded more than once in a three-year period. Nutrient and nutrient response values do not apply to tidally influenced areas that fluctuate between predominantly marine and predominantly freshwaters during typical climatic and hydrologic conditions.		
1. Dona and Roberts Bay	0.18 mg/L as annual mean	0.42 mg/L as annual mean	4.9 µg/L as annual mean
2. Upper Lemon Bay	0.26 mg/L as annual mean	0.56 mg/L as annual mean	8.9 µg/L as annual mean
3. Lower Lemon Bay	0.17 mg/L as annual mean	0.62 mg/L as annual mean	6.1 µg/L as annual mean
4. Charlotte Harbor Proper	0.19 mg/L as annual mean	0.67 mg/L as annual mean	6.1 µg/L as annual mean
5. Pine Island Sound	0.06 mg/L as annual mean	0.57 mg/L as annual mean	6.5 µg/L as annual mean
6. San Carlos Bay	0.045 mg/L as long-term average	0.44 mg/L as long-term average	3.7 µg/L as long-term average
7. Tidal Myakka River	0.31 mg/L as annual mean	1.02 mg/L as annual mean	11.7 µg/L as annual mean
8. Tidal Peace River	0.50 mg/L as annual mean	1.08 mg/L as annual mean	12.6 ug/L as annual mean
9. Matlacha Pass	0.08 mg/L as annual mean	0.58 mg/L as annual mean	6.1 µg/L as annual mean
10. Estero Bay (including Tidal Imperial River)	0.07 mg/L as annual mean	0.63 mg/L as annual mean	5.9 µg/L as annual mean
11. Little Hickory Bay	0.070 mg/L as AGM	0.63 mg/L as AGM	5.9 mg/L as AGM
12. Water Turkey Bay	0.057 mg/L as AGM	0.47 mg/L as AGM	5.8 µg/L as AGM
13. Moorings Bay	0.040 mg/L, not to be exceeded in > 10% of the samples	0.85 mg/L, not to be exceeded in > 10% of the samples	8.1 µg/L as AGM
15. Upper Caloosahatchee River Estuary	0.086 mg/L as long-term average	TMDL	4.2 µg/L as long-term average
16. Middle Caloosahatchee River Estuary	0.055 mg/L as long-term average	TMDL	6.5 µg/L as long-term average
17. Lower Caloosahatchee River Estuary	0.040 mg/L as long-term average	TMDL	5.6 µg/L as long-term average
Tidal Cocohatchee River/ Ten Thousand Islands	Criteria expressed as AGM not to be exceeded more than once in a three year period.		
1. Tidal Cocohatchee River	0.057 mg/L as AGM	0.47 mg/L as AGM	5.8 µg/L as AGM
3. Rookery Bay/Marco Island	0.046 mg/L as AGM	0.30 mg/L as AGM	4.9 µg/L as AGM
4. Naples Bay	0.045 mg/L as AGM	0.57 mg/L as AGM	4.3 µg/L as AGM
5. Inner Gulf Shelf	0.018 mg/L as AGM	0.29 mg/L as AGM	1.6 µg/L as AGM
8. Blackwater River	0.053 mg/L as AGM	0.41 mg/L as AGM	4.1 µg/L as AGM
9. Coastal Transition Zone	0.034 mg/L as AGM	0.61 mg/L as AGM	3.9 µg/L as AGM
10. Gulf Islands	0.038 mg/L as AGM	0.44 mg/L as AGM	3.4 µg/L as AGM
11. Inner Waterway	0.033 mg/L as AGM	0.69 mg/L as AGM	5.2 µg/L as AGM
12. Mangrove Rivers	0.02 mg/L as AGM	0.71 mg/L as AGM	3.7 µg/L as AGM
13. Shark River Mouth	0.02 mg/L as AGM	0.75 mg/L as AGM	2.2 µg/L as AGM
14. Ponce de Leon	0.02 mg/L as AGM	0.52 mg/L as AGM	3.0 µg/L as AGM

Clam Bay (Collier County)	No more than 10 percent of the individual TP or TN measurements shall exceed the respective limits.	
	TP Upper Limit (mg/L) = $e^{(1.06256 - 0.0000328465 * \text{Conductivity}(\mu S))}$	TN Upper Limit (mg/L) = 2.3601 – 0.0000268325*Conductivity (µS)

Unionized Ammonia

Table 7.4-d 2015 Unionized Ammonia Criteria

Freshwater Classes	Total Ammonia Nitrogen (TAN) TAN (mg/L) = $NH_4^+ + NH_3$
Class I Class III Class III- limited	The 30-day average TAN value shall not exceed the average of the values calculated from a specific equation, with no single value exceeding 2.5 times the value from that equation:

Former Water Quality Standards

The previous water quality standards did not include TN or TP. Instead, they used narrative criteria, chl-a, and Trophic State Index (TSI) as surrogate indicators. TSI is calculated based on chl-a, TN, and TP, and ranges on a scale from 1 to 100.

For all surface waters: Waterbodies were classified as impaired if algal mats were present in sufficient quantities to pose a nuisance or hinder reproduction of a threatened or endangered species. Additional criteria were also outlined for three types of waterbodies: streams, estuaries, and lakes.

Table 7.4-e 2010 Stream and Estuarine Nutrient Criteria

Waterbody	Maximum Chl-a	Percentage increased over historical values
Streams	20 µg/l as annual mean	50%
Estuaries	11 µg/l as annual mean	50%

Table 7.4-f 2010 Lake Nutrient Criteria

Long Term Geometric Mean Lake Color and Alkalinity	Annual Mean TSI maximum	Units Increased over historical Values
> 40 Platinum Cobalt Units	60	10
≤ 40 Platinum Cobalt Units	40	10

2) Oxygen Depletion

New Water Quality Standards

Biological Oxygen Demand (BOD): FDEP has a narrative criteria for BOD, i.e., it **"**shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions."

Dissolved Oxygen: FDEP organizes Class I, III, and III- limited Freshwaters into 5 Bioregions, two of which cover the estuaries in this Report Card (Table 7.4-g). More information on the change is available on in section 7.5.

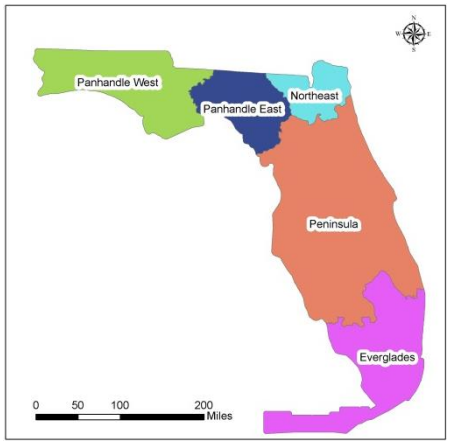


Table 7.4-g 2015 Freshwater DO Criteria

Freshwater Class	Bioregion	Daily Average DO Saturation Value
Class I Class III Class III limited	Peninsula	38%
	Everglades	DO Site Specific Alternative Criteria

Table 7.4-h 2015 Freshwater DO Criteria cont.

Freshwater Class	Average Minimum DO (mg/L)	Absolute Minimum DO (mg/L)
Class IV	4.0 , 24-hr period	3.0
Class V (flows > 250 f^3/sec)	0.3, 50% samples annually	0.1

Table 7.4-i 2015 Saltwater DO Criteria

Saltwater Class	Monitoring Time Frame	Average Minimum Average DO Saturation Levels	Overall Time Frame
Class II Class III Class III Limited	1 day	42%	More than 10 % values
	7 days	51%	12 weeks
	30 days	56%	Annual

Former Water Quality Standards

Biological Oxygen Demand: The water quality standards for BOD did not change between 2010 and 2015.

Dissolved Oxygen:

Table 7.4-j 2010 DO Criteria

Classes	Average Minimum DO (mg/L)	Absolute Minimum DO (mg/L)
Class I	>5.0	5.0
Class II	5.0 in a 24 hour period	4.0
Class III- fresh	>5.0	5.0
Class III- marine	5.0 in a 24-hour period	4.0
Class IV	4.0 in a 24 hour period	3.0
Class V (flows >=250)	0.3, 50% samples annually	0.1

3) Pathogens

New Water Quality Standards

Table 7.4-k 2015 Pathogen Criteria

Class	Bacteria	TPTV MPN	TPTV MF	Monthly Geometric Mean	Median MPN/MF Counts	Absolute Maximum
Class I	E. coli	410	410	126		
Class II	Fecal Coliform	43	31		14	800
	Enterococci	130	130	35		
Class III-Freshwater	E. coli	410	410	126		
Class III-Marine	Enterococci	130	130	35		

MPN= Most Probably Number
MF= Membrane Filter
TPTV = 10% Threshold Value
Units per 100 mL of water

Former Water Quality Standards

Table 7.4-l 2010 Pathogen Criteria

Class	Bacteria	TPTV	Monthly Average Count	Absolute Maximum
Class I	Fecal coliform	400	200	800
Class II	Fecal Coliform	43	14	800
Class III-Freshwater	Fecal Coliform	400	200	800
Class III-Marine	Fecal Coliform	400	200	800

4) Metals

New Water Quality Standards

Table 7.4-m 2015 Metals Criteria

Class	Cadmium (µg/L)	Mercury (µg/L)	Iron (mg/L)	Lead (µg/L /L)	Copper (µg/L)
Class I	$e^{(0.7409[\ln H]-4.719)}$	0.012	1.0	$e^{(1.273[\ln H]-4.705)}$	$e^{(0.8545[\ln H]-1.702)}$
Class II	8.8	0.025	0.3	8.5	3.7
Class III- Fresh	$e^{(0.7409[\ln H]-4.719)}$	0.012	1.0	$e^{(1.273[\ln H]-4.705)}$	$e^{(0.8545[\ln H]-1.702)}$
Class III- Marine	8.8	0.025	0.3	8.5	3.7
Class IV		0.2	1.0	50	500
Class V		0.2		50	500

5) Physical

New Water Quality Standards

pH

Table 7.4-n 2015 pH Criteria

Class	Range used	Unit variation from natural background
Freshwater: Class I Class III- fresh Class IV	6 < pH < 8.5	1
Coastal Water: Class II Class III	6.5 < pH < 8.5	1
Open Water: Class II Class III	6.5 < pH < 8.5	0.2
Class V	5 < pH < 9.5	Must be within range (with exception of certain swamps)

When pH is less than the lower end of the range, it cannot vary below the natural background. When pH is greater than the upper end of the range, it cannot vary above natural background. When pH is within the range, it cannot vary outside of the range.

Dissolved Solids

Table 7.4-o 2015 Dissolved Solids Criteria

Classes	Monthly Average	Absolute Maximum
Class I	500 mg/L	1,000 mg/L

Chloride

Table 7.4-p 2015 Chloride Criteria

Class	Chloride Criterion (mg/ L)
Class I	250
Class II	> 10% above normal background
Class III- marine	> 10% above normal background
Class V- marine	> 10% above normal background

Specific Conductance

Table 7.4-q 2015 Specific Conductance Criteria

Class	Maximum percentage above background	Measured Specific Conductance (micromhos/cm)
Class I	50%	1,275
Class III- freshwater	50%	1,275
Class IV	50%	1,275
Class V		4,000

Turbidity/ Total Suspended Solids

Table 7.4-r 2015 Turbidity Criteria

Class	Maximum Level above Natural Background Conditions (NTU)
All classes	29

6) Biology

New Water Quality Standards

Shannon-Weaver Diversity Index

Table 7.4-s 2015 Biology Criteria

Classes	Hester- Dendy type Samplers Maximum acceptable % of background level	Ekman or Ponar type Samplers Maximum acceptable % of background level
Class I	75	75
Class II		75
Class III- freshwater	75	75
Class III- marine		75

7.5 Explanation of Changes in Water Quality Standards

Dissolved Oxygen Water Quality Standards Changes and Implementation

The Florida Department of Environmental Protection (FDEP) conducts a Triennial Review of State Water Quality Standards, per the requirements of the Clean Water Act (CWA). During the 2012 Triennial Review process, FDEP adopted new Dissolved Oxygen (DO) water quality standards for fresh and marine waters in Florida. The prior standards were based on maintaining DO at levels to protect aquatic life as a concentration measurement in milligrams per liter (mg/l). Fish and other aquatic life depend on sufficient DO in the water column to respire and function during all life stages. The previous Class I and III freshwaters stated that DO concentrations "*Shall not be less than 5.0 mg/L.*"[279] For Class II and Class III marine waters, the standards stated that DO concentrations "*Shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L.*"[279] Additionally, for both fresh and marine waters, the criteria indicated that normal daily and seasonal fluctuations above these levels should be maintained. Other states in the southeast, such as North Carolina[280] and Georgia,[281] have similar standards in place.

FDEP's decision to change these standards was predicated on the idea that Florida waterbodies naturally exhibit lower DO regimes than in other parts of the country due to the preponderance of wetlands, high levels of groundwater and surface water interaction, and the unique combination of high temperatures, high biological oxygen demand (BOD), and low flow periods.[282]

Another driving factor behind the changes in standards was the sheer number of waterbodies being placed on the state's 303(d) list for low DO.[282]

The newly adopted freshwater DO standards were derived regionally based on the Stream Condition Index (SCI) bioregions (Figure 7.5-a). The Panhandle, Northeast, Big Bend, and Peninsula Bioregions had concentration standards that were replaced with a new percent saturation standard.

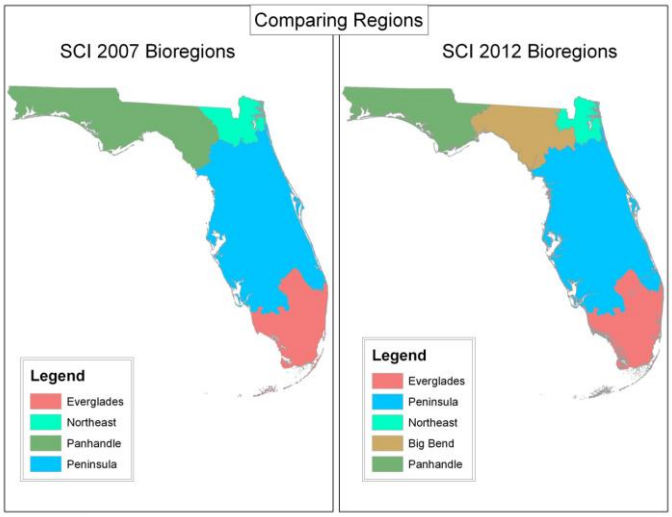


Figure 7.5-a Stream Condition Index Bioregions

The Everglades Protection Area (EvPA) within the Everglades bioregion is currently regulated under a DO Site Specific Alternative Criteria (SSAC), which is maintained as the regionally appropriate standard. Waters outside the EvPA in South Florida fall under the Peninsula DO criteria. With the exception of the Panhandle and Everglades bioregions, the balance of the changes resulted in a weakening of the water quality standards for DO throughout the state of Florida.

The criteria changed to percent saturation because, unlike a concentration standard, it takes into account water temperature, which impacts the solubility of DO throughout a daily cycle of fluctuation. For example, DO concentrations are inversely related to water temperature—the higher

the water temperature, the lower the DO concentration.[283] Although it can be a more accurate measurement, it can also be more complex in terms of the type and quantity of data collected. For example, a single grab sample of water now requires a temperature recording in addition to the concentration measurement and then must be converted into a percent saturation reading, unless modern sampling instruments that are capable of doing the calculation are used. Moreover, because historical DO data has been collected and recorded as a concentration, comparisons between waterbodies before and after the new standards take effect will be difficult.

Current Status

These DO standards changes may result in a significant number of waterbodies being delisted from the 303(d) list as FDEP goes through the rotating basin assessment process. However, the basin groups utilized in this Report Card were assessed under the prior concentration standards and an analysis of the DO revisions impact is not possible at this time. In the future, FDEP will have completed assessments with the new standards in all of the watersheds covered by the Report Card, which will allow the assessment data to be used in future Report Cards. For purposes of this report, data as recent as Cycle 3, Group 1 were used to calculate the water quality grades.

Numeric Nutrient Criteria Water Quality Standards Changes and Implementation

History of Numeric Nutrient Criteria in Florida

Nutrient pollution is one of the most prevalent water quality issues in the United States. In Florida alone, over 50% of assessed rivers, 82% of assessed lakes, and 32% of assessed bays and estuaries are listed for a nutrient-related impairment.[284] This widespread problem was recognized by the Environmental Protection Agency (EPA) in June 1998 when the agency published a national nutrient strategy, known as Numeric Nutrient Criteria (NNC),[285] to help states develop more effective water quality standards for nutrient pollution. This national strategy launched a nearly decade-long battle over the development of appropriate and scientifically defensible criteria in the state of Florida.

Throughout the early 2000s, FDEP relied on a narrative nutrient standard and chlorophyll-a levels to determine whether a waterbody was attaining its designated use. The narrative standard states “In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna."[286] Unfortunately, this standard proved inadequate in identifying and addressing nutrient pollution. As a result, increasing numbers of Florida waterbodies were being degraded, resulting in harmful algal blooms, fish kills, and other nutrient pollution-related problems.

Due to the escalating severity of the nutrient impairments exhibited in Florida waters and the state's slow pace of NNC development, the Conservancy of Southwest Florida, along with partner groups represented by the Earthjustice law firm, filed a suit in 2008 against EPA alleging three main points: (1) there was an unacceptable delay by EPA in setting NNC; (2) EPA had previously determined that NNC are necessary per the Federal Clean Water Act; and (3) EPA was obligated to promptly propose these criteria for Florida.[287] As a result, EPA determined that NNC were in fact necessary under Clean Water Act (CWA) section 303(c)(4)(b) to protect water quality and that the current narrative standard was insufficient. EPA entered into a Consent Decree with Earthjustice in 2009 that outlined a schedule for implementation.[288]

Figure 7.5-b Freshwater Nutrient Regions

Pursuant to the timeline in the Consent Decree, EPA promulgated NNC for streams and lakes outside of south Florida in 2010. In 2011, FDEP resumed the state's NNC development, resulting in two sets of NNC for Florida waterbodies. The most significant differences between the two sets of standards were evident in the implementation plan proposed by FDEP and how the nitrogen and phosphorus numbers were treated within the context of the implementation plan. FDEP's nutrient numbers, although the same numerically as EPA's, are treated as thresholds as opposed to actual numeric criteria. For example, the plan requires several biological and vegetative assessments to be conducted before a waterbody can be considered impaired, even if that waterbody exhibits nutrient levels in excess of the numeric thresholds.

Despite the concerns expressed by environmental organizations, including the Conservancy, of FDEP's approach to implementation, EPA eventually withdrew the federal NNC in favor of the state's rulemaking, effective October 27, 2014.[289] In the process, EPA also revised the original 2009 Consent Decree to remove the provision related to downstream protective values.[290]

Current Status

Florida has officially adopted the nutrient criteria for streams, rivers, lakes, springs, and estuaries and began implementing the new criteria in the Cycle 3 watershed assessment for Group 2 waterbodies. South Florida flowing waters and tidal creeks continue to be excluded from numeric criteria and are being assessed under the previous narrative standard.

Similar to the DO standards revisions, implementation of the NNC may result in a significant number of waterbodies being delisted from the 303(d) list as FDEP completes the rotating basin assessments. However, the basin groups used in this Report Card were assessed under the prior concentration standards, and an analysis of the impact of the NNC revisions is not possible at this time. In the future, FDEP will have completed assessments with the newly adopted standards in all of the watersheds covered by the Report Card, allowing the assessment data to be used in future Report Cards. For the

purposes of this report, data as recent as Cycle 3, Group 1 were used to calculate the water quality grades.

Statewide Mercury Total Maximum Daily Load

Mercury pollution is a significant problem impacting Florida's wildlife and human health. In 2013, 8,316,160 acres of lakes, estuaries, and coastal waters and 1,857,920 acres of rivers were listed for mercury impairment.[291] However, there are a number of unique issues surrounding mercury pollution that set it apart from other types of pollutants in Florida. For example, mercury pollution impairment in Florida is assessed through measured concentrations in fish tissue and not through a specific water quality standard for surface waters. "In other words, no waterbody in Florida has been identified as impaired for mercury because of the concentrations of mercury in the water. Instead, the Florida Department of Environmental Protection (FDEP) assigned impairments based on exceedances of the Florida Department of Health (FDOH) guidelines for fish consumption."[291]

Another challenge is the source of mercury pollution, primarily attributed to atmospheric deposition from locations generally originating outside Florida's state boundaries. In addition, methylated mercury—the toxic form of the metal that bioaccumulates in fish tissue and biomagnifies up the food chain—has documented hotspots, particularly in the Everglades and south Florida region, which are exacerbated by sulfate runoff from the Everglades Agricultural Area (EAA). Sulfate-reducing bacteria are one of the primary methylators of mercury.[292]

Typically, Total Maximum Daily Loads (TMDLs) are proposed for a waterbody or sometimes several connected waterbodies. However, FDEP adopted and the Environmental Protection Agency (EPA) approved a statewide mercury TMDL for Florida in 2013 that applies to all of the waterbodies that were listed as impaired for mercury, based on fish tissue concentrations, at the time of adoption. The TMDL will also apply to new impairment listings in most instances. There were a number of concerns raised by the Conservancy of Southwest Florida and other organizations regarding Florida's statewide TMDL for mercury, including the need to be more protective of sensitive populations, such as pregnant women and recreational anglers, the need to account for bioaccumulation factors in endangered species such as the Florida panther, and the need to reduce sulfates in order to address local sources of methylated mercury.[292],[293]

Beyond the content of the TMDL, adoption of the TMDL also impacts watershed assessments and the water quality grades in this report. Once a waterbody has an adopted TMDL, it is moved from category 5 (impaired) to category 4a (TMDL adopted) on FDEP's watershed assessment lists, regardless of whether the waterbody is meeting the restoration targets defined in the TMDL document. The results of this are evident in the watersheds contained in Group 1 Cycle 3, where mercury is no longer listed in category 5 and is not captured as a pollutant in the Report Card methodology (Figure 7.5-c).

Figure 7.5-c Category 4a Mercury Listings for Group 1, Cycle 3

7.6 Category 3 Listings

Water quality data collection is foundational for determining whether a waterbody is or is not meeting water quality standards. Without data, there is no information on which to base assessment. There are a number of data gaps evident in water quality data collection, and FDEP places waterbodies with insufficient data into several different categories: 3a – no data is available for a particular parameter; 3b – insufficient data is available for a particular parameter; and 3c – the parameter is potentially not meeting standards, but more data needs to be collected to verify. The following maps and tables depict data gaps for the ten estuary watersheds in this Report Card and highlight the continued need for funding and resources necessary to collect sufficient data for all waterbodies.

Categories 3a Listings for All Parameter Categories

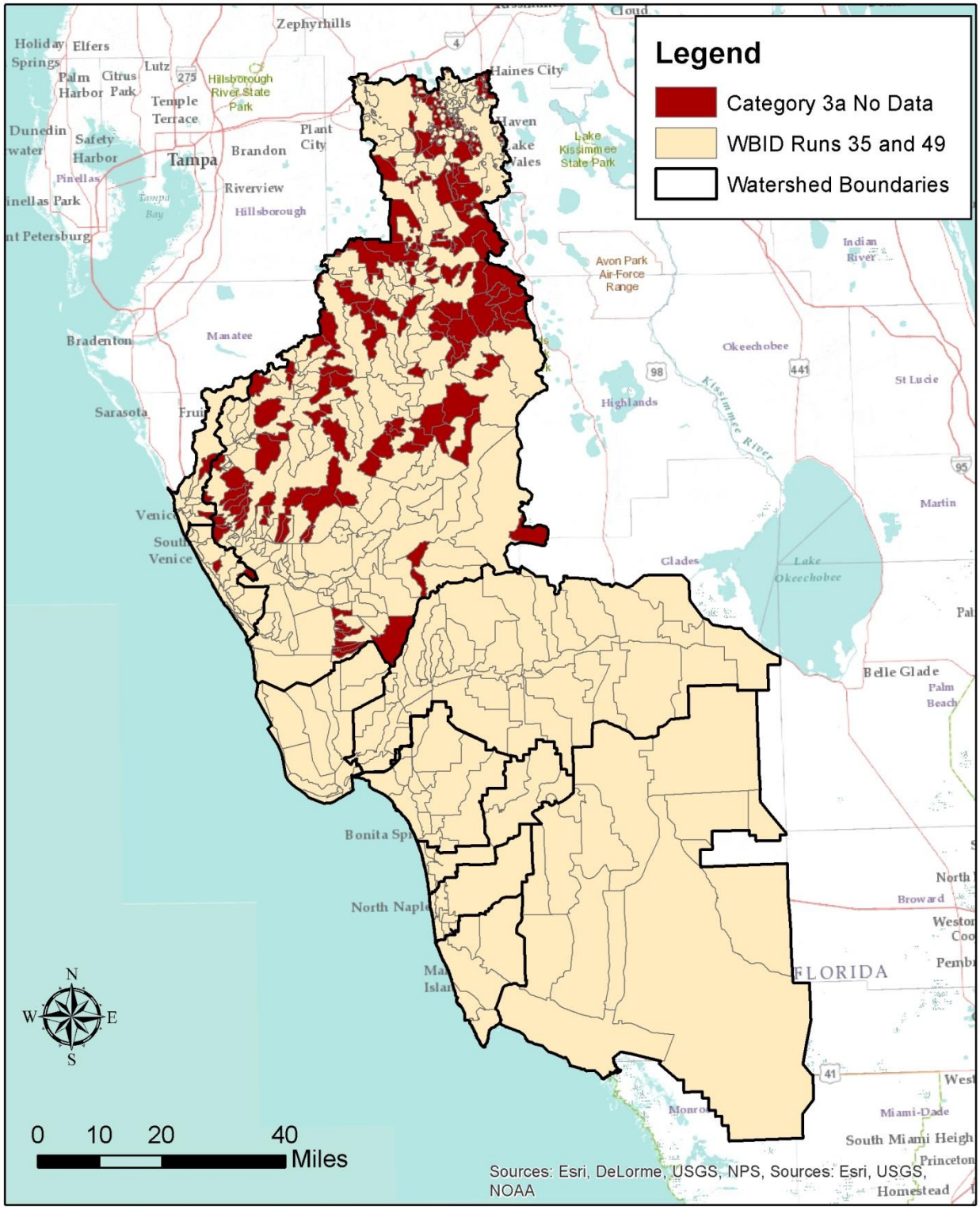


Figure 7.6-a Category 3a Map

Categories 3a & 3b Listings for "Biology" Parameter Category

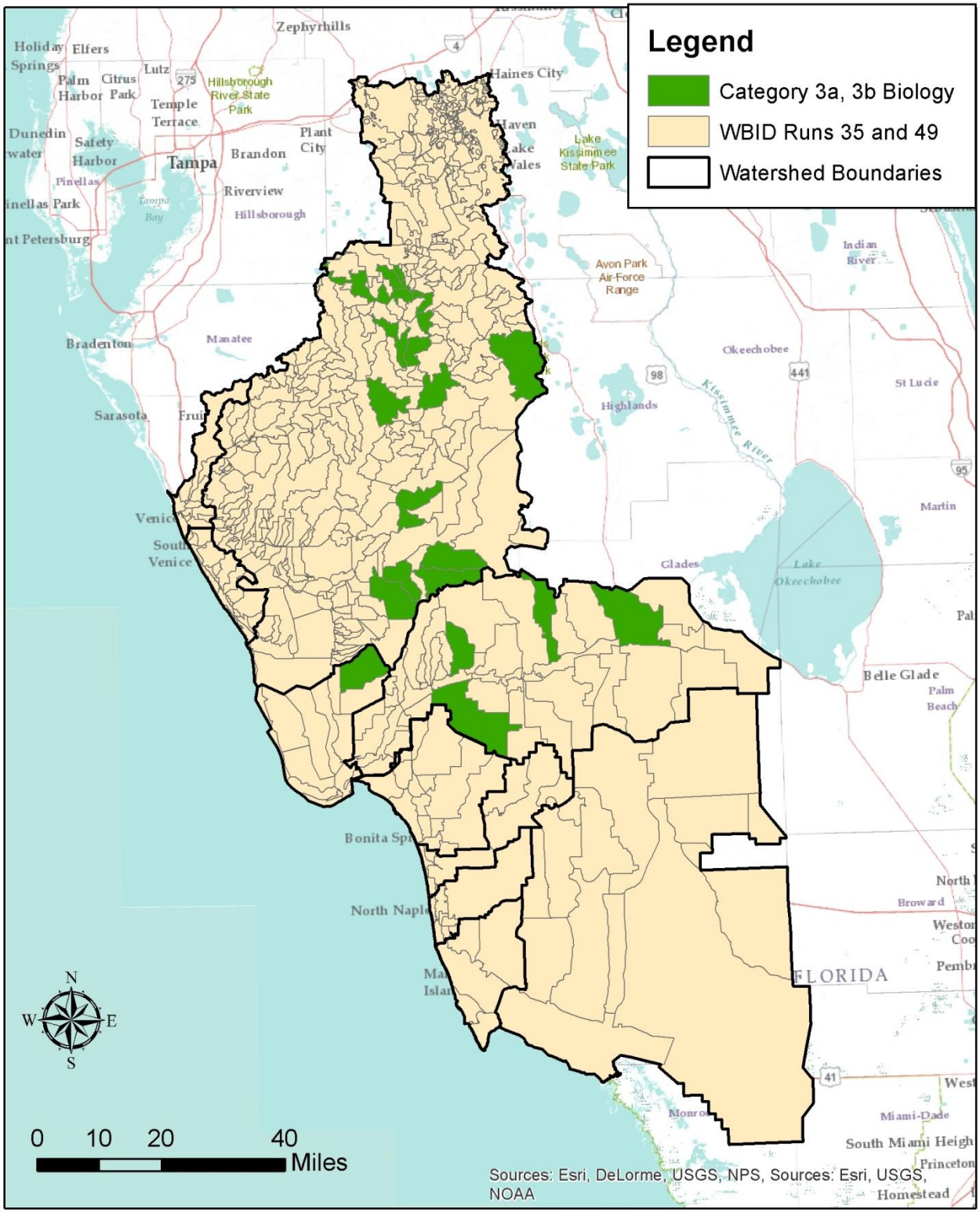


Figure 7.6-b Category 3a or 3b "Biology" Map

Categories 3a & 3b Listings for "Metals" Parameter Category

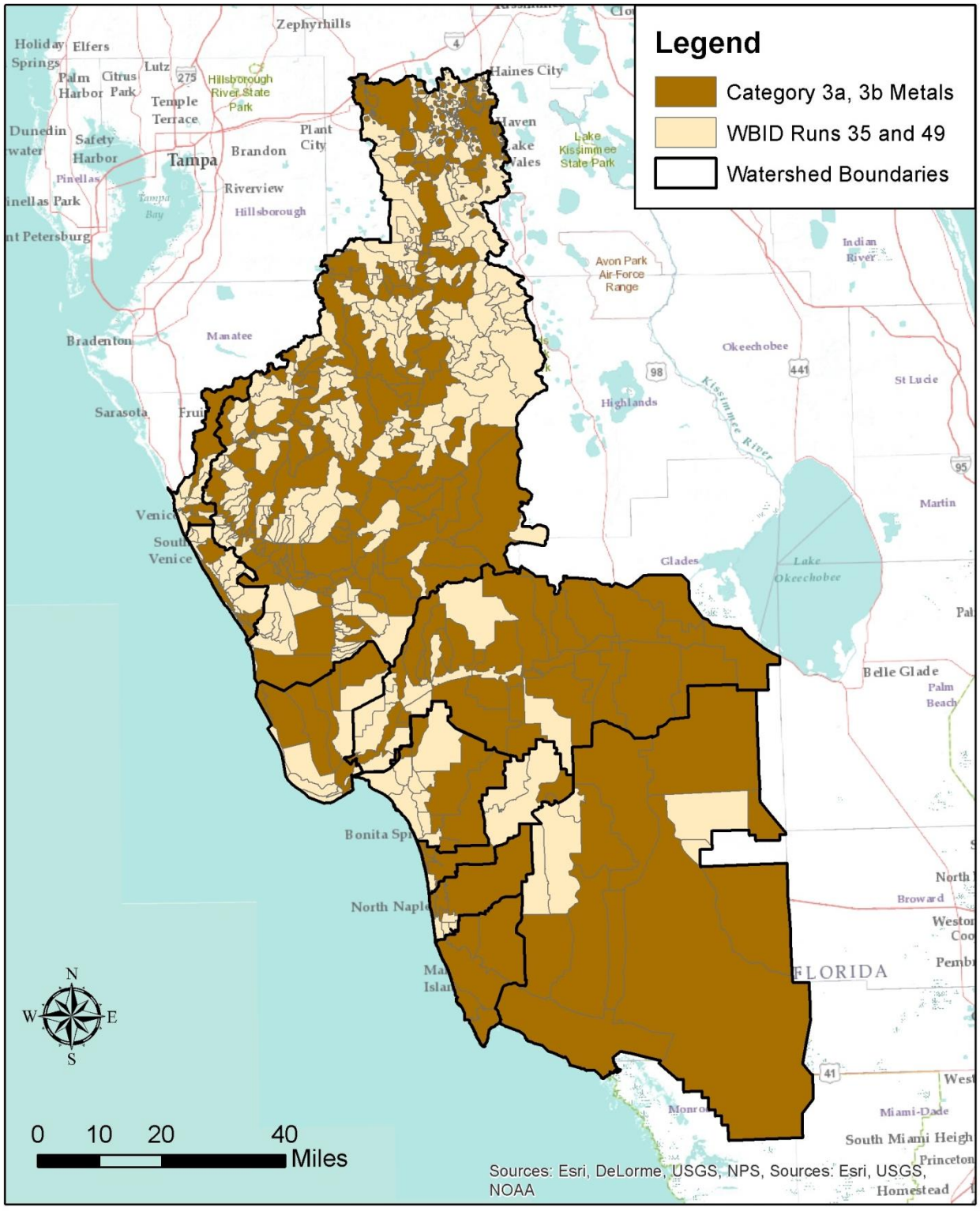


Figure 7.6-c Category 3a or 3b Metals Map

Categories 3a & 3b Listings for "Nutrients" Parameter Category

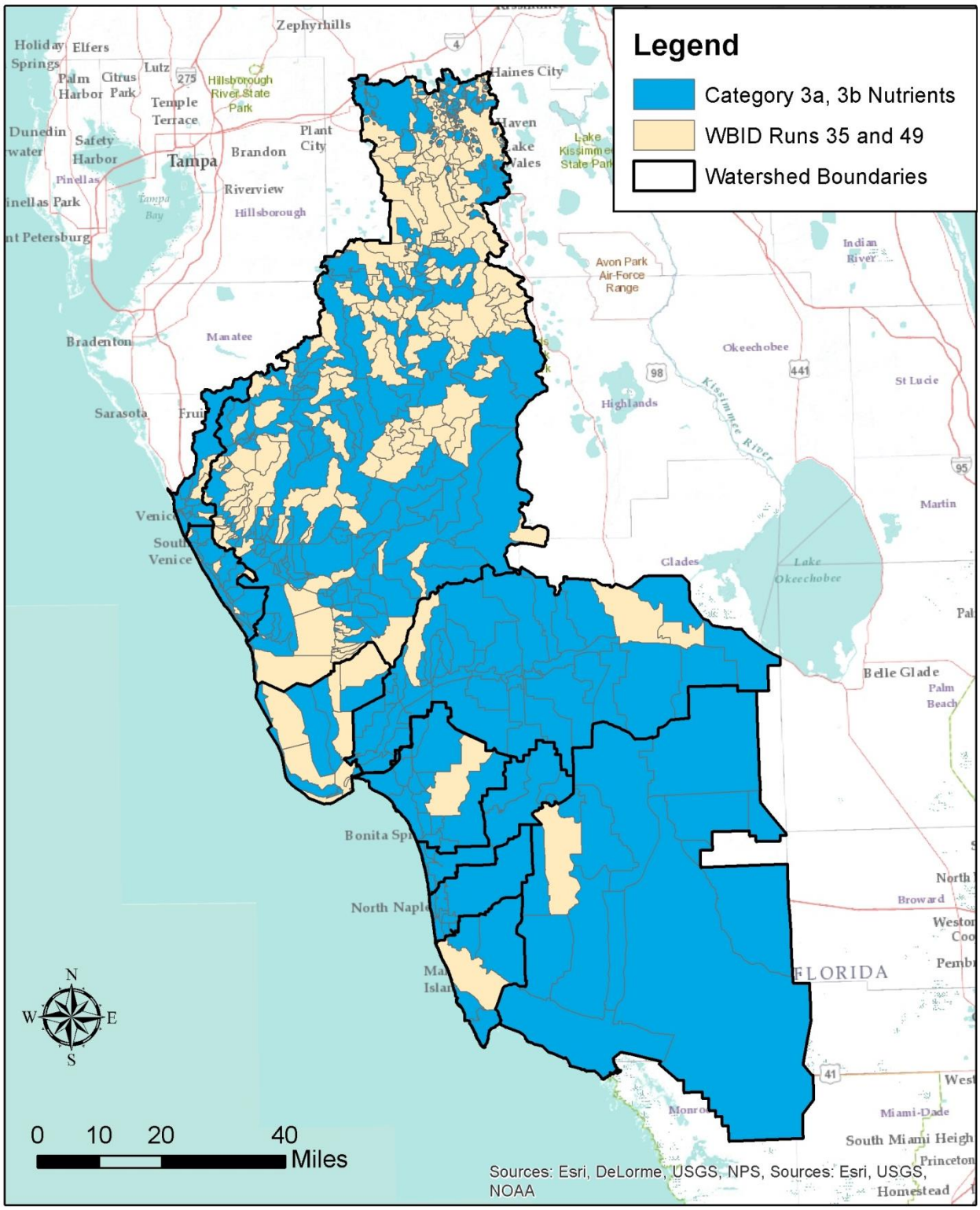


Figure 7.6-d Category 3a or 3b Nutrients Map

Categories 3a & 3b Listings for "Oxygen" Parameter Category

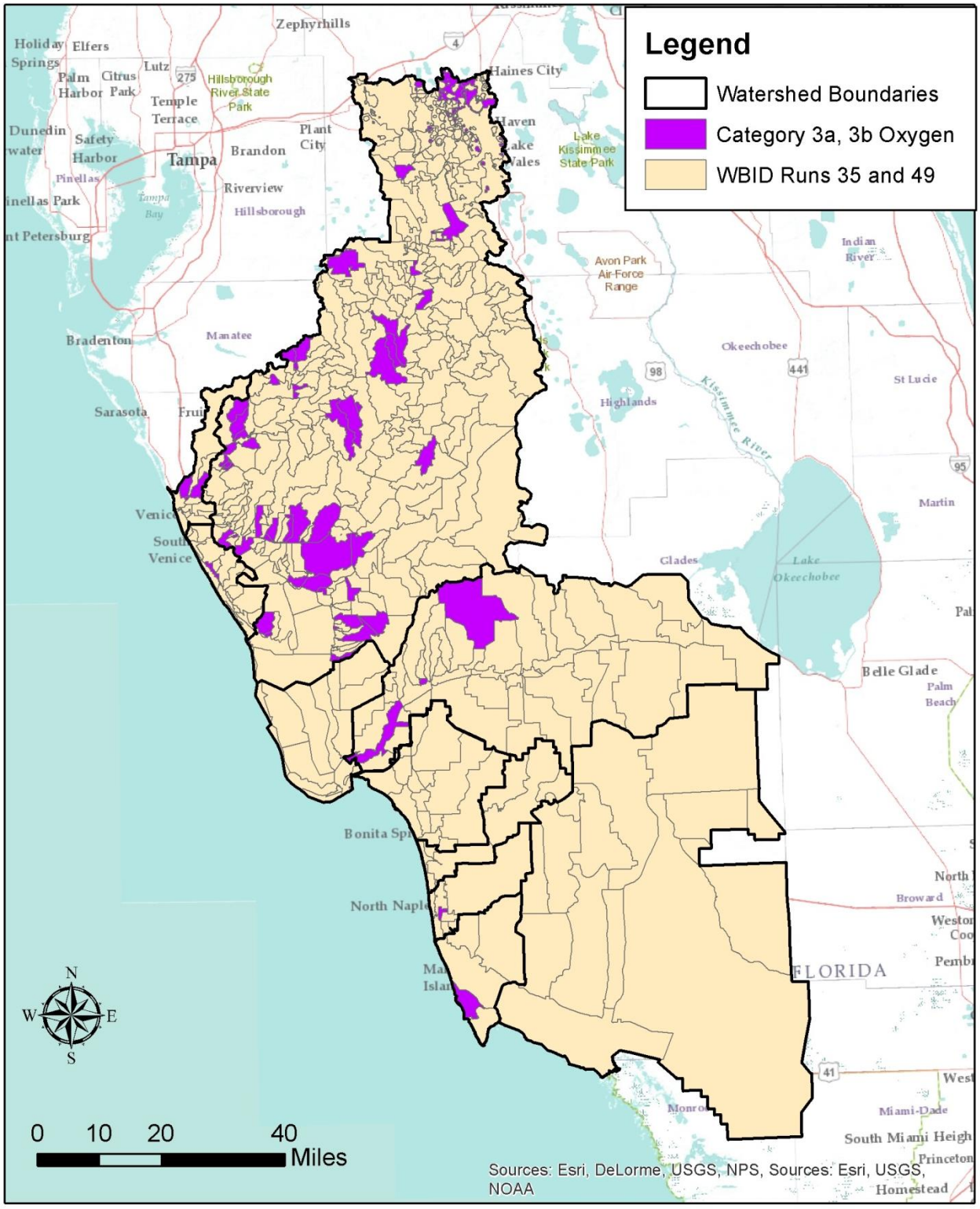


Figure 7.6-e Category 3a or 3b Oxygen Map

Categories 3a & 3b Listings for "Pathogens" Parameter Category

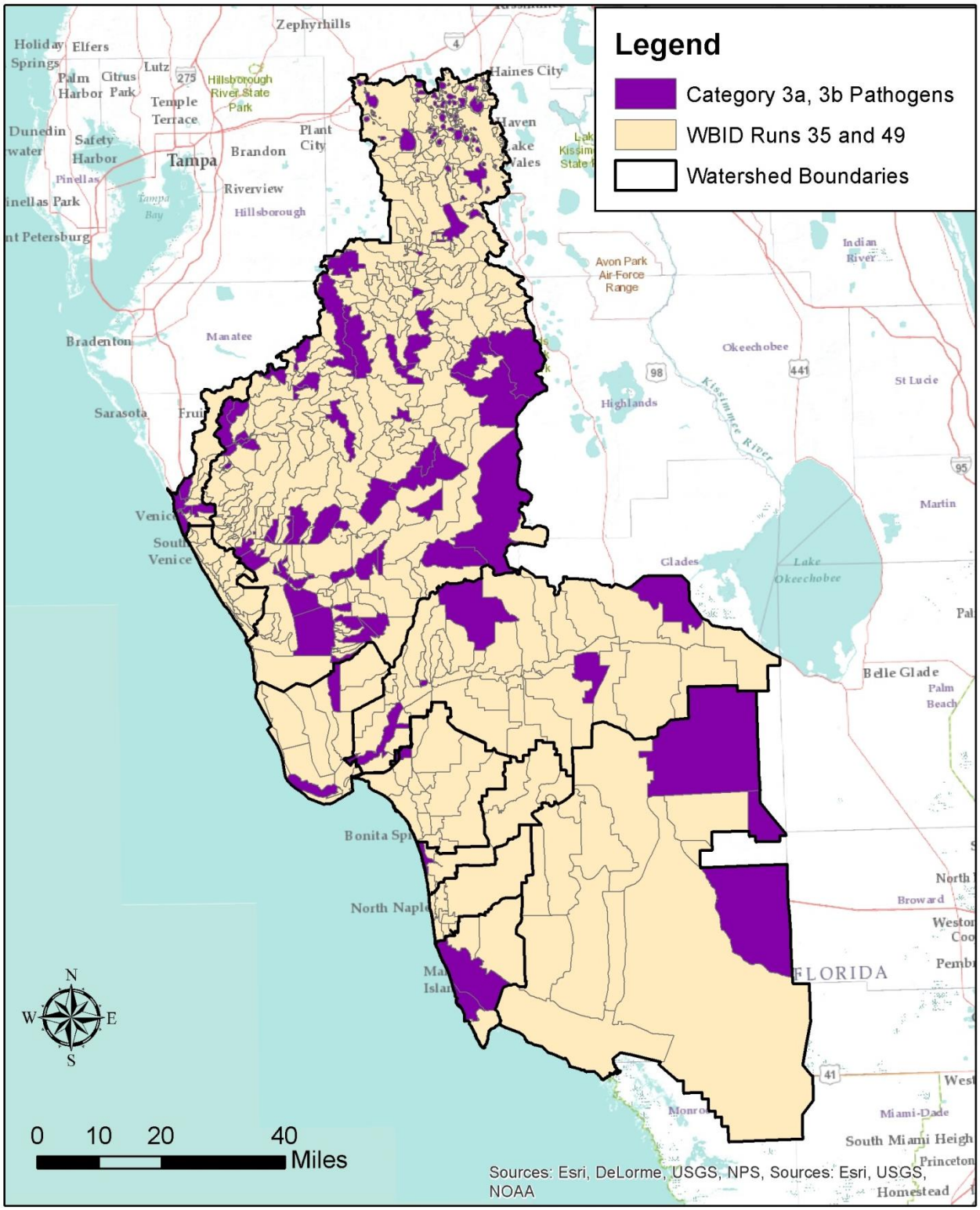


Figure 7.6-f Category 3a or 3b Pathogens Map

Categories 3a & 3b Listings for "Physical" Parameter Category

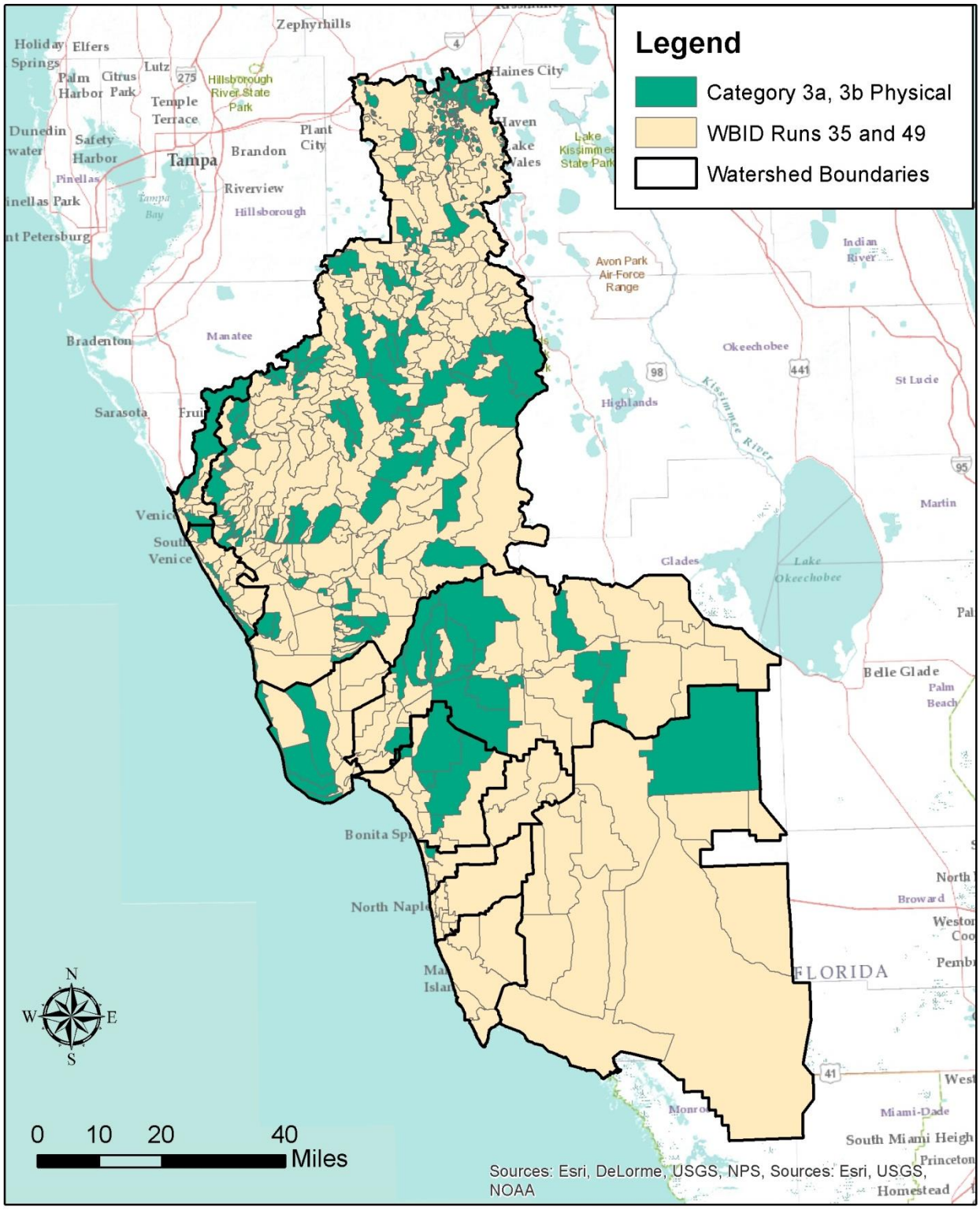


Figure 7.6-g Category 3a or 3b Physical Map

Category 3c Listings by Parameter Category

Figure 7.6-h Category 3c Map

Table 7.6-a Instances of Category 3 Listings by Parameter Category

Total Number of Listings In Categories 3a "No Data" and 3b "Insufficient Data" by Parameter Category

Watershed	Biology	Metals	Nutrients	Oxygen	Pathogens	Physical	Grand Total
Coastal Venice		5	21	4	8	17	**55**
Lemon Bay		6	19	2		9	**36**
Greater Charlotte Harbor	14	301	371	75	119	364	**1,244**
Pine Island Sound	1	18	9	2	3	6	**39**
Caloosahatchee River	4	71	98	11	13	54	**251**
Estero Bay		17	29		1	8	**55**
Wiggins Pass/ Cocohatchee River		12	15		1	1	**29**
Naples Bay		10	19	2	1	4	**36**
Rookery Bay		8	8	1	2		**19**
Ten Thousand Islands		17	26		3	1	**47**
Grand Total	**19**	**465**	**615**	**97**	**151**	**464**	**1,811**

Total Number of Listings in Category 3c "Potentially Impaired" by Parameter Category

Watershed	Biology	Metals	Nutrients	Oxygen	Pathogens	Physical	Grand Total
Coastal Venice	2		1	2	2	2	**9**
Lemon Bay		3	1	1	1	1	**7**
Greater Charlotte Harbor	41	13	38	9	17	66	**184**
Pine Island Sound			2				**2**
Caloosahatchee River	10	16	8		2	7	**43**
Estero Bay				1			**1**
Wiggins Pass/ Cocohatchee River	1	1				1	**3**
Naples Bay						1	**1**
Rookery Bay						1	**1**
Ten Thousand Islands		1	1			2	**4**
Grand Total	**54**	**34**	**51**	**13**	**22**	**81**	**255**

Numbers represent the number of times a watershed is listed in Categories 3a or 3b for any of the parameter categories assessed. A WBID may be counted more than once for a specific parameter category if more than one parameter is listed. For example, WBID 3258X in Estero Bay is listed for both alkalinity and pH in the physical parameter category.

WBIDs Listed in Category 3a "No Data" for all Parameters

Table 7.6-b WBIDs Listed in Category 3a for all Parameters

Coastal Venice

WBID	Acres
1987	3,675.42
2016	1,355.58
Total	**5,031.00**
Total Watershed Area:	62,961
Percent:	**8%**

Lemon Bay

WBID	Acres
2050	1,327.37
2057	1,840.08
Total	**3,167.45**
Total Watershed Area:	62,320
Percent:	**5%**

Greater Charlotte Harbor

WBID	Acres
1488C1	161.38
1488D1	8.67
1488D2	13.58
1488D3	44.83
1492	1,047.33
14922	11.06
1500	3,403.40
15005	18.01
1501B1	554.50
1501E	854.56
1501F	2,282.81
1510	821.30
15102	16.12
1521C1	9,076.25
1521R	261.91
1539Y1	750.53
1545	1,536.74
1548A	469.04
1582A	51.76
1582B	92.78
1586	1,885.28
1588	914.33
1589A	654.50
1590	2,552.67
1590C	65.25
1590D	70.48
1590E	20.99
1598	3,218.23
1602	4,812.42

WBID	Acres
1629A	32.72
1634	2,636.62
1638	1,096.72
1644A	803.31
1644B	778.16
1647B	9,535.10
1672	12,257.83
1677B	19,491.64
1718	335.00
1720	166.45
1722	5,507.83
1727	639.94
1728	615.18
1734	505.87
1735	2,557.20
1737	212.87
1738	11,933.39
1740	12,314.65
1741	2,233.73
1744	534.35
1745	630.89
1746	625.65
1750	872.32
1759	1,261.68
1763C	13,284.41
1763D	6,651.94
1765	247.84
1766	1,216.72
1773	2,792.79

1608	1,033.38
WBID	**Acres**
1611	6,520.38
1616	1,014.50
1622B	40.35
1622C	10,266.25
1623N	4,513.79
1629	1,176.75
1801	1,075.89
1802	6,614.08
1805	2,189.76
1808	3,563.57
1814	4,561.26
1815	6,821.88
1820	5,708.56
1821	2,406.59
1822	6,112.71
1824	1,498.18
1827	8,722.26
1835	3,335.69
1836	8,434.89
1837	11,773.81
1838	3,946.49
1845	2,121.63
1851	3,170.64
1852	6,710.61
1854	3,044.25
1863	1,674.52
1867	3,782.77
1870	3,270.51
1878	2,886.27
1879	1,398.56
1884	2,175.56
1886	4,027.04
1902	1,716.19
1904	3,977.59
1905	2,449.96
1907	2,855.62
1915	4,757.33
1918	5,497.73
1919	1,205.14

1775	904.96
WBID	**Acres**
1776	12,965.60
1777	3,952.15
1786	1,676.66
1791	1,116.61
1795	906.24
1799	897.45
1965	4,685.24
1969	6,899.01
1970	2,539.69
1973	11,369.74
1977	10,190.83
1980	3,379.84
1986	6,006.72
1988	2,394.49
1989	19,534.55
1990	6,792.50
1998	3,660.84
1999	3,703.73
2000	10,014.31
2003	4,275.22
2004	1,338.71
2005	3,317.81
2006	2,497.86
2007	2,635.75
2011	1,164.63
2012	483.57
2013	858.24
2019	267.31
2020	10,610.62
2022	1,784.23
2024	980.83
2025	2,392.77
2029	622.39
2031	3,051.07
2032	1,260.13
2044	4,721.86
2058	3,367.28
2077	2,155.03
2083	549.20

1920	5,364.07
WBID	**Acres**
1928	17,560.39
1934	1,696.04
1942	9,701.98
1945	9,276.15
1946	1,656.86
1952	2,874.08
1956	2,619.34
1957	9,487.81
1959	2,391.00
1960	1,483.94
1963	6,202.32

2084	1,400.17
WBID	**Acres**
2086	1,657.87
2088	1,163.01
2091	1,857.63
2093	272.51
2093A	2,400.82
2094	1,710.88
3240T	19,007.55
Total	567,206.53
Total Watershed Area:	2,075,831
Percent:	27%

7.7 Current TMDLs, BMAPs, and RAPs

Approved Total Maximum Daily Loads (TMDLs)

When FDEP verifies that a waterbody is impaired for a particular pollutant, the waterbody is listed in Category 5 and a Total Maximum Daily Load (TMDL) must be developed. A TMDL is a threshold for the amount of a given pollutant that a waterbody can assimilate and still meet the water quality standards for its specific class. The purpose of the TMDL is to reduce the amount of pollutants in the water body to the point it is considered unimpaired.[294] Table 7.7-a is the list of current TMDLs in the southwest Florida region that have been adopted by the state and approved by the EPA as of December 2015. Information was collected from FDEP geospatial database.

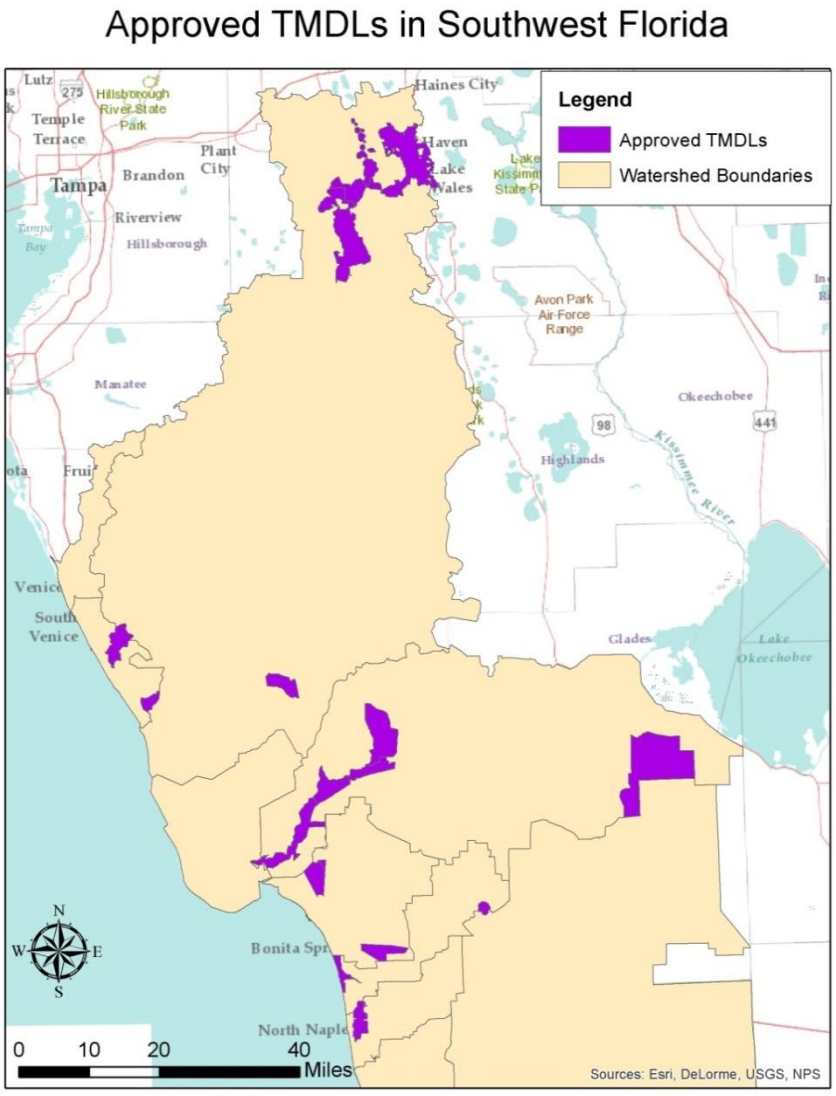


Figure 7.7-a Approved TMDLs in Southwest Florida- Map

Southwest Florida Waterbodies under an Approved TMDL

Table 7.7-a Approved TMDLs in Southwest Florida

Waterbody Name	WBID	Pollutant (Parameter)
Lemon Bay		
Coral Creek (East Branch)	2078B	Dissolved Oxygen
Gottfried Creek	2049	Fecal Coliform
Greater Charlotte Harbor		
Alligator Creek (North Prong)	2071	Fecal Coliform
Lake Cannon	1521H	Nutrient
Lake Howard	1521F	Nutrient
Lake Idylwild	1521J	Nutrient
Lake Jessie	1521K	Nutrient
Lake Lulu	1521	Nutrient
Lake May	1521E	Nutrient
Lake Mirror	1521G	Nutrient
Lake Shipp	1521D	Nutrient
Peace River above Bowlegs Creek	1623J	Fecal Coliform
Peace Creek Drainage Canal	1539	Fecal Coliform
Wahneta Farms Drainage Canal	1580	Fecal Coliform
Caloosahatchee River		
Caloosahatchee Estuary (Tidal Segment 1)	3240A	Nutrient
Caloosahatchee Estuary (Tidal Segment 2)	3240B	Nutrient
Caloosahatchee Estuary (Tidal Segment 3)	3240C	Nutrient
Nine Mile Canal	3237D	Fecal Coliform
Trout Creek	3240G	Fecal Coliform
Estero Bay		
Hendry Creek	3258B	Dissolved Oxygen
Hendry Creek (Marine Segment)	3258B1	Fecal Coliform
Hendry Creek (Marine Segment)	3258B1	Dissolved Oxygen
Imperial River	3258E	Dissolved Oxygen
Wiggins Pass/Cocohatchee River		
Cocohatchee River	3259A	Fecal Coliform
Lake Trafford	3259W	Dissolved Oxygen, Nutrient, and Un-Ionized Ammonia
Naples Bay		
Gordon River Extension	3278K	Dissolved Oxygen

Southwest Florida Waterbodies under a Developing TMDL[295]

Table 7.7-b Developing TMDLs in Southwest Florida

Waterbody Name	WBID	Pollutant (Parameter)
Caloosahatchee River		
Billy Creek	3240J	Dissolved Oxygen and Nutrient
Caloosahatchee River (between S-79 and S-78)	3235B	Nutrient
Cypress Branch	3235G	Dissolved Oxygen and Nutrient
Deep Lagoon Canal	3240A4	Dissolved Oxygen and Nutrient
Jack's Branch	3235D	Nutrient
Lake Hicpochee	3237C	Dissolved Oxygen and Nutrient
Long Hammock Creek	3237B	Dissolved Oxygen and Nutrient
Nine Mile Canal	3237D	Dissolved Oxygen and Nutrient
Popash Creek	3240Q	Dissolved Oxygen and Nutrient
S-4 Basin	3246	Dissolved Oxygen and Nutrient
Townsend Canal	3235L	Dissolved Oxygen and Nutrient
Pine Island Sound		
Cape Coral	3240A2	Nutrient

Basin Management Action Plans and Reasonable Assurance Plans

Once a TMDL is determined for the pollutant(s) that impairs a waterbody, FDEP develops a Basin Management Action Plan (BMAP) with local stakeholders. BMAPs outline the specific actions that will be taken to reduce a pollutant's concentration to meet its TMDL threshold. BMAPs can include "permit limits on wastewater facilities, urban and agricultural best management practices (BMPs), conservation programs, financial assistance and revenue generating activities, etc." However, if an impaired waterbody already has programs being implemented that will reduce pollutant discharges, FDEP will assist stakeholders in developing a Reasonable Assurance Plan (RAP), and the specific waterbody will neither receive a TMDL or BMAP. These waterbodies are listed in Category 4b.[296] Table 7.7.-c is the list of ongoing BMAPs and RAPs as of 2016 and 2014, respectively. Data was collected from the FDEP Geospatial Database and the FDEP 2016 Integrated Water Quality Assessment Report.[297]

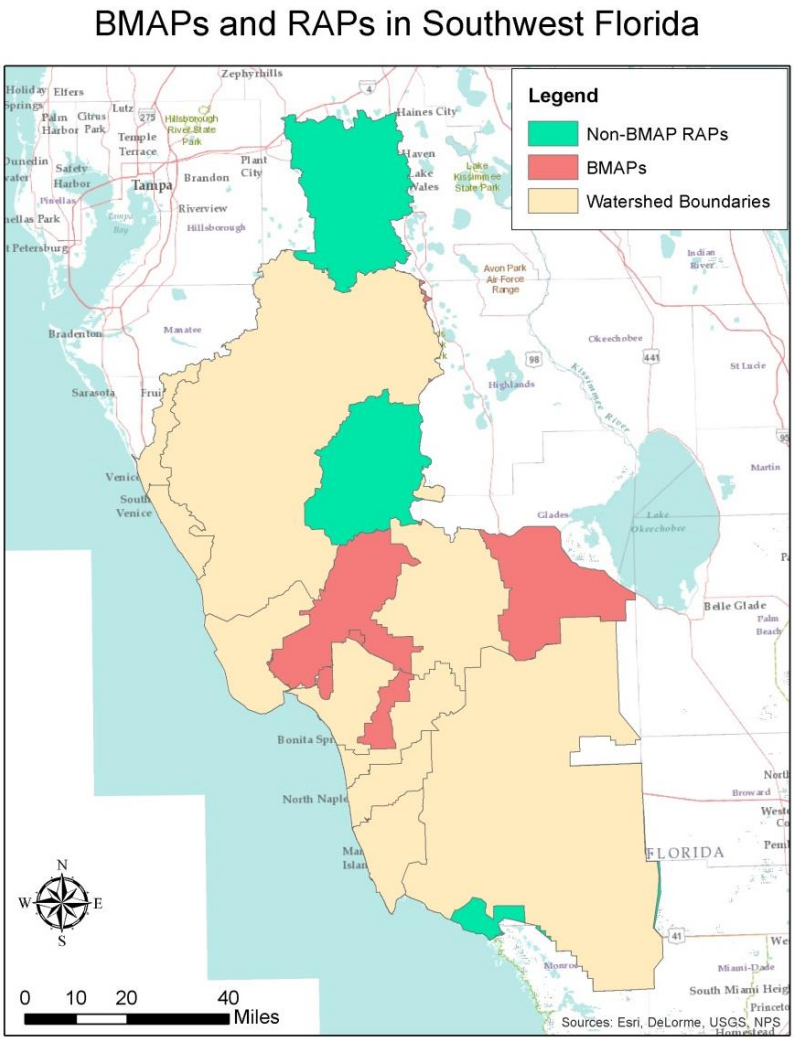


Figure 7.7-b BMAPs and RAPs in Southwest Florida- Map

Category 4e: BMAPs in Southwest Florida

Table 7.7-c BMAPs and RAPs in Southwest Florida

BMAP	Lake Okeechobee Basin	Caloosahatchee Estuary Basin	Everglades West Coast
Watershed	Caloosahatchee River	Caloosahatchee River	Caloosahatchee River/Estero Bay
Adoption Date	12/9/2014	11/27/2012	11/27/2012
Estimated Acres	3,898,203	277,408	55,469
Parameter Impairments	Nutrients (TP)	Nutrients (TN)	Nutrients (TN)
Total Reductions as of 2016	N/A	172,201 lbs/yr	Hendry Creek Basin 6,664 lbs/yr
			Imperial River Basin 3,533 lbs/yr

Category 4b: Non-BMAP RAPs in Southwest Florida

RAP	Shell, Prairie, and Joshua Creeks	Upper Peace River and Winter Haven Lakes
Watershed	Greater Charlotte Harbor	Greater Charlotte Harbor
Adoption Date	02/2004	N/A
Parameter Impairments	Specific Conductance, Chloride, and Total Dissolved Solids[298]	

8 APPENDIX E: Additional Indicators of Estuarine Health

8.1 Extent of Exotic Species Infestation

Exotic species are plants and animals not originally found in an area that have been introduced either intentionally or accidentally by humans. Exotic species are considered to be invasive if they cause damage to the natural environment by spreading and outcompeting for resources such as space, light, and nutrients. Invasive species are inherently exotic, but not all exotic species are invasive.[299] Invasive species threaten the diversity and abundance of native species and can negatively impact human health and the economy. An invasion or infestation of exotic species can indicate poor ecological health of a natural system.[300]

Florida is especially vulnerable to exotic species infestations. The Port of Miami and other international trading centers are hubs of the exotic pet and plant trade. Non-native species can be transported from other areas through ballast water as well as packaging materials.[301] More significantly, the exotic pet trade elicits the unauthorized escape or release of these species by their owners into the wild.[302] Florida also has a large extent of disturbed land that makes it easier for exotic species to become established.[303] Florida's subtropical climate makes it easy for exotics, especially reptiles, to become establish and thrive. Additionally, Florida's peninsular shape isolates it from other land at similar latitudes, preventing species from moving across different areas.[301]

There have been over 400 species of exotic marine and terrestrial wildlife noted in Florida since it was colonized in the 16th century. Of these, about 123 have established populations that are unlikely to be eradicated without human intervention, including 36 reptiles, 22 freshwater fishes, 18 mammals, 12 birds, and 4 amphibians.[301] The cost to control exotic species infestations costs the United States about $137 billion each year and $179 million for Florida's agricultural business alone.[304]

The following is a list of non-native species that are prevalent in the Report Card watersheds.

Brazilian Pepper (*Schinus terebinthifolius*)

Brazilian pepper is native to Brazil, Argentina, and Paraguay and was introduced as an ornamental plant to central and south Florida in the 19th century. It currently occupies over 700,000 acres in Florida, primarily in areas that have been disturbed. It can form dense forests in areas adjacent to mangroves and coasts that prevent other vegetation from growing. The dense forest creates a closed canopy that is light limiting and provides a poor habitat, threatening the survival and persistence of native species. Brazilian pepper can also alter natural fire regimes.[305] Birds and mammals are excellent dispersal agents in transporting Brazilian pepper seeds, which stay viable for up to two months. High germination rates, ease of dispersal, and an aggressive nature make Brazilian pepper a successful invader species.[306, 307]

Figure 8.1-a Photo of Brazillian Pepper

Current Brazilian pepper research/projects:

- The Leaflet Galling Psyllid *Calophya terevinthifolii*, a Candidate BioControl Agent of Brazilian Peppertree (James P. Cuda, Center for Aquatic and Invasive Plants, University of Florida, IFAS - jcuda@ifas.ufl.edu)

Australian pine (*Casuarina equisetifolia*)

Australian pine was introduced to Florida in the 1890s to provide shade and establish windbreaks along canals, roads, and agricultural fields. It can grow in sandy and nutrient-poor soils, easily colonizing disturbed areas such as roadsides, empty lots, and filled wetlands. Australian pine also reproduces rapidly by wind, water, and birds, which aid in dispersing its seeds.[308]

Figure 8.1-b Photo of Australian Pine

Australian pine trees are resistant to salt spray and can establish quickly along beaches where dredge spoil has been left or native vegetation has been destroyed. They produce a dense layer of leaf litter, inhibiting the growth of native tree species. Because of their shallow root systems, Australian pines facilitate beach erosion, as the native vegetation they replace has deeper root systems. They can also uproot during high wind events and obstruct coastal storm evacuation routes. The dense, shallow root system also hinders the ability of the threatened American crocodile and endangered and threatened sea turtles to build nests. Moreover, Australian pines do not provide adequate habitat for native wildlife.[309]

One of the Conservancy's senior biologists, David Addison, along with other scientists, conducted a study on Keewaydin Island to determine if the removal of invasive Australian pine would impact temperature dependent sex determination of loggerhead sea turtle hatchlings. They determined that eliminating Australian pine trees did not have an impact on hatchling sex determination, and therefore removal should continue in order to preserve suitable nesting habitat.[310]

Current Australian pine research/projects:

- *Casuarina equisetifolia*, Australian Pine (Michael G. Andreu, University of Florida – mandreu@ufl.edu. (352) 846-0355)

Figure 8.1-c Photo of Melaleuca Strand

Melaleuca (*Melaleuca quinquenervia*)

Melaleuca was introduced to Florida from Australia and Malaysia in the early 1900s as a commercial timber product, an ornamental tree for landscaping, and a windbreak. It is an evergreen tree that can grow to 65 feet tall and has papery bark. Melaleuca was also planted to dry up the Everglades in an effort to reduce mosquito populations and make room for development. Melaleuca trees can adapt well to disturbances and can grow up to 6 feet per year in disturbed swamps, marshes, and pine flatwoods. If a melaleuca tree is damaged so that water cannot reach the seed capsules (i.e., fires and freezes), seeds will be released. One tree can house from 2 to 20 million seeds, and these seeds can remain viable for up to ten years.[311]

Melaleuca is highly invasive, rapidly replacing native cypress and sawgrass in the Everglades. Once it moves into an area, it forms dense stands in previously unforested areas that are poor habitat for native wildlife and it disturbs natural water flows. Additionally, melaleuca stands alter the natural fire regime because of oils in the leaves that create hot crown fires. Hot crown fires threaten nearby developed areas and cause the native vegetation in the area to experience increased mortality.[311]

Current melaleuca research/projects:

- The Area-wide Management and Evaluation of *Melaleuca quinquenervia* (TAME Melaleuca) – Paul Pratt, USDA/ARS Invasive Plant Research Laboratory – paul.pratt@ars.usda.gov. (954) 475-6549)
- Litter Cover of the Invasive Tree *Melaleuca quinquenervia* Influences Seedling Emergence and Survival (Min B. Rayamajhi, USDA/ARS Invasive Plant Research Laboratory – min.rayamajhi@ars.usda.gov. (954) 475-6552)
- Florida's Established Arthropod Weed Biological Control Agents and Their Targets (James P. Cuda, University of Florida - jcuda@ufl.edu. (352) 392-1901)

Asian Green Mussel (*Perna viridis*) [312]

Figure 8.1-d Asian Green Mussel

Asian green mussels were first observed in Tampa Bay in 1999 after having been introduced to the Gulf of Mexico in the 1990s from the Indian and Pacific Oceans. Most likely, they were introduced as larvae via ship ballast water released into Gulf after being transported from their native range. They spread to Charlotte Harbor by 2000 and the Ten Thousand Islands by 2002. The Asian green mussel has a bright green shell and can grow to over six inches long.[313] The larvae are planktonic and are reproductively mature at only two to three months old.[314]

Upon their introduction, Asian green mussels out competed native species for space and were often not eaten by native predators. This allowed them to spread in the waters around Florida and as far north as Charleston, South Carolina. Asian green mussels attach to solid, submerged surfaces such as pipes, rocks, muddy bottoms, boat hulls, and buoys. They can attach to these structures in large masses, creating problems such as clogged intake pipes, restricted water flow to hatcheries and power plants, sunken buoys, and ruined boat hulls and propellers. Because green mussels out compete native mussels and grow at rapidly, they sustain considerable population numbers in Florida waters. This is potentially

detrimental to native mollusks such as the eastern oyster (*Crassostrea virginica*). Consequently, this can cause a decline in the abundance of fishes and crabs that feed on native bivalves.[313]

There are documented sightings of Asian green mussels in all ten watersheds included in this report. To help prevent the spread, boaters can inspect their boat hulls and remove any green mussels that have attached. Asian green mussels are known to accumulate toxins and harmful plankton, posing a threat for future harvesting as a management tool. Continued monitoring and research is necessary to determine its potential as an estuarine health indicator to identify strategies to control and manage its persistence and spread.[314]

Recently completed Asian green mussel research/projects:

- Temperature, Salinity, and Aerial Exposure Tolerance of the Invasive Mussel, *Perna viridis*, in Estuarine Habitats: Implications for Spread and Competition with Native Oysters, *Crassostrea virginica* (Katherine McFarland, Florida Gulf Coast University

Wild Hogs and Boar (*Sus scrofa*)

Wild hogs are suspected to have been introduced to southwest Florida as early as 1539 by Hernando de Soto when he established a settlement in the Charlotte Harbor area. Since then, the population has grown tremendously as a result of hogs escaping captivity or being deliberately released to improve hunting opportunities.[315] There are between 500,000 and one million wild hogs in Florida alone, with a reported population estimate of about 6.3 million across the United States.[316, 317]

Figure 8.1-e Photo of Wild Hog

There are several negative impacts associated with wild hog infestations. They are opportunistic feeders, eating almost anything depending on availability. Their favorite food is acorns, but when acorns are scarce wild hogs will eat agricultural crops, livestock feed, and tree seedlings. When they eat tree seedlings and seeds, the hogs damage farms and forests, especially in areas where long-leaf pines are native and sparse. They even can eat ground-nesting species including sea turtles, mammals, and

birds, as well as smaller livestock including chicken, goats, and lambs.[315] Wild hogs have been linked to the decline of more than 26 species of plants and animals listed as of special concern, rare, threatened, or endangered.[318] Wild hogs compete with deer, turkey, and squirrels for the same food sources, further threatening native species' survival. Furthermore, wild hogs exhibit rooting behavior, or the digging for food underground. This uproots and weakens native vegetation and causes soil erosion. Their wallowing behavior destroys stream banks and ponds, degrading water quality. Boars also scrape off the outside bark of a tree with their tusks to display dominance. Hogs also carry various diseases including pseudorabies, brucellosis, tuberculosis, and many others. [315] An outbreak of pseudorabies in Florida panthers was likely caused by the panthers consuming infected wild hogs.[318] Millions of dollars are spent every year to combat damage done by wild hogs and to protect livestock.[315]

The Conservancy's senior biologist, David Addison, along with other scientists, conducted a study on Keewaydin Island that examined the impact of feral swine and their removal on nesting marine turtles. The study concluded that caging sea turtle nests did not prevent destruction by wild hogs, but the median time of egg survival was longer for caged nests than for uncaged nests. Because wild hogs still inhabit Keewaydin Island, Conservancy staff continues to remove hatched eggs, unviable eggs, and dead hatchlings from nests during surveys to disassociate sea turtle nests as a food source for wild hogs.[319]

Current wild hog and boar research/projects:

- Environmental Impacts of Feral Swine in Rangelands of South Florida (Samantha Wisely, University of Florida – wisely@ufl.edu. (352) 846-0645)
- Fine-scale, Spatial and Temporal Assessment Methods for Feral Swine Disturbances to Sensitive Plant Communities in South-central Florida (Rodney K. Felix, Jr., USDA/National Wildlife Research Center – Rodney.felix.1@us.af.mil. (352) 375-2229)

Cuban Tree Frog (*Osteopilus septentrionalis*)

Cuban tree frogs are native to Cuba, the Bahamas, and the Cayman Islands and were introduced to the Florida Keys in the 1920s, most likely arriving in shipping crates. They are the largest species of tree frog in Florida, ranging from one to four inches long, with adult females sometimes exceeding six inches. Their coloration can vary from brown to green and can sometimes be difficult to distinguish from native tree frogs.[320, 321]

Figure 8.1-f Photos of Cuban Tree Frogs

Several negative impacts have been associated with the invasion of Cuban tree frogs in Florida. Because they can survive in both urban and natural areas, they are known to eat native tree frogs such as the squirrel tree frog (*Hyla squirella*) and the green tree frog (*Hyla cinerea*), causing a decline in their populations. They also secrete a sticky substance from their skin that makes them unappealing to predators. Additionally, Cuban tree frogs are notorious for causing electrical short-circuits by entering transformer boxes and damaging electrical switches. They can also cause other economic harm by damaging air conditioning units and electric water pump housings.[320]

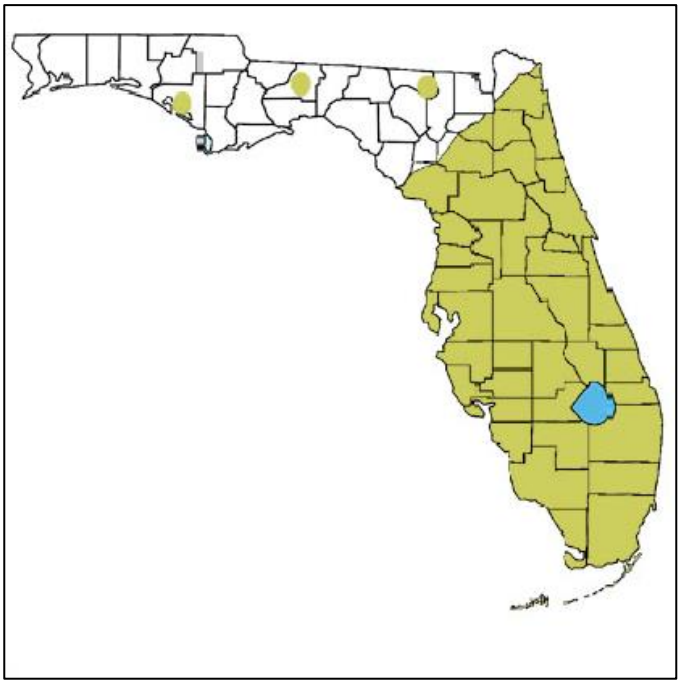


Figure 8.1-g Current Range of the Cuban Tree Frog in Florida

There are several ongoing efforts to monitor the status of the Cuban tree frog infestation. The University of Florida has mapped the extent of the Cuban tree frog in Florida (Figure 8.1-g). The Conservancy conducted a biological monitoring study of aquatic and terrestrial fauna in the Picayune Strand from 2005 to 2007 and found that the Cuban tree frog was the dominant anuran species in the Ten Thousand Islands watershed.[322]

Current Cuban tree frog research/projects:

- Southwest Florida Amphibian Monitoring Network (John Cassani, jcassani@comcast.net. (239) 633-7274)
- Citizen Science Cuban Tree Frog Management (Dr. Steven Johnson, University of Florida, tadpole@ufl.edu. (352) 846-0557)

Burmese Python (*Python molurus*)

Burmese pythons are native to Southeast Asia but have an established population in south Florida with documented sightings as early as the 1980s. These pythons were once a popular species in the exotic pet trade due to their large size and seemingly docile nature.[323] Burmese pythons are tan with dark blotches that fit together like puzzle pieces, similar to the markings of a giraffe. The head is pyramid shaped with an arrowhead shape extending toward the nose. They are semi-aquatic and are great climbers, as well.[323] According to the U.S. Fish and Wildlife Service, about 99,000 Burmese pythons were imported to the United States between 1996 and 2006. They used to be sold for just 20 dollars at a local flea market or pet store.[324] Now they can no longer be acquired as pets or transported into Florida under the Lacey Act. Burmese pythons are one of the largest snake species in the world, with reports of individuals captured in Florida being over 17 feet long. They were likely introduced to the wild both intentionally and accidentally as escapees or as released pets that became too demanding to feed and grew too large.[323,325]

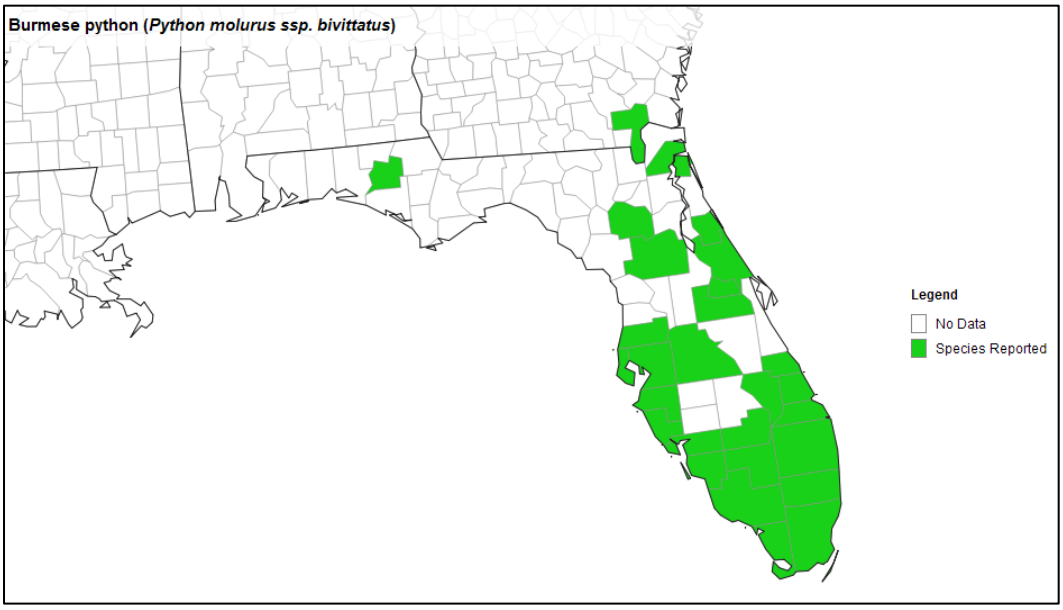


Figure 8.1-h Reported Sightings of Burmese Pythons by County

Burmese pythons have several negative impacts on native wildlife. They prey on several different wildlife species, including deer, bobcats, rabbits, rodents, Key Largo wood rats, alligators, wood storks, white ibises, limpkins, and others. Because pythons are a new addition to the south Floridan environment, they disrupt the natural food web and impact the natural ecosystem. Burmese pythons also out compete full-grown native snakes due to their large size, taking over their habitat and prey. Harmful impacts are expected to increase as Burmese pythons are confirmed to be reproducing in the wild, with females carrying up to 50 eggs at a time. More research is being conducted to further determine the python's impact on native wildlife and ecosystems.[326,323] Scientists at the Conservancy of Southwest Florida have been collaborating with a wide variety of federal and state agencies, and partners to conduct research on the biology and control of invasive reptiles in Florida. The objective of

the project is to conduct radiotelemetric fieldwork to develop a database of movement behavior and habitat use of invasive Burmese pythons in Southwest Florida. This information will be used to develop a management strategy for this invasive reptile. Over the course of four breeding seasons, the Conservancy's wildlife biologists have removed more than 6,500 pounds of python and more than 3,000 developing python eggs from the local ecosystem.

Figure 8.1-i Photo of Burmese Python

Current Burmese python research/projects:

- Radio-telemetric Study of Burmese Pythons in Southwest Florida (Ian Bartoszek, Conservancy of Southwest Florida, ianb@conservancy.org, (239) 262-0304)
- Marsh Rabbit Mortalities Tie Pythons to the Precipitous Decline of Mammals in the Everglades (Robert A. McCleery, University of Florida, ramccleery@ufl.edu. (352) 846-0566)
- Radiotelemetry and Control of Burmese Pythons (Dr. Frank Mazzotti, University of Florida, fjma@ufl.edu. (954) 577-6304)

Other Exotic Species

Lionfish (*Pterois volitans*) are native throughout the western Pacific and were first sighted in Florida in 1985 near Dania Beach on the Atlantic Coast. Since then, lionfish have become an established invader along the Atlantic Coast, throughout the Caribbean Sea, and in the Gulf of Mexico.[327,328] Lionfish are voracious predators and can inhabit diverse marine environments including reefs, mangroves, seagrasses, mudflats, canals, docks, and shipwrecks.[329] In some areas, they have reduced native fish populations by up to 90 percent. However, there are no predators in its invasive range, and native predators are even known to avoid the lionfish.[330] Although lionfish are a marine species, a recent study found that they can tolerate a wide range of salinity and therefore have the ability to colonize estuaries.[331] Efforts to remove lionfish from their current invaded range are crucial in preventing the spread into Florida's estuaries.[332] Lionfish can safely be removed from marine waters using hand-held nets, hook and line, or spears. However, people should be careful when handling lionfish because their venomous spines can cause painful injuries to people, even after the fish is dead.[333]

Cane toads (*Rhinella marina*) also known as marine toads or giant toads, were introduced to southern Florida by an accidental release of about 100 individuals from the Miami airport by a pet trader in 1955. They are aggressive predators that eat native frogs, toads, and even pet food. Cane toads are a serious threat to native wildlife, domestic animals, and humans due to their ability to secrete a highly toxic substance when threatened.[334] Cane toads were first observed on Sanibel Island in 2010 and, as of 2013, there is a confirmed breeding population there. It is vital to remove individuals from the relatively isolated island of Sanibel before the population spreads to other areas of southwest Florida.[335]

Nile monitors (*Varanus niloticus*) are native to Africa and are thought to have been introduced to Florida by accidental or intentional pet release. They can grow to over six feet and are voracious carnivores, eating any available prey, including both wildlife and pets. There is an established population of Nile monitors in the City of Cape Coral, where they pose a threat to native wildlife. They prey on individuals and eggs of species such as burrowing owls, ground-nesting birds, gopher tortoises, and alligators. Nile monitors thrive in the man-made canal system that sustains Cape Coral and have the potential to expand their range. The City of Cape Coral Environmental Resources Division and the University of Tampa have teamed up to trap and remove Nile monitors from the city in an effort to control the population and prevent its spread to other areas.[336]

There are also established population of iguanas in southwest Florida, including the black spiny-tailed iguana (*Ctenosaura similis*) and the green iguana (*Iguana iguana*). They were introduced to the wild via intentional or accidental releases associate with the pet trade. South Florida's subtropical climate is perfect for the survival of iguanas, and the extensive herbaceous food supply allows them to reproduce prolifically. Iguanas can cause damage to landscapes by eating trees, shrubs, plants, flowers, berries, and other fruits. Iguanas that burrow next to seawalls can cause soil erosion potentially resulting in their collapse. They also have sharp claws and teeth and are a possible source of salmonella. There are several methods for removal of individuals, and efforts must continue to control their population.[337]

Extent of Exotic Species Conclusion

Not all of the aforementioned exotic species are restricted to the watersheds included in this report, and management efforts may be required regionally or state-wide. The South Florida Water Management District and the Southwest Florida Water Management District include exotic plant species in their Florida Land Use and Cover Classification System (FLUCCS) data sets. However, the water management districts only record coverage of Brazilian pepper, Australian pine, and melaleuca, and use broad classifications. This, in addition to the fact that land cover was mostly recorded using aerial photography, would not make the data set useful in determining the true extent of exotic plant species. Furthermore, there is no documented comprehensive report for exotic animal species that would be a useful tool in determining the impacts that invasive animals have on Florida's natural environment.

The extent of exotic species invasions can serve as an indicator of ecosystem health. The presence and degree of infestation of exotic species impacts the natural environment in ways that alter its structure and function. Impacts include loss of biodiversity, alteration of natural food webs, degradation of natural resources, competition with native species, and threats to economic and human health. New

technologies have improved scientists' abilities to research and implement techniques to combat, monitor, and control invasive species.[338]

Current invasive species monitoring projects:

- The Florida Invasive Species Partnership (FISP) is an interagency collaboration effort to manage exotic non-native species in Florida. FISP facilitates communication among federal, state, and local agencies as well as non-governmental organizations to protect Florida's natural environment and reduce the threat of invasive species. FISP supports Cooperative Invasive Species Management Areas—groups of stakeholders that work towards managing regional invasive species.
- Early Detection and Distribution Mapping System (EDDMapS) is a web-based mapping tool that documents the distribution and spread of invasive species nationwide. It uses the technique of early detection and rapid response that is critical in invasive species management and also encourages public participation to help reduce damage to the environment and human welfare.

8.2 Extent of Submerged Aquatic Vegetation Remaining

Submerged aquatic vegetation (SAV) are flowering plants that grow immersed in coastal marine water and provides several important functions for estuarine environments. SAV provides shelter, habitat, nursery areas, and food sources for fishes, crustaceans, mollusks, microbes, sea turtles, and manatees. SAV also provides shoreline protection by absorbing wave energy, thereby mitigating impacts on the shore. SAV vertical and horizontal roots and rhizomes stabilize sediments, preventing erosion and damage from storm events. Additionally, seagrasses sustain water clarity by trapping particles and nutrients stirred up by wind and wave energy. Finally, SAV use photosynthesis to sequester carbon from the atmosphere and add dissolved oxygen to the water.[339]

In addition to providing several important ecosystem functions, SAV is an indicator for coastal ecosystem status and health. Seagrasses are sensitive to changes in water quality parameters such as salinity, light penetration, turbidity, and pollution. SAV requires clear water so that light is able to penetrate the water column and reach the submerged seagrass blades. If there is a decline in water quality, seagrasses can exhibit increased epiphyte loading, low shoot density, and other symptoms related to increased light attenuation. Dredging for navigation purposes stirs up sediment and other particles in the water that increase turbidity, inhibiting sunlight penetration and subsequent seagrass growth.[340] Excess nutrients from stormwater and pollution runoff can fuel growth of phytoplankton and stimulate algal blooms, further reducing the light that can reach SAV. Additionally, if low salinity conditions exist for an extended period of time due to increased freshwater inflows during Florida's wet season, SAV health will likely suffer.[341] Seagrasses are also known to bioaccumulate toxins such as herbicides, pesticides, and heavy metals. An increase in toxin accumulation in SAV may indicate that runoff from non-point pollution sources is a problem in a particular estuary.[342]

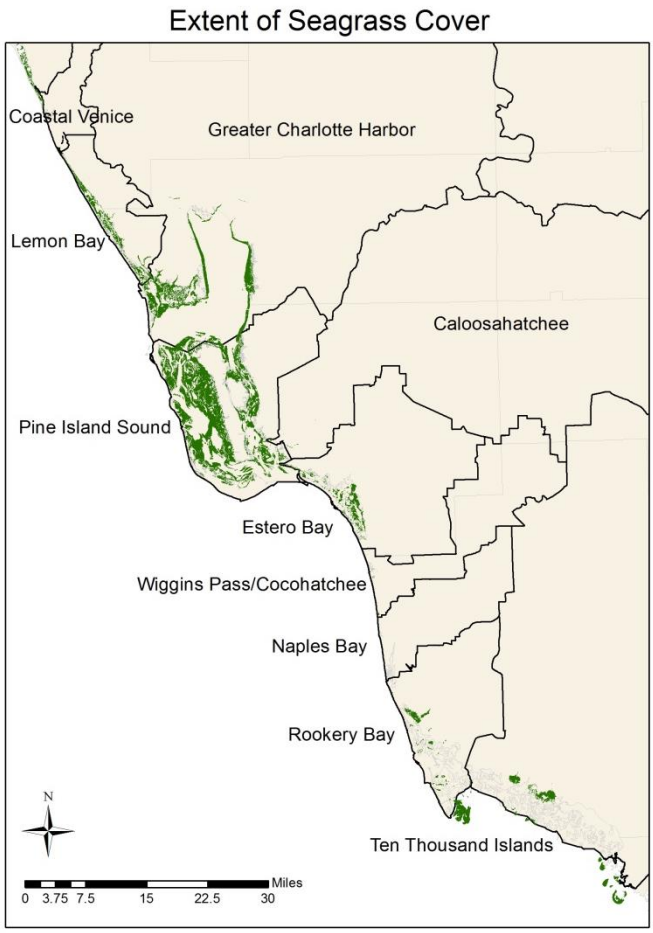


Figure 8.2-a Extent of Seagrass Cover in the Ten Watersheds

The Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission has (FWC) created a GIS data set of statewide seagrass using a variety of source agencies' data from 1987 to

2010. This data set represents the most recently available extent of continuous and patchy seagrasses mapped using photography and field measurements. The available area of seagrass in the 10 estuaries in this report is shown in Fig. 8.2-a above. Naples Bay in particular has seen a 90 percent loss of seagrass since the 1950s due to increased nutrients, increased turbidity and sediment loading from dredging and boat wakes, and increased freshwater inputs.[343] The acreage of continuous and patchy seagrasses for each watershed of this report was calculated using the FWC data set and summarized in Table 8.2-a below.

The lack of consistent historic data is a constraint of using seagrass coverage as an indicator for ecosystem health across the ten watersheds. Florida's statewide seagrasses have not yet been fully mapped, so the data set used for this analysis represents the area of available seagrass coverage. Seagrass has also not been mapped to a consistent depth or distance offshore. Additionally, there are gaps in data in areas that were inaccessible for field measurement collection or that could not be captured by aerial photography.[344]

Table 8.2-a Current Area (Acres) of Continuous and Patchy Seagrass in the Ten Watersheds

Watershed	Continuous Seagrass	Patchy Seagrass	Total Seagrass
Coastal Venice	37	65	102
Lemon Bay	2,909	1,297	4,206
Greater Charlotte Harbor	10,292	5,767	16,059
Pine Island Sound	36,778	5,002	41,780
Caloosahatchee	3	78	81
Estero Bay	3,266	359	3,625
Wiggins Pass/Cocohatchee	15	54	69
Naples Bay	0	0	0
Rookery Bay	5	1,803	1,808
Ten Thousand Islands	0	2,303	2,303

8.3 Harmful Algal Blooms, Red Tide, Fish Kills, and Beach Advisories

Prevalence of Harmful Algal Blooms, including Red Tide

Harmful Algal Blooms (HABs) are the rapid proliferation and accumulation of a toxic or nuisance algae resulting from a combination of biological, chemical, and physical changes in a waterbody system. They are associated with negative effects on human and aquatic health. HABs most commonly occur in coastal marine ecosystems but can occur in the open ocean, brackish water, or freshwater. They are usually caused by microscopic algae or phytoplankton, such as cyanobacteria (blue-green algae), diatoms, and flagellates. The introduction or excessive input of nutrients from sewage, groundwater inputs, and agricultural runoff entering the waterbody fuel HABs.[345]

There are several negative impacts associated with HABS. HABs degrade water quality, increase threats to human health, and destroy fisheries. They produce harmful neurotoxins that cause disease and death in marine life including, fish, seabirds, dolphins, sea turtles, and manatees. The neurotoxins can also cause gastrointestinal, respiratory, neurological, and cognitive illnesses in humans.[346] The massive increase in photosynthetic activity of the algae depletes dissolved inorganic carbon and raises pH to dangerous levels. The increase in algal biomass limits the light that reaches the littoral zone, limiting plant growth and inhibiting predators' ability to pursue and catch prey. Eventually, the algal blooms die, turning the water into a hypoxic or anoxic zone with insufficient amounts of dissolved oxygen to support aquatic plant and animal life.[347] HABs do not always remain as isolated events, as eddies can transport nutrients from open ocean waters to near-shore waters, especially in the case of the dinoflagellate *Karenia brevis,* a common cause of HABs along the coast in southwest Florida. HABs are also known to cause amnesic shellfish poisoning (ASP) syndrome. Filter feeders such as oysters, mussels, and clams consume *K. brevis,* concentrating the toxin that is then transferred to the people eating them. An ASP outbreak caused over one hundred illnesses and several deaths in 1987.[345], [348]

Figure 8.3-a Red Tide off the Coast of Sanibel

Massive HABs caused by *K. brevis* are known as red tides because, in high concentrations, the algae make the water appear a reddish-brown color. Red tides are a nearly annual occurrence along Florida's gulf coast.[349] Brevetoxins, a type of neurotoxin produced by *K. brevis,* can be carried by the air from the beach causing respiratory irritation for inland residents, especially those with preexisting respiratory problems such as asthma.[346] *K. brevis* blooms originate offshore, proliferating from both organic and inorganic nutrients. However, once the bloom is carried inshore, anthropogenically introduced nutrients from stormwater and fertilizer runoff can contribute to the severity and duration of red tide events.[350] A recent study published in the journal *Harmful Algae* has identified twelve sources of nutrients in southwest Florida that feed red tide, including estuary water carrying excess nutrients from anthropogenic sources, in addition to naturally occurring nutrient sources.[351] Local fertilizer ordinances are being more widely implemented to control water pollution through local policy. The ordinances institute best management practices (BMPs) to reduce the amount of nutrients entering local waterbodies. Implementation of BMPs helps local governments comply with total maximum daily load (TMDL) limits and meet applicable water quality standards.[352]

Cyanobacteria are the most prevalent phytoplankton associated with HABs in freshwater ecosystems.[353] Because cyanobacterial HABs occur in freshwater, they threaten the health of water sources for drinking, fishing, recreation, and irrigation.[354] They often occur from overloading of nutrients such as nitrogen and phosphorus from urban, agricultural, and industrial sources. The increase in anthropogenic nutrient loading combined with vertical stratification, increasing temperatures, and increasing residence time promote cyanobacteria persistence and dominance in a variety of aquatic environments. Once it is established, the bloom may persist for extended periods of time, even after nutrient levels have decreased.[355]

Figure 8.3-b Algal Bloom in the Caloosahatchee River

The most recent ride tide event in southwest Florida began in the end of September through December 2016. It impacted shores in Charlotte, Lee, and Collier counties and led to several fish kills.[356]

Current Research/Projects

- HAB Monitoring Database (Fish and Wildlife Research Institute (FWRI), Florida Fish and Wildlife Conservation Commission (FWC))
- Red Tide Current Status Statewide Information and Database (FWC)
- Harmful Algal Bloom Operational Forecast System (HAB-OFS) (National Oceanic and Atmospheric Administration (NOAA))

- Investigating the occurrence, persistence and adverse effects of red tide neurotoxins in water, air and marine organisms (PI R. Pierce, Mote Marine Laboratory and Aquarium Cooperative program with FWRI, FWC)
- Time-series sampling in Pinellas and Manatee Counties (FWRI, FWC)
- Swimming behavior of the Florida red tide (Matt Garrett, FWRI, FWC, matt.garrett@myFWC.com)
- Evaluation of rapid brevetoxin tests for use in shellfish regulation, the shellfish industry, and aquaculture (Leanne Flewelling, FWC, leanne.flewelling@myFWC.com)

Prevalence of Documented Fish Kills

A fish kill is a sudden, localized mortality event of fish populations due to a natural or artificial change in the waterbody condition.[357] FWC operates a database that records fish kills in Florida. There were 889 recorded cases of fish kills between 01/01/2011 and 10/25/2016 in Charlotte, Collier, DeSoto, Glades, Hardee, Hendry, Lee, Manatee, Polk, and Sarasota counties, the counties in which the study watersheds occur (Figure 8.3-d). The suspected causes for these fish kills were algae blooms, low dissolved oxygen concentrations, pollution, and red tide events. Sarasota County had the highest reported number of fish kills with 215 events, followed by Lee County with 179 events.

Figure 8.3-c A pile of dead fish from a die-off at Delnor-Wiggins Pass State Park in October 2012

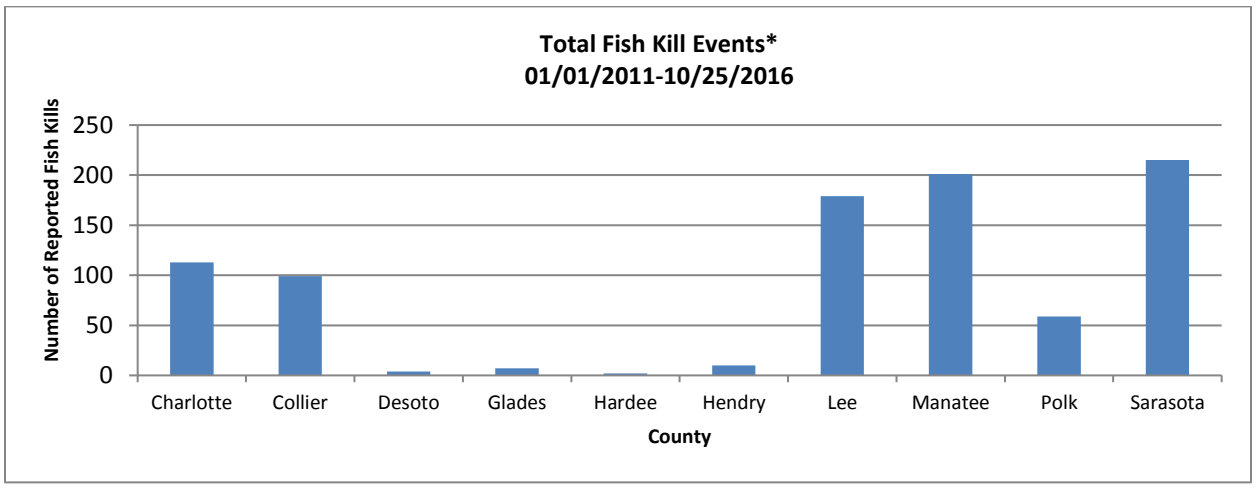


Figure 8.3-d Total Fish Kill Events, *with the following probable causes: algae blooms, low DO, pollution, and red tide

FWC also records monthly fish kill data and creates maps to illustrate location and type of event. They include fish kills, diseased/lesioned fish, and other events. Reported fish kills for August 2016 are represented in Figure 8.3-e.[358]

The most recent wave of fish kills occurred in Pinellas, Manatee, Sarasota, Charlotte, Lee and Collier counties in October 2016 and resulted from a red tide bloom that quickly expanded after Hurricane Matthew.[359]

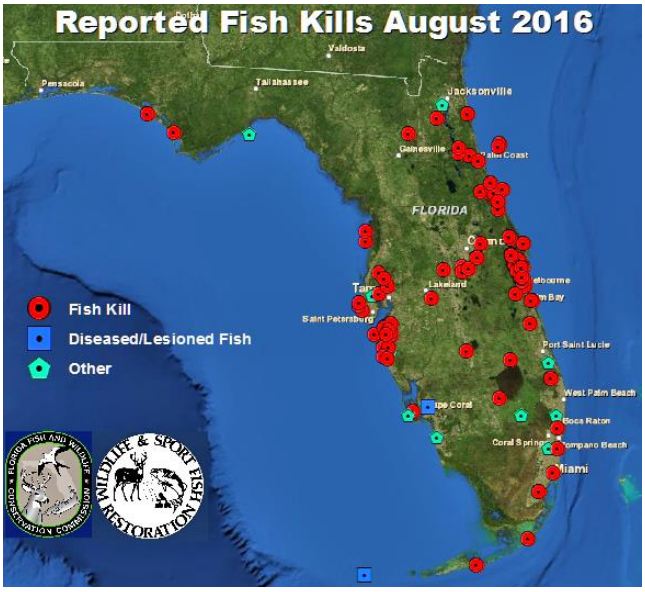


Figure 8.3-e FWC Reports of FIsh Kills August 2016

Current fish kill research/projects:

- Florida Fish and Wildlife Conservation Commission (FWC) fish kill database and kill maps http://myfwc.com/research/saltwater/health/fish-kills-hotline/

Prevalence of Beach Advisories and Closures

Beach advisories and closures are attributed to increased nutrients and harmful substances in coastal waters. The poor water quality responsible for beach advisories and closures is often linked to stormwater runoff with high levels of bacteria.[360] The U.S. Environmental Protection Agency (EPA) estimates that over 10 trillion gallons of untreated stormwater enter surface waters every year. Because this is mostly undetected, EPA projects that close to 3.5 million people fall ill from contact with the untreated water. Illnesses connected with coming into contact with sewerage overflows include stomach viruses, pink eye, skin rashes and irritation, respiratory infections, hepatitis, and meningitis.[361] *Enterococcus* is used as the primary fecal indicator bacterium (FIB) because of its historic association with negative health effects in recreational waters impacted by point source pollution. The degree of contamination can vary spatially and temporally, so testing at different water depths, distances from shore, and times of day is essential for representative and accurate measurements.[362]

In 2000, Congress enacted the Beaches Environmental Assessment and Coastal Health (BEACH) Act that strengthened the Clean Water Act in regards to recreational water quality. The BEACH Act promoted accurate, timely, and cost-effective modelling and analysis of harmful pathogens in recreational waters.[363] EPA has developed Beach Action Values (BAVs) to assess beach swimmer health and safety. The BAV system is used as a precautionary target to make decisions about swimmer safety and communicate the best information to the public regarding public health and beach water quality.[357]

EPA revised its criteria for monitoring FIB in 2012. Previously, EPA had been using recreational water quality criteria (RWQC) recommendation standards developed in 1986. The updated RWQC recommendations now meet the requirements set by the BEACH Act that EPA research and publicize associations between pathogens and human health. They address all coastal and non-coastal waters designated for human contact and recreational use by focusing on magnitude, duration, and frequency of the bacteria presence.[364] Before the EPA revised the criteria in 2012, the approved methodologies for FIB monitoring took about 18–24 hours to produce sample test results. Because of the time lag between sampling and results, beach advisories and closures were often issued several hours to days after beach goers had already been exposed to the harmful water. The new tests can produce results in three hours or less.[365]

In addition to federal recreational water quality protection, there are also measures put in place by the state of Florida. The Florida Department of Health (FDOH) administers the Florida Healthy Beaches Program that works to ensure all 34 coastal counties of Florida take beach water samples every week and report beach advisories. The FDOH does not have the authority to close beaches and can only issue advisories and warnings when bacterial levels exceed certain thresholds. Advisories are issued in regards to enterococci levels and warnings are issued for fecal coliform levels, another FIB. Human health advisories and warnings are only declared when two samples in a row exceed the thresholds.[355] In 2013, Florida reported a total of 636 coastal beaches (Table 8.3-a). Of the reported beaches, only 10% exceeded the BAV for enterococci.[357] None of these beaches are located in the watersheds included in this Report Card.

Table 8.3-a Florida Healthy Beaches Program Beach Statuses

Beach Quality	Average Enterococci count (per 100 mL)
Good	0- 35
Moderate	36- 70
Poor	71+

The Natural Resources Defense Council publishes a *Testing the Waters* Annual Report that compiles all advisories and warnings for beaches by state. Beach advisory and closing data for this report were used from the 2014 *Testing the Waters* Report in addition to FDOH's Florida Healthy Beaches Program and the EPA's Beach Advisory and Closing Online Notification system. For this Report Card, beaches that experienced advisories and warnings were categorized by watershed for analysis. Fig. 8.3-f illustrates the number of advisory/closure days from 2011 to 2014, with levels being the highest in 2011 and lowest in 2014. Although there were no beach advisories in 2014, southwest Florida does continue to have them as a result of high bacteria levels. A recent example was in October 2015 at Sanibel's Blind Pass Beach in Lee County, where sections of beach contained high levels of both enterococci and fecal coliform.[366]

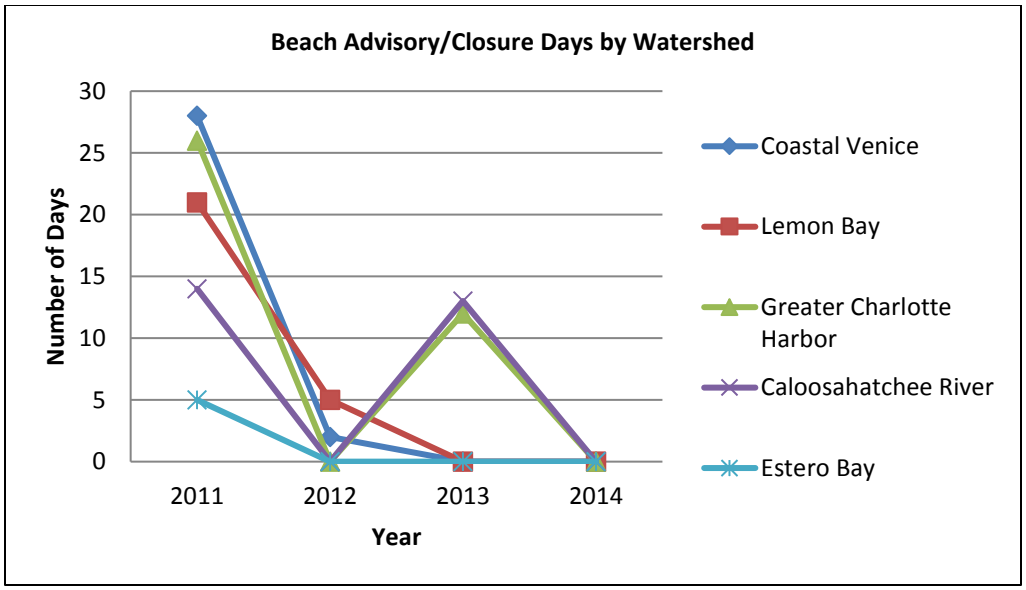


Figure 8.3-f Number of Beach Advisory/ Closure Days by Watershed

Current beach closure and advisories research/projects

- Florida Healthy Beaches Program (Florida Department of Health (DOH) – http://www.floridahealth.gov/environmental-health/beach-water-quality/
- Testing the Waters, Annual Report (Natural Resources Defense Council - https://www.nrdc.org/sites/default/files/ttw2014.pdf)
- Beach Advisory and Closing Online Notification (BEACON) 2.0 system (Environmental Protection Agency (EPA) - http://watersgeo.epa.gov/beacon2/reports.html#)

8.4 Pesticide Prevalence

Pesticides are chemicals used to eliminate or mitigate specific pests that humans find problematic and include insecticides, herbicides, and fungicides.[367] Although many find pest elimination beneficial, pesticides also pose several human health and environmental concerns. All forms of pesticides, even organic forms, contain toxic compounds in order to be effective.[368] Pesticides especially pose a concern for aquatic ecosystems and are harmful to organisms in fragile estuarine environments. Animals may die from directly ingesting the pesticide or eating an animal that died from pesticide poisoning. Pesticides residues may also accumulate within living tissue and within a food web, so chronic exposure may also impact organisms.[369] Pesticide pollution has also caused fish kills throughout the country.[370,371] Pesticide pollution is also difficult to control in waterways because, as non-point source pollution, pesticides enter water resources from various places through surface runoff. Common sources of pesticide pollution include agriculture, golf courses, and lawn maintenance.[372]

At the national level, pesticide use is regulated by the US Environmental Protection Agency (EPA) and must comply with the Federal Insecticide, Fungicide, and Rodenticide Act.[373] EPA reviews pesticides to determine their degree of impact on human health and the environment. EPA has banned many pesticides over time due to environmental impacts that stem from their use, and species under the Endangered Species Act are also protected from pesticide use.[370]

In Florida, pesticide use is regulated by the Florida Department of Environmental Protection (FDEP) and the Florida Department of Agriculture and Consumer Services (FDACS). Pesticide users must register products with FDACS.[374] Agricultural operations and golf courses minimize pesticide pollution by implementing Best Management Practices (BMPs), which are enforced by FDEP, FDACS, and university or agricultural professional associations.[375] Florida also has a program to aide pesticide users properly dispose of pesticides that are canceled or suspended through Operation Cleansweep. The state has provided funds for Operation Cleansweep since its 1996 pilot program (excluding the years between 2010 and 2013).[376] However, pesticide water quality monitoring is generally insufficient throughout the southwest Florida region, and it is therefore difficult to determine the impact of pesticides on estuaries and associated watersheds.

States are expected to comply with the EPA's pesticide recommended criteria, and they are also allowed to pass stricter recommendations or expand on the EPA's recommendations.[373] After the 2015 Triennial Review of State Water Quality Standards, FDEP adopted standards for three pesticides that were not previously regulated: carbaryl, chlorpyrifos, and diazinon.[377] EPA classifies these pesticides as non-priority pollutants, but it has established recommended criteria for each of them.[378]

Carbaryl, commonly known as Sevin, is an insecticide and molluscicide that is used to control insects, snails, and slugs. It is also used in orchards to thin fruits. Although carbaryl is widely used in Florida, the compound is toxic to fishes, aquatic-phase amphibians, and freshwater invertebrates. Carbaryl is the second most frequently documented pesticide found in water and is detected in 50% of the country's

urban streams.[379] FDEP has adopted state freshwater criterion for carbaryl based on the EPA 2012 criteria. [377, 378]

Chlorpyrifos is a common mosquitocide in Florida and has a wide range of uses such as protecting food and feed crops, golf course turf, green houses, non-structural wood treatments, and bait stations. The only allowed residential use of chlorpyrifos is for roach bait station products. FDEP adopted the EPA-recommended criteria for the compound established in 1986.[377]

The insecticide diazinon is regularly used to control insects, acarians, and spiders. Although it became illegal in 2004 to sell diazinon products for residential use, diazinon is still legal for non-residential uses, including agriculture. FDEP has adopted the most recent EPA recommendations established in 2005. [420]

Table 8.4-a is a summary of the water quality standards adopted by the FDEP for carbaryl, chlorpyrifos, and diazinon in 2015.[380]

Table 8.4-a 2015 FDEP Water Quality Criteria for Carbaryl, Chlorpyrifos, and Diazinon

Pesticide	Organisms that are controlled	Class I Freshwater Criteria (µg/L)	Class II Saltwater Criteria (µg/L)	Class III Freshwater Criteria (µg/L)	Class III Saltwater Criteria (µg/L)
Carbaryl	Insects, snails, slugs, thins fruit	2.1	-	-	-
Chlorpyrifos	Mosquitos, roaches	0.041	0.0056	0.041	0.0056
Diazinon	Insects, acarians, spiders	0.17	0.82	0.17	0.82

EPA is currently conducting a nationwide assessment of chlorpyrifos, malathion, diazinon, carbaryl, and methomyl. In a separate review, the National Marine Fisheries Service has agreed to complete a final biological opinion for chlorpyrifos, malathion, and diazinon by December 2017 and a review for carbaryl, and methomyl by December 2018. As a result of litigation with the Center for Biological Diversity, the EPA also intends to assess nationwide impacts for atrazine, simazine, propazine, and glyphosate.[370]

On the regional level, the South Florida Water Management District (SFWMD) conducts quarterly pesticide monitoring for seventy-two pesticides and their degradation products at twenty-six designated stations. This monitoring is done in accordance with specific permits, settlement agreements, or for designated waterbodies that require additional protection. Unfortunately, most of the monitoring stations are outside the southwest Florida region. A map of stations (Fig. 8.4-a) and results have been included as an estimate of pesticide presence in south Florida and as indicative of the need to conduct more robust sampling in coastal regions. Although The Southwest Florida Water Management District (SWFWMD) does not have a pesticide monitoring program, in January 2015, a number of pesticide

compounds were detected by the SFWMD (Table 8.4-b). The compounds and concentrations detected were those expected from areas of historical and current intensive agricultural activity and were not expected to be harmful.[381]

Pesticide residues (µg/L) detected above the method detection limit in surface water samples collected by SFWMD in January 2015.

Table 8.4-b Pesticide Residues Detected in Water Samples Collected by SFWMD in January 2015

Station	S18C	S178	S177	S331	S332DX	S4	S2	S3	S65E
2,4-D	-	-	-	-	-	0.0084	0.004	0.007	0.0033
ametryn	-	-	-	-	-	0.0150	-	-	-
atrazine	-	-	-	-	-	0.17	0.12	0.10	0.025
atrazine desethyl	-	-	-	-	-	0.017	0.017 I	0.017	-
bentazon	0.0046	0.0048	0.0076	0.012	0.0088	0.0084	0.0074	0.008	0.016
diuron	-	-	-	-	-	-	-	-	-
imidacloprid	-	-	0.0046	-	-	-	-	-	0.0052
metribuzin	-	-	-	-	-	-	-	-	-
norflurazon	-	-	-	-	-	-	-	-	-
Number of compounds detected at location	1	1	2	1	1	5	4	4	4

Station	S191	FECSR78	S31	S356-334	S333	S12A	US41-25	TAM BR105	S140
2,4-D	0.025	-	-	-	0.0076	-	-	-	0.0082
ametryn	-	-	-	-	-	-	-	-	-
atrazine	0.021	0.014	0.014	-	0.11	0.023	0.015	0.017	0.057
Atrazine desethyl	-	-	-	-	-	-	-	-	-
bentazon	-	-	0.036	0.009	0.034	-	-	-	0.0062
diuron	-	-	-	-	-	-	-	-	0.0031
imidacloprid	-	-	-	-	-	-	-	-	0.0041
metribuzin	-	-	-	-	0.021	-	-	-	-
norflurazon	-	-	-	-	-	-	-	-	0.034
Number of compounds detected at location	2	1	2	1	4	1	1	1	6

Station	S190	L3BRS	S8	S6	S7	S5A	S9	Total Number of Compound Detections
2,4-D	-	0.0042	-	0.01	0.0034	0.0022	0.012	12
ametryn	-	0.021	0.024	0.058	0.026	-	-	5
atrazine	0.033	0.15	0.19	0.18	0.41	0.16	-	18
atrazine desethyl	-	-	-	0.016	0.013	0.023	-	6
bentazon	-	0.014	0.015	0.034	0.024	0.0081	0.031	19
diuron	-	-	-	-	-	-	-	1
imidacloprid	-	-	-	-	-	0.0028	-	4
metribuzin	-	-	-	0.12	-	-	-	2
norflurazon	-	-	-	-	-	-	-	1
Number of compounds detected at location	1	4	3	6	5	5	2	68

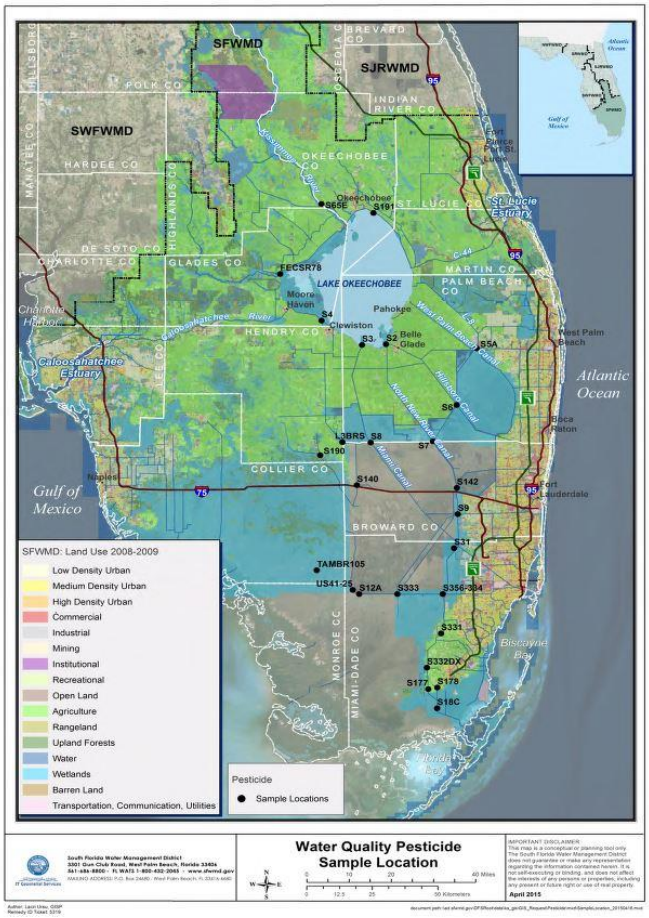


Figure 8.4-a SFWMD Pesticide Monitoring Network January 2015 Sampling Locations

8.5 Salinity

Salinity ranges from fresh (less than one part per thousand: ppt) to saltwater (35 ppt). There are four main mixing zones: stratified, partially mixed, fully mixed, and inverse. Coastal waters are considered stratified if there is a sharp increase in salinity with water depth. In partially mixed coastal waterways, tidal currents generate turbulence that promotes vertical mixing, but the tidal currents are not strong enough to fully mix the water column. Fully mixed conditions occur in coastal waterways where tide, river, or wave energy produces enough turbulence to fully mix the water column, creating a uniform salinity profile with depth though salinity still varies between the riverine and oceanic ends of the estuary. Inverse estuaries are caused by high evaporation rates in the presence of low freshwater inflow. The estuarine water can become denser than the oceanic water and sink below it, forming a hypersaline bottom layer.[382]

Salinity regimes are important in determining the distribution and types of organisms found within an estuary (Table 8.5-a).[383]

Table 8.5-a Salinity Regimes in an Estuary

Type of Water	Concentration (parts per thousand)	Classification
Freshwater	Less than 0.5 ppt	Freshwater
Brackish	0.5- 5.0 ppt	oligohaline
	5 – 18 ppt	mesohaline
	18 – 30 ppt	polyhaline
Marine	30-40 ppt	euhaline
	>40 ppt	hyperhaline

Salinity can affect the health of an estuary. Even though organisms in estuarine aquatic systems are tolerant of natural salinity fluctuations, they still thrive under specific optimal salinity ranges. For example, most seagrasses seem to thrive in water with a salinity of 20 ppt.[384] Oysters require salinities above 4–5 ppt with an optimal range between 14 and 28 ppt. Higher salinities become more suitable for the oyster's predators, such as oyster drills, and the parasite *Perkinsus marinus.*[385] Blue Crabs can thrive in a variety of salinities, but juvenile blue crabs prefer to reside in low salinity waters.[386] The desired salinity range for spotted sea trout is 10–45 ppt for adults and 19–38 ppt for juveniles, with an optimal salinity of 20 ppt.[387]

Salinity in southwest Florida's estuaries is usually lowest during the months of June through September, coinciding with the wet season and associated increases of freshwater flows. Likewise, highest salinities are recorded during the dry season, January through March, when freshwater input is greatly diminished. Variations in salinity are controlled by precipitation, the amount and timing of freshwater runoff, evaporation, regulated water releases, and tidal fluctuations.[388] However, these patterns are increasingly exacerbated as increased impervious surface coverage, channelization, and water demand prevent ground recharge and amplify peak discharges. Particularly, freshwater releases from Lake Okeechobee greatly affect salinity in Pine Island Sound, Caloosahatchee, and Estero Bay watersheds and

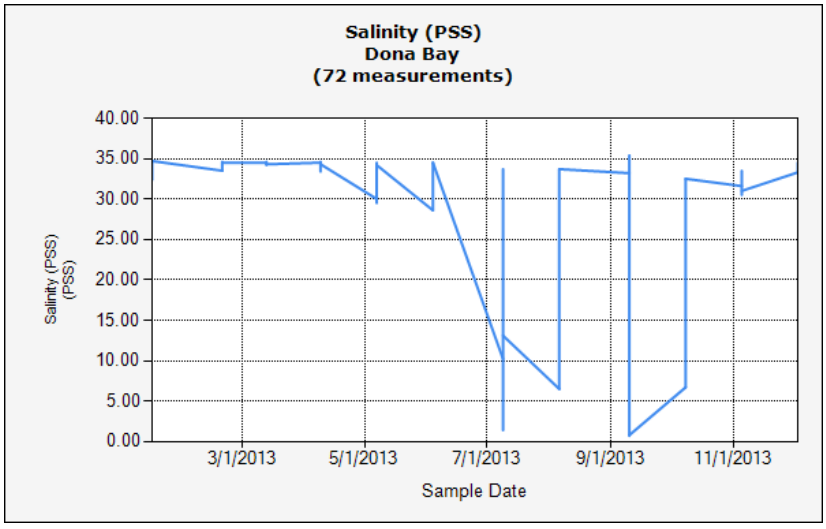
are often responsible for high fluctuations in salinity. Below is a description of the particular salinity regimes in each of the watersheds. Salinity unit measurements in this section vary based on the data provider and are reported in PSS (practical salinity scale), PSU (practical salinity unit), or PPT (parts per thousand). Salinity units are functionally equivalent.[389]

Coastal Venice

Physical and hydrologic alterations to the Coastal Venice watershed have led to impacts on freshwater flow and salinity. The man-made Cow Pen Slough and Blackburn canals bring added freshwater from the Myakka River basin into Shakett Creek and Dona Bay. As a result, oyster beds and hard clams are killed off yearly due to extended periods of reduced salinity.[390] Lyons Bay is not as impacted and maintains higher salinity during the wet season.

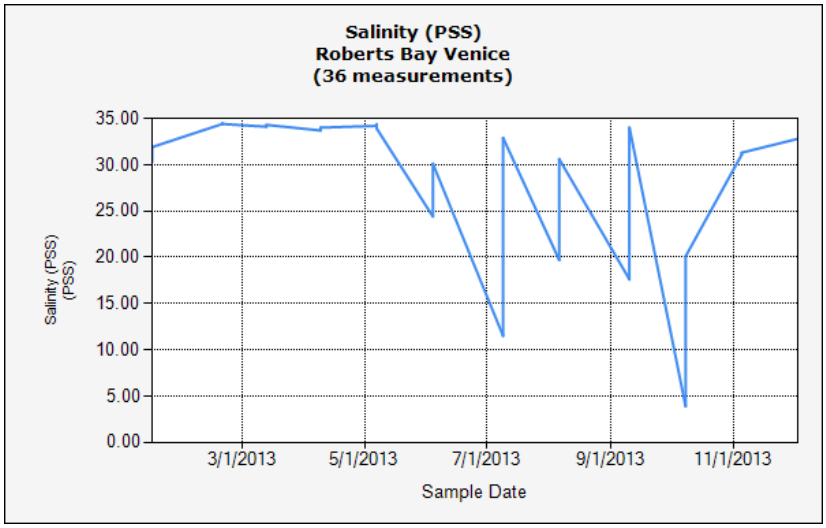
A priority action in the Dona Bay Watershed Management Plan is to improve salinity conditions to return long-term establishment of oyster beds and hard clams to the bays. The completion of the current restoration plan would reduce the instances where salinity drops below 10ppt.[390]

Salinity data taken from the Dona and Roberts Bay Conditions Report during 2013 and between 2010 and 2015[391] indicate that salinity ranged from almost 0 ppt to approximately 35ppt (Figures 8.5-a through 8.5-c).



Salinity Levels in Dona Bay, 2013

Salinity Levels in Roberts Bay, 2013



Salinity Levels in Lyons Bay, 2013

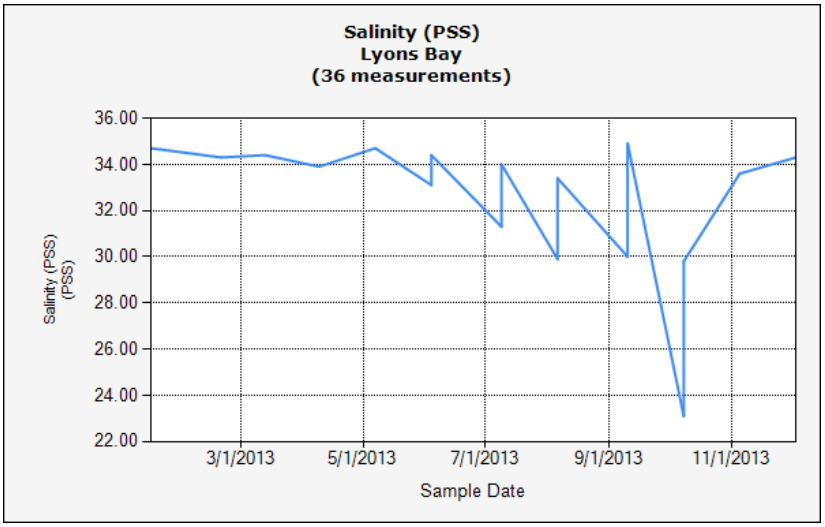
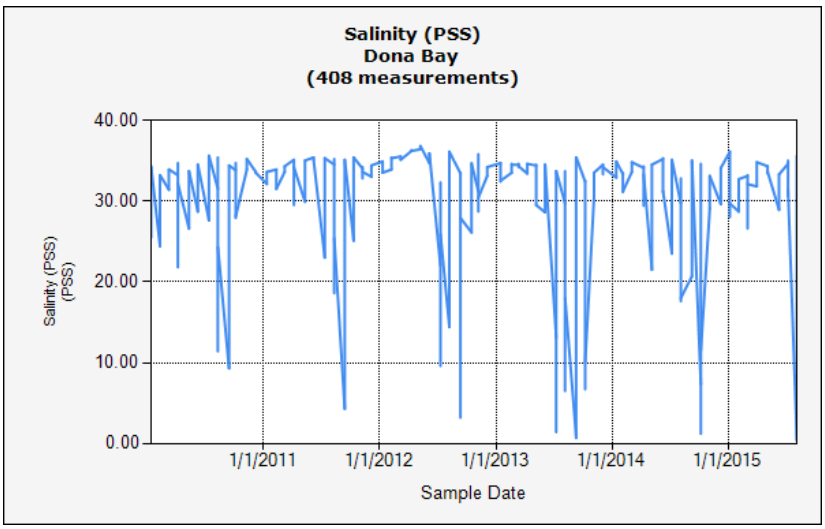
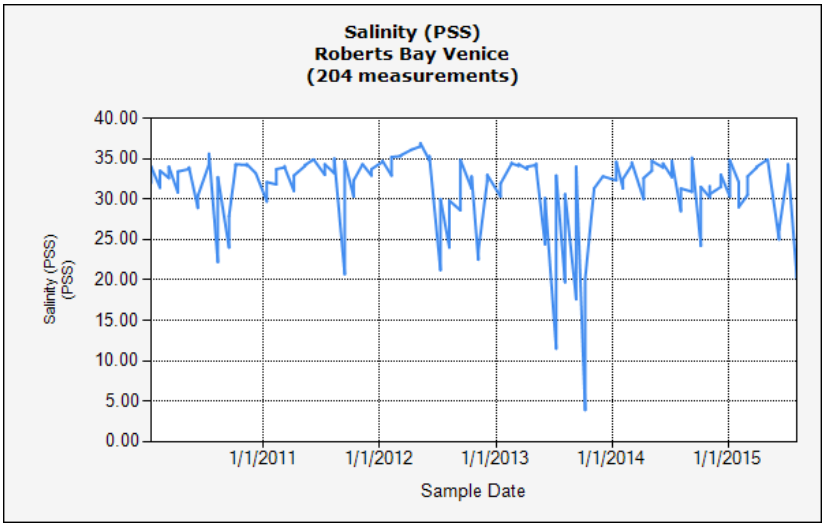


Figure 8.5-a Salinity Levels in Coastal Venice, 2013

Salinity Levels in Dona Bay, 2010-2015



Salinity Levels in Roberts Bay, 2010-2015



Salinity Levels in Lyons Bay, 2010-2015

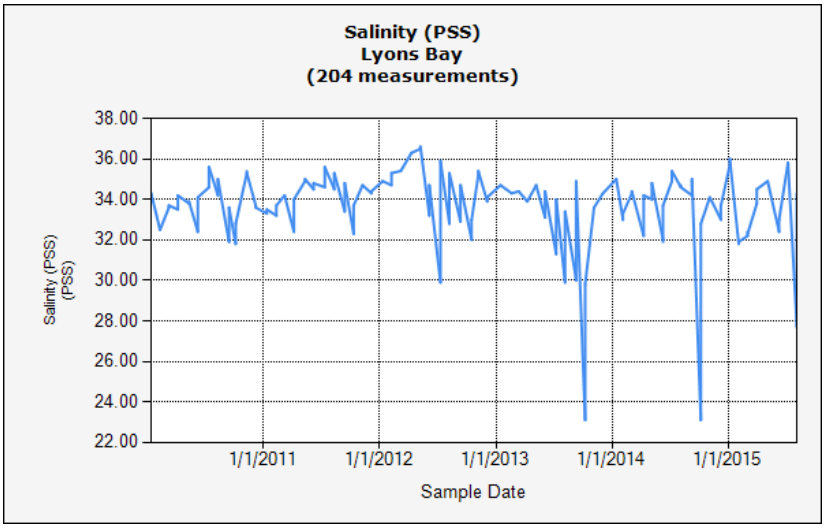


Figure 8.5-b Salinity Levels in Coastal Venice, 2010-2015

Salinity Five-Year Trend in Coastal Venice

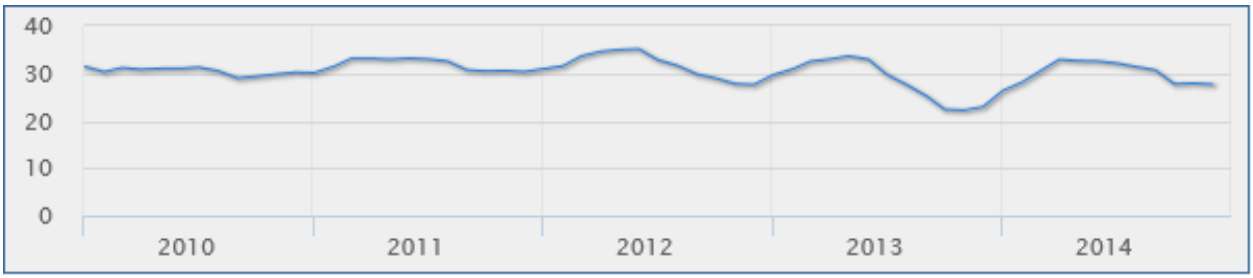


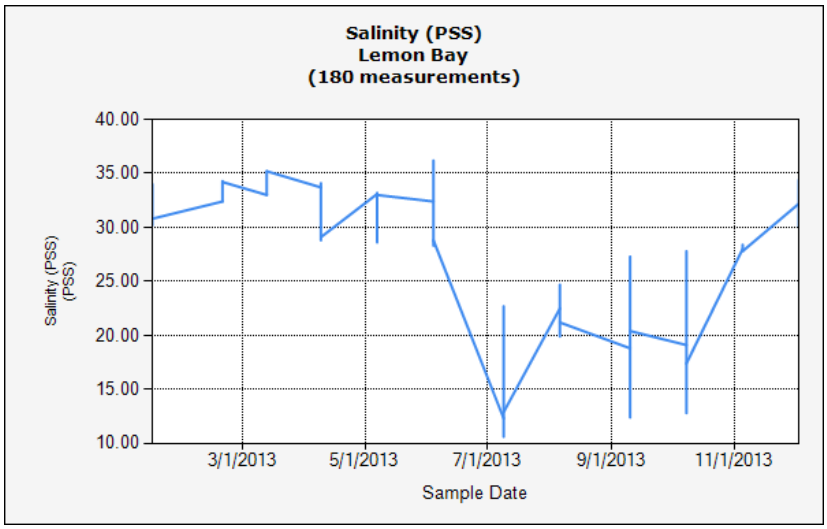
Figure 8.5-c Five-Year Salinity Trend in Coastal Venice

Lemon Bay

Freshwater flows into Lemon Bay from its tributaries affect seasonal salinity patterns, and the northern areas of Lemon Bay experience higher flows and therefore lower salinities. Anthropogenic freshwater input has caused current salinities to be 2 ppt below historic levels. However, current levels continue to exist in the polyhaline to euhaline ranges, supporting the critical natural resources inhabiting the estuary. Nevertheless, Sarasota County has set targets designed to return Lemon Bay to modeled historic salinities and continue to support aquatic life.[392, 393]

Salinity data taken from Upper and Lower Lemon Baby in 2013 and from Lemon Bay between 2006 and 2016[394] indicate that salinities have ranged from ~12 ppt to ~41 ppt (Figures 8.5-d through 8.5-f). The Sarasota County Water Atlas annual bay conditions report for 2014 also provides salinity trends for both the upper and lower portions of Lemon Bay.

Salinity Levels in Upper Lemon Bay, 2013



Salinity Levels in Lower Lemon Bay, 2013

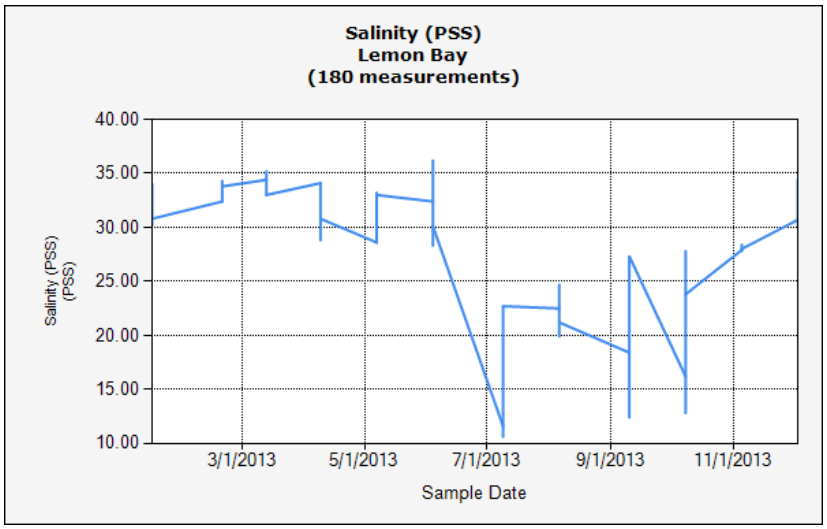


Figure 8.5-d Salinity Levels in Upper and Lower Lemon Bay, 2013

Salinity Trend in Lemon Bay, 2006-2016

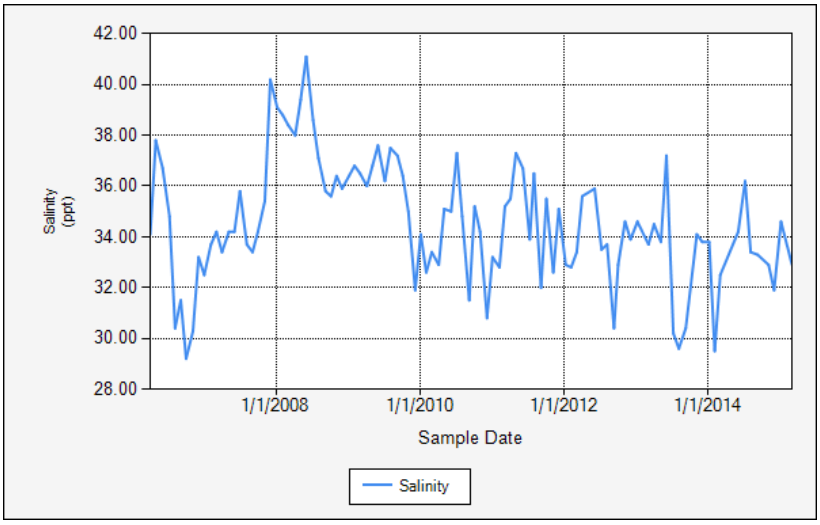
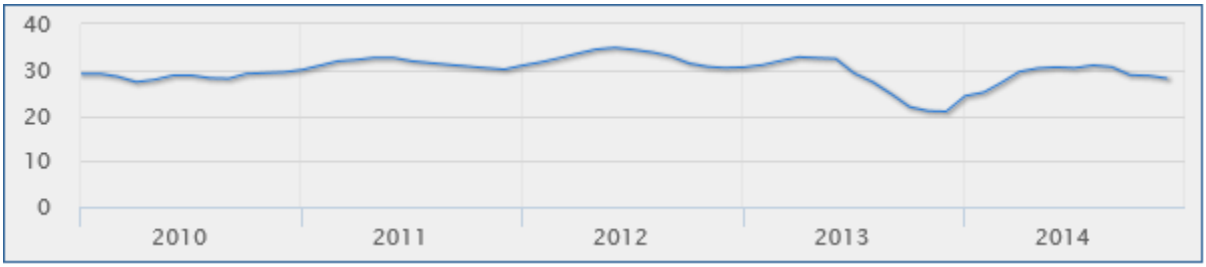


Figure 8.5-e Salinity Levels in Lemon Bay, 2006-2016

Salinity Trend- Upper Lemon Bay



Salinity Trend- Lower Lemon Bay

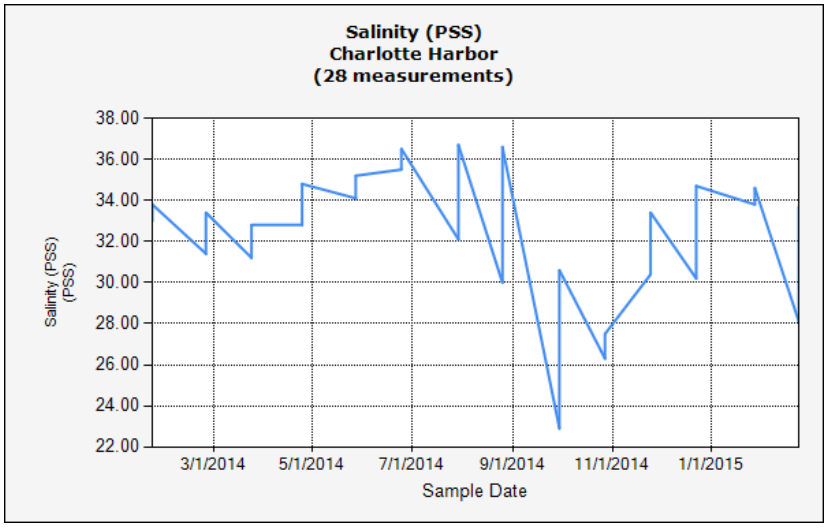
Figure 8.5-f Salinity Trends in Upper and Lower Lemon Bay, 2010-2015

Greater Charlotte Harbor

Seasonal salinities in the Charlotte Harbor estuary largely fluctuate according to the freshwater discharges from the Peace and Myakka Rivers, following seasonal rainfall patterns. Particularly during the wet season, freshwater flows from the rivers cause vertical stratification with the freshwater flowing above the denser saline water below. The presence of barrier islands restricts tidal inflows from the Gulf of Mexico. Waves are channeled into the passes at high velocities and can travel as much as 25 to 27 miles upstream from the mouths of the rivers.[395, 396] Water demand and altered hydrology have decreased freshwater input from the Peace River and increased freshwater input from the Myakka River.[7]

CHNEP has mapped out ideal polyhaline, mesohaline, and oligohaline zones for the entire estuary during wet season and dry season conditions. To mitigate the impacts of development, the program aims overall to reduce salinities during the dry season and increase salinities during the wet season.[7]

Salinity data taken from the Charlotte Harbor estuary between 2010 and 2015[397] demonstrate that salinities have ranged from almost 10 ppt to above 40 ppt (Figure 8.5-g).



Salinity levels in Charlotte Harbor, 2014-2015

Salinity trends in Charlotte Harbor, 2010-2015

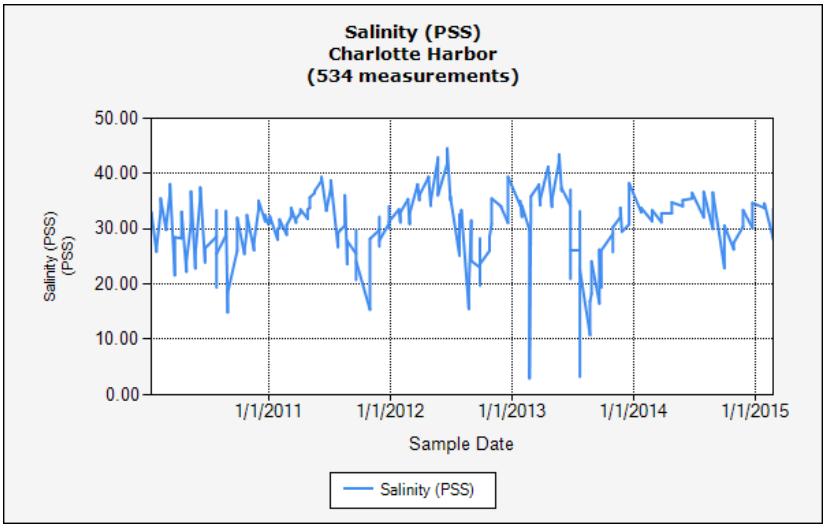


Figure 8.5-g Salinity Trends in Charlotte Harbor

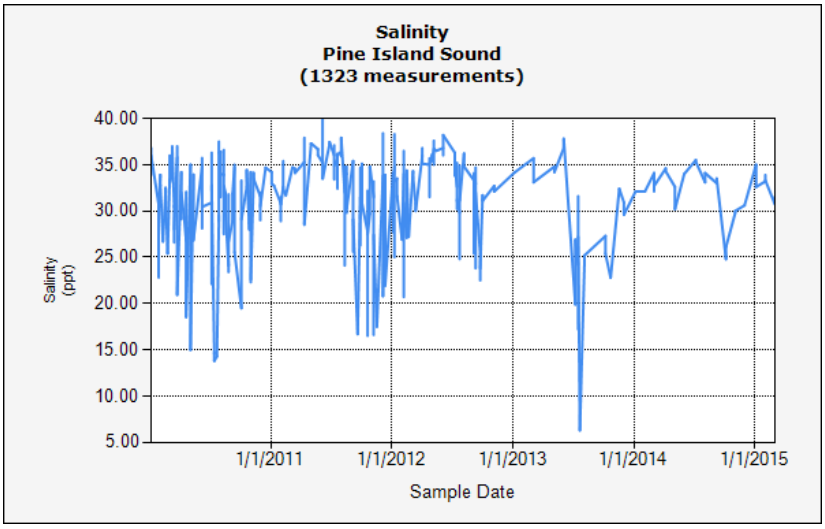
Pine Island Sound

The Pine Island Sound estuary has generally higher and more uniform salinities than the Charlotte Harbor estuary. Seasonal salinity fluctuations are mostly influenced by its tributaries and the North Spreader Canal System (NCS).[396] Following the removal of the Ceitus Barrier in 2008, freshwater input has increased in Matlacha Pass, impacting marine life during the wet season. Salinity now drops to nearly 0 ppt at the Ceitus Barrier's former location following heavy rainfalls.[398] On the other hand, the Charlotte Harbor National Estuary program has determined that salinity ranges in Matlacha Pass and San Carlos Bay should be mesohaline during the wet season and polyhaline during the dry season, and Pine Island Sound is targeted at polyhaline levels during the wet season and euhaline levels during the dry season. Another specific goal is to maintain an average monthly salinity at levels greater that 20–25ppt at the Sanibel Causeway to maintain seagrass coverage.[7]

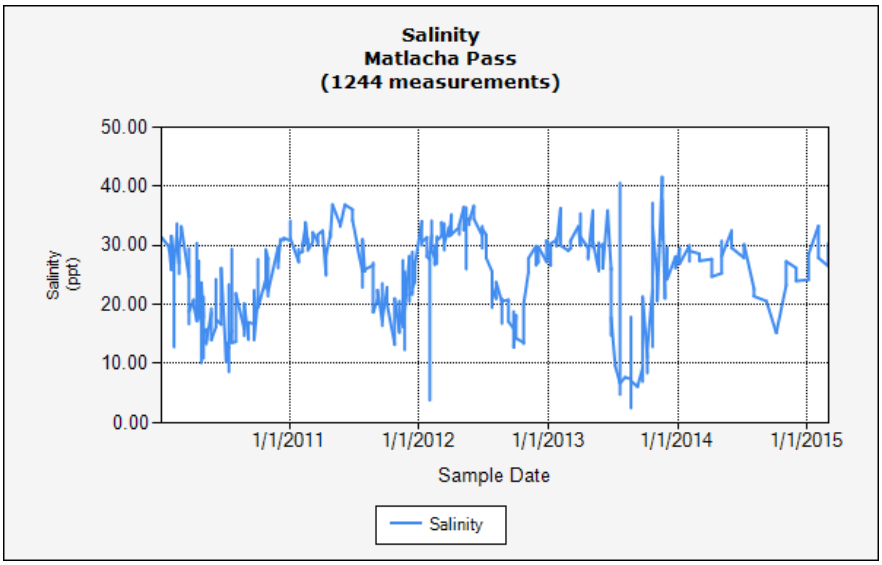
Lee County and the City of Cape Coral are currently working on a watershed initiative that is evaluating water quality conditions in the NSC and adjacent waters of Matlacha Pass to determine impacts from the removal of the Ceitus barrier in 2008 and to assess future management actions. Part of the study includes an analysis of salinity that links salinity with freshwater discharge from the NSC weirs.[399]

Salinities were collected courtesy of the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network at data stations located in Pine Island Sound, Matlacha Pass, and San Carlos Bay.[397] The data show that salinity levels have ranged between 8 ppt and almost 40 ppt (Figure 8.5-h).

Salinity Levels in Pine Island Sound, 2010-2015



Salinity Levels in Matlacha Pass, 2010-2015



Salinity Levels in San Carlos Bay, 2010-2015

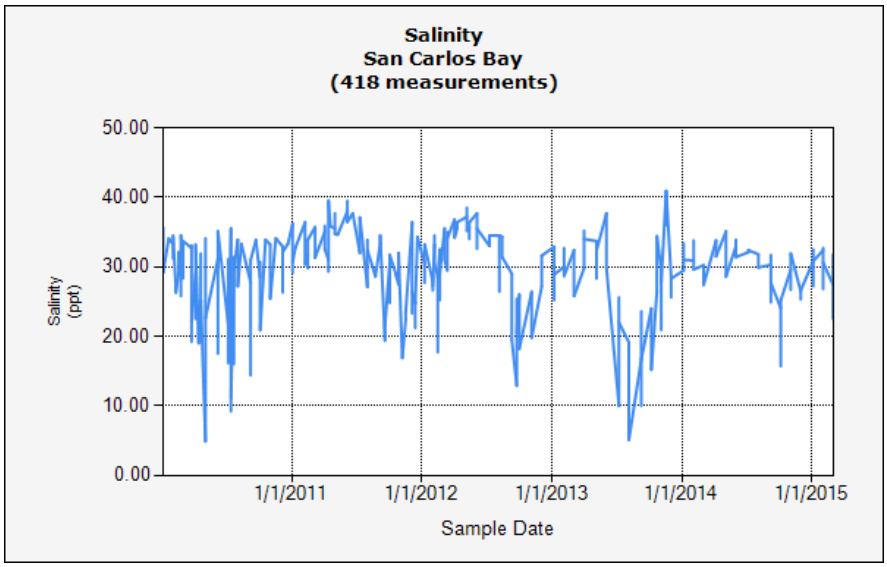


Figure 8.5-h Salinity Levels in Pine Island Sound Watershed, 2010-2015

Caloosahatchee River

Seasonal variations in salinity in the Caloosahatchee River estuary are affected by seasonal rainfall and, more significantly, by controlled freshwater discharges from the W.P. Franklin Lock and Dam (S-79) and Lake Okeechobee. The most significant threat to aquatic life occurs during the dry season, when low flows from S-79 cause a spike in salinity. As part of the 2009 Caloosahatchee River Watershed Protection Plan, the South Florida Water Management District (SFWMD) established maximum salinity criteria at its Fort Myers and I-75 Bridge monitoring stations.[400] Specifically, salinity must not exceed 10 ppt (daily average) and 20 ppt (30-day average) at the Fort Myers station, and salinity must not exceed 5 ppt (30-day average) at the I-75 Bridge station.

However, the past few years in south Florida have been exceptionally wet: 2014 had the wettest April–July period of record in south Florida since 1932,[401] and in 2016 El Niño rainfall during the dry season was 86% higher than the long-term average (1997-2016). These rain patterns have led to high freshwater flows Lake Okeechobee and low salinity throughout the year, often reaching 0 ppt.[402] Hence, the salinity criteria have been exceeded less frequently than over the average period of record (Table 8.5-b).[402]

Table 8.5-b Percentage of Days where Salinity Criteria were Exceeded

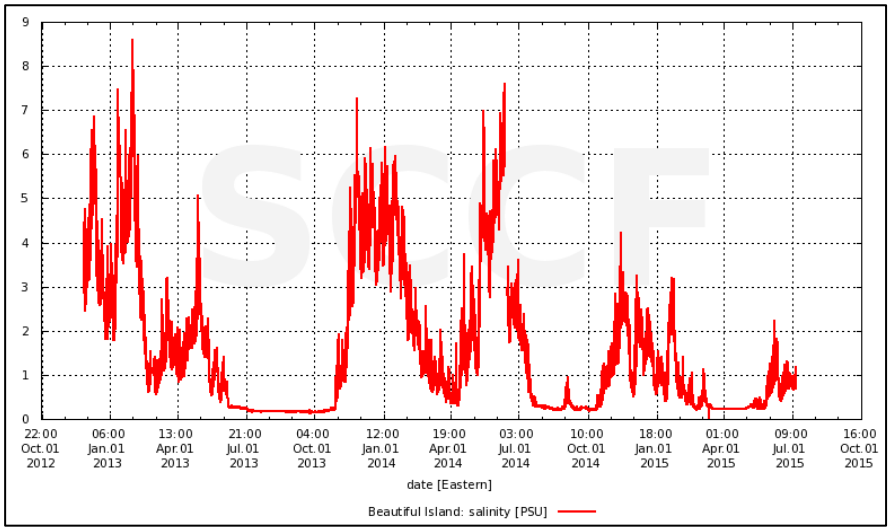
	Ft. Myers Station		I-75 Bridge Station
Period of Record	Days with average salinity >20ppt	Days with 30-day average salinity >10ppt	Days with 30-day average salinity > 5ppt
WY1994-WY2016	6.1%	28.0%	35.9%
WY2014	0.0%	0.0%	0.0%

WY2015	0.0%	6.3%	0.0%
WY2016	0.0%	0.0%	N/A

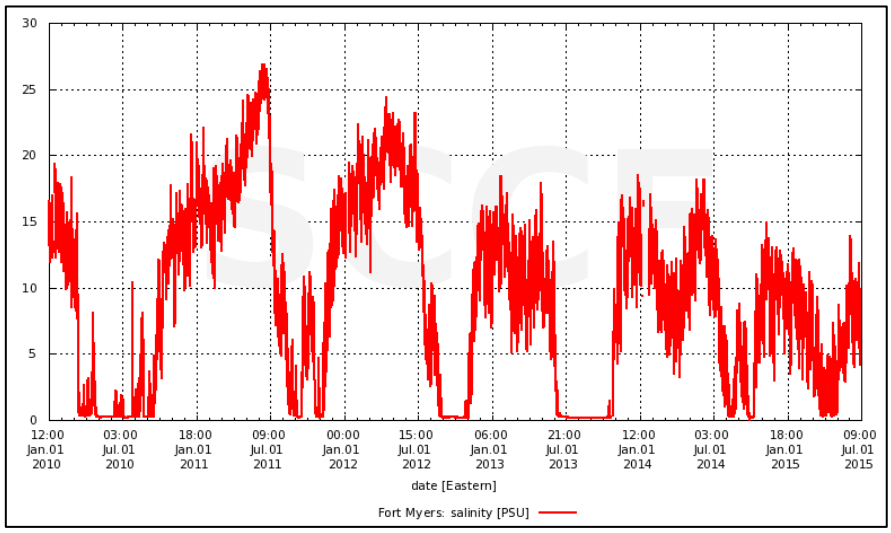
The target salinity level in the Southwest Florida Comprehensive Watershed Plan (SWFCWP) for the Caloosahatchee River estuary is a range of 10–25 ppt by the year 2050.[403] The Charlotte Harbor National Estuary program has also created a Hydrologic Vision map of optimal salinities in the estuary. The program aims to restore more natural salinity conditions in the Caloosahatchee to stabilize the environment for several key species including seagrasses, blue crab, oysters, clams, and juvenile fishes. SFWMD is also currently considering an update to the Caloosahatchee Minimum Flows and Levels (MFL) that will hopefully take into account optimal salinity ranges for several of these species.[404]

Seasonal trends in salinity as measured by three water quality sensors in the Caloosahatchee River (Figure 8.5-i) are presented below; graphs and real time salinity data can be found on the website for the Sanibel-Captiva Conservation Foundation's River, Estuary, and Coastal Observing network (SCCF RECON). Salinity appears to range between almost 0 ppt and ~35 ppt.[405]

Salinity Levels on Beautiful Island, October 2012-July 2015



Salinity Levels in Ft. Myers, January 2010- July 2015



Salinity Levels in Shell Point, January 2010-July 2015

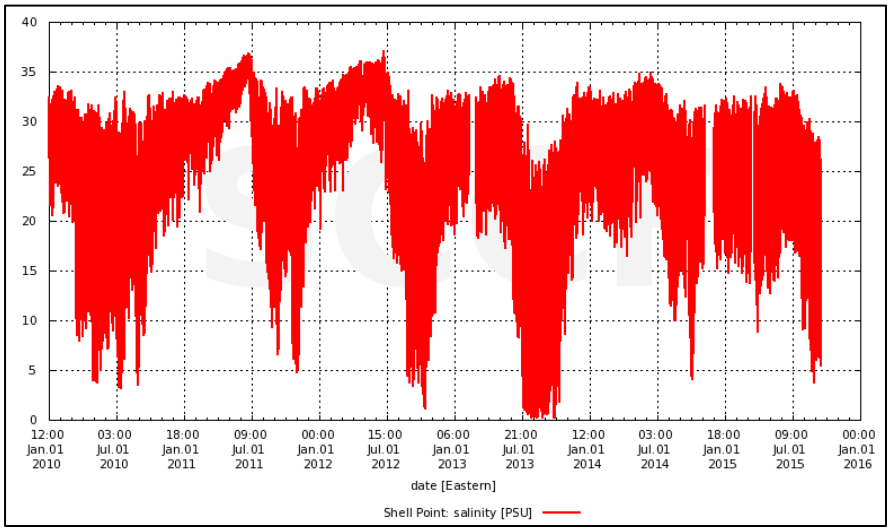


Figure 8.5-i Salinity Levels in the Caloosahatchee River Estuary

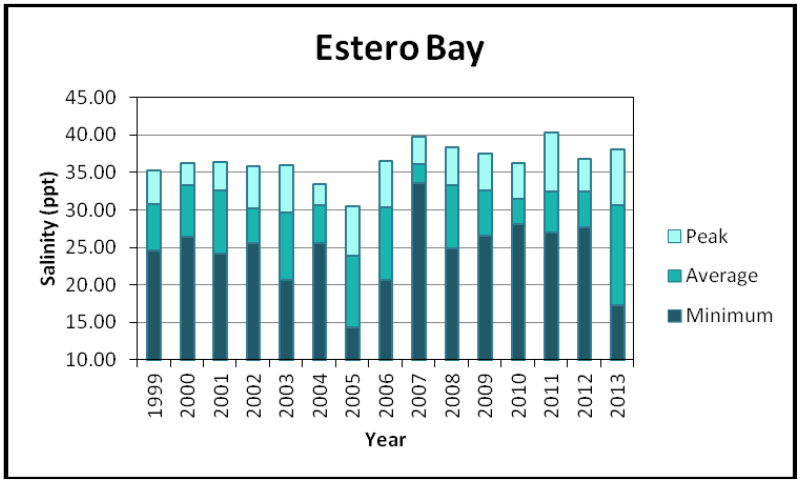
Estero Bay

Seasonal fluctuation in salinity levels in Estero Bay are determined by freshwater discharges from its tributaries, corresponding with seasonal rainfall trends. The smaller bays that comprise Estero Bay exhibit distinct salinity regimes determined by their proximity to the tributaries and the presence of hydrologic barriers such as oyster bars and barrier islands. The northern bay is more affected by the Caloosahatchee River estuary and is generally less saline.[406] However, Lee County Environmental Laboratory has observed a trend of increasing salinity during the last decade. Salinities for Estero Bay (2011–2013) have yearly averages of 30–32.5ppt, nearly marine conditions.[407]

The SWFCWP has identified a target range of 15–25 ppt for Estero Bay by 2050.[407] CHNEP has also mapped optimal locations for marine and polyhaline regimes during the dry season, as well as polyhaline, mesohaline, and oligohaline conditions during the wet season.[7]

According to the 2014 State of the Bay Report, between 1999 and 2013 salinities in Estero Bay ranged between approximately 15 ppt and 41 ppt (Figure 8.5-j).[407] For the period of 2010 to 2015, the Charlotte Harbor Water Atlas reports salinities ranging from ~10 ppt to almost 38ppt.[408,409]

Salinity Levels in Estero Bay, 1999-2013



Salinity levels in Estero Bay, 2009-2015

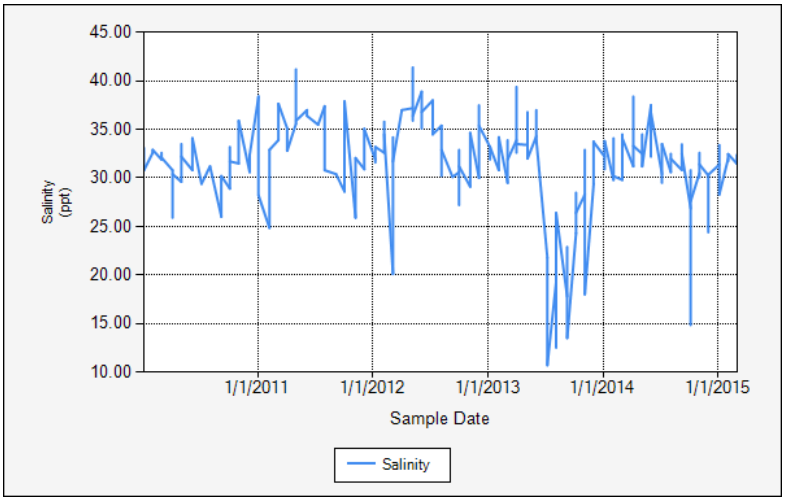
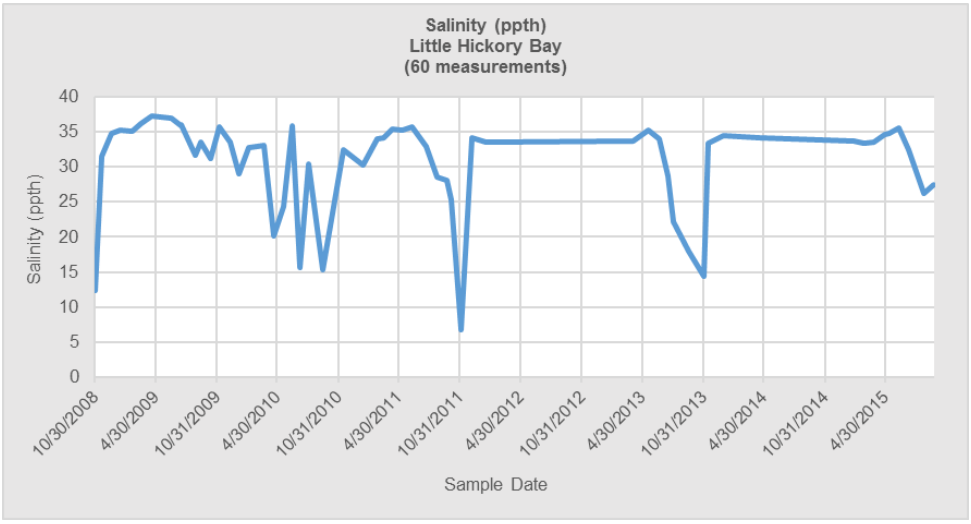


Figure 8.5-j Salinity Levels in Estero Bay

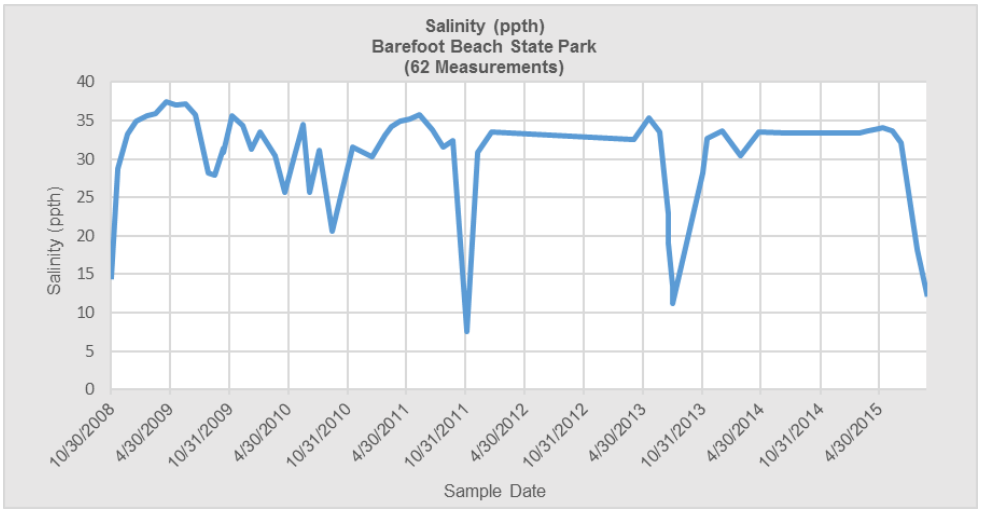
Wiggins Pass/Cocohatchee River

Seasonal fluctuations in salinity levels in the Wiggins Pass estuary are determined by freshwater discharges from the Cocohatchee River. Due to the presence of the Cocohatchee Main Canal and ongoing development in the Golden Gate Estates, the salinity range in the estuary is extremely large, ranging from 0 ppt in the rainy season to 35 ppt in the wet season. Gated structures control water flows based on ground water levels and flood protection rather than providing for optimal ecosystem health.[410] Analysis of salinity indicates that there is not enough flow from the primary canals to Wiggins Pass during the dry season.[411]

Water from Wiggins Pass flows southward into Water Turkey Bay and then continues southward into Vanderbilt Lagoon. Based on data from Collier County Coastal Zone Management Department, between 2008 and 2015, salinities at stations closest to Wiggins Pass ranged from 6.76 ppt to 37.45 ppt (Figure 8.5-k)[412].



Salinity Levels in Little Hickory Bay, 2008-2015



Salinity Levels in Barefoot Beach State Park, 2008-2015

Figure 8.5-k Salinity Levels in Wiggins Pass/ Cocohatchee River

Naples Bay

Seasonal fluctuations in salinity are largely influenced by the controlled discharges of the Golden Gate Canal System. Since the weir-controlled canal has a seasonal discharge range of 0 cfs to 1,400 cfs, the salinity regime has a much higher variability than historical conditions. In addition, freshwater flows from the canal during the wet season cause extreme stratification in the water column that can diminish dissolved oxygen concentrations near the bottom, impede vertical mixing, and decrease water clarity. The Bay was previously a suitable habitat for oysters, but rapid swings in salinity create additional stress

for them. Current efforts to divert and reduce freshwater from the Golden Gate Canal aim to reduce the extremes in salinity variability.[413]

Based on USGS monitoring stations, salinities in Naples Bay ranged from 8 ppt to almost 35 ppt during the period 2011–2014 (Table 8.5-c).

Average salinity in Gordon River (Marine Segment) and Naples Bay by season from USGS continuous recorders (mid-2011 or early 2012 through October 2014).

Table 8.5-c Average Salinity in Gordon River and Naples Bay, 2011 - 2014

Location	Mean Salinity (ppt)			
	Dry Season (December–May)		Wet Season (June–November)	
	Surface	Bottom	Surface	Bottom
Gordon River at Rowing Club Point	26.3	29.4	8.4	15.9
Naples Bay at City Dock	31.4	32.4	19.3	27.9
Naples Bay Mid Estuary	34.2	34.6	23.5	31.6
Naples Bay at Gordon Pass	34.4	34.6	31.8	32.7

Rookery Bay

Seasonal fluctuations of salinity in Rookery Bay are dictated by freshwater discharges from Henderson Creek, which is regulated by a weir. Similar to other controlled estuaries, water is flushed out during the wet season for flood control and can be held back during the dry season to maintain drinking and irrigation water.[260] As a result, the salinity range is wide, from 18.5 to 39.4 ppt, with dry season salinity exceeding levels in the Gulf of Mexico.[414]

Target salinities established by SWFCWP for the Rookery Bay estuary system are 20–30 ppt by the year 2050.[403]

Data collected by the Rookery Bay National Estuarine Research Reserve[415] recorded salinities ranging from ~12 ppt to ~38 ppt for the period 2010–2015 (Figure 8.5-l).

Salinity Levels from the Lower Henderson Creek Station, 2010-2015

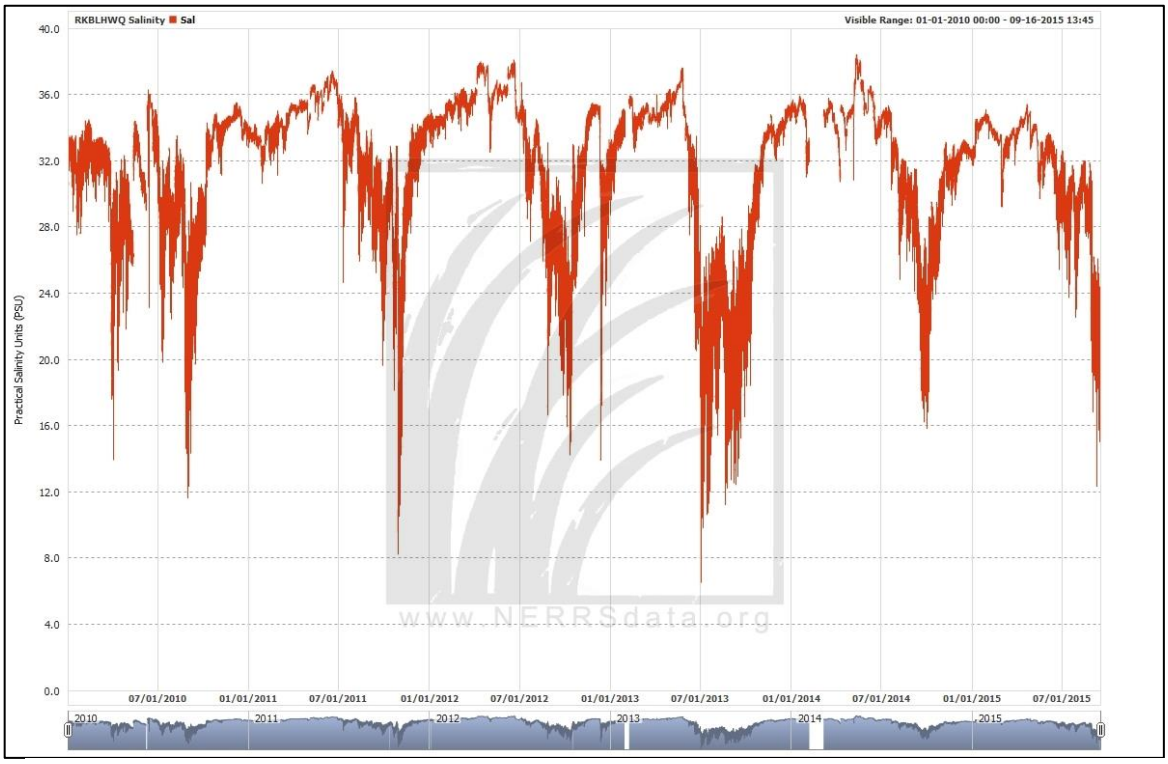


Figure 8.5-l Salinity Levels in Rookery Bay, 2010-2015

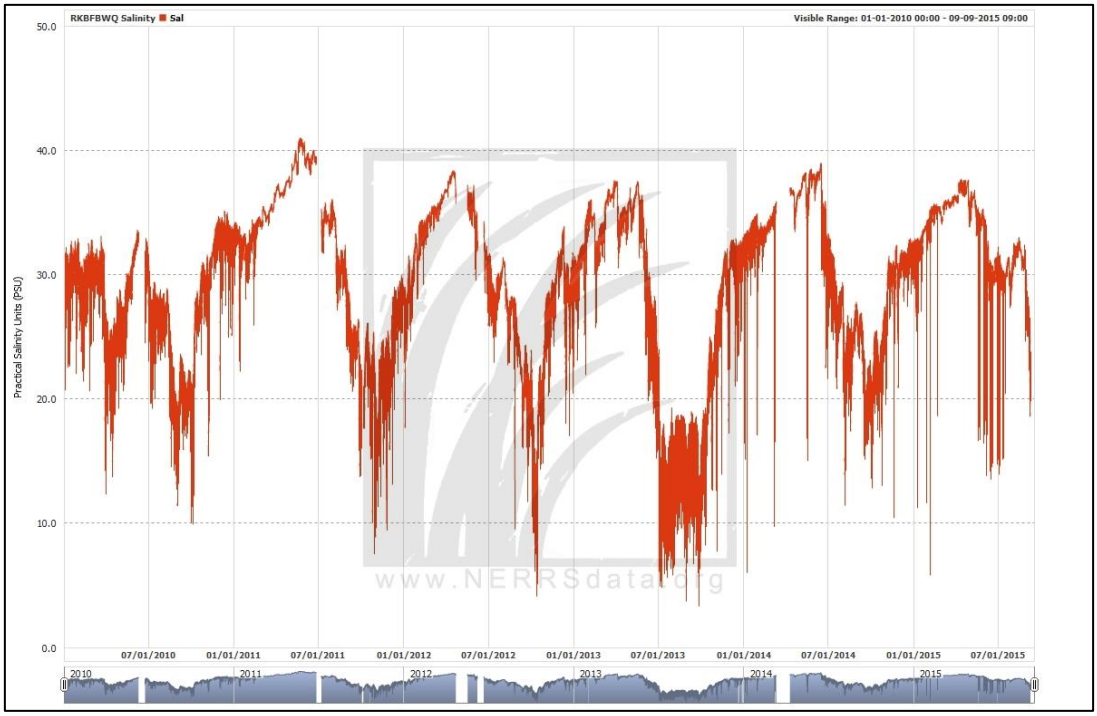
Ten Thousand Islands

Seasonal fluctuations of salinity in the Ten Thousand Islands watershed are dictated by both natural and controlled freshwater discharges from its rivers and tributaries. Natural sources of freshwater flow include the Barron, Ferguson, East, Fakahatchee, Wood, Little Wood, Pumpkin, Whitney, and Palm Rivers. The estuary receives altered freshwater flow from the Faka Union Canal, Barron River Canal, U.S. 41 Canal, and the Fakahatchee watershed. Hydrologic alterations in the western portion of the watershed have resulted from the development of the Southern Golden Gate Estates, irrigation, and urban growth. Lower salinities occur during the wet season where the mouths of larger canals exist, including the Faka Union and Barron River Canals. Hypersaline conditions exist throughout the estuary during the dry season, and are attributable to the natural lack of rainfall and high rate of evaporation.[416]

Target salinities established by SWFCWP for the Ten Thousand Islands estuary and Barron River estuary systems are 16–30 ppt by the year 2050. More specifically, salinity levels should be 20–30 ppt for Blackwater Bay, Buttonwood Bay, Pumpkin Bay, and Fakahatchee Bay, and Faka Union Bay salinities should be 10–30 ppt.[403]

Data collected by RBNERR from the Fakahatchee River and Fakahatchee Union Stations[415] demonstrate that salinities ranged from almost 0 ppt to 40 ppt for the period 2010–2015 (Figure 8.5-m).

Salinity Levels from the Fakahatchee River Station, 2010-2015



Salinity Levels from the Faka Union River Station, 2010-2015

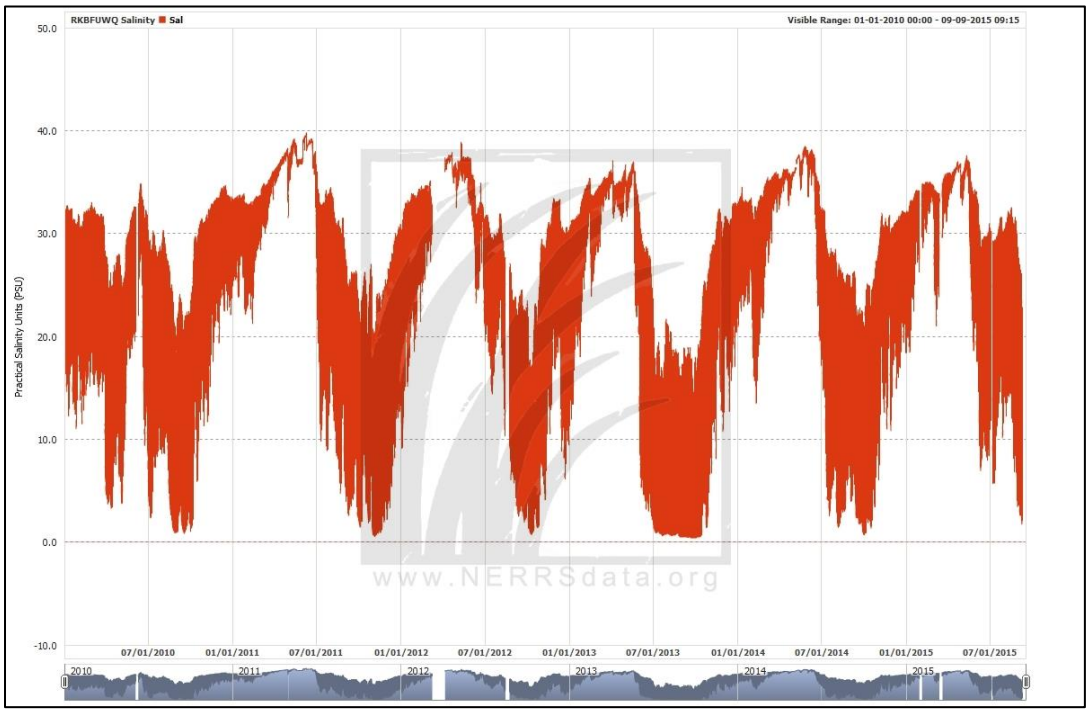


Figure 8.5-m Salinity Levels in the Ten Thousand Islands

9 APPENDIX F: Miscellaneous

9.1 The BP Deepwater Horizon Oil Spill and the RESTORE Act

In 2011, the BP Deep Water Horizon Oil Spill had a catastrophic effect on gulf shore ecosystems. Although southwest Florida saw negligible immediate impacts from the spill, it is important to continue considering its potential impact on long-term watershed health. In May 2015, BP declared that the disaster was over and that the spill did not have any long-term effects on wildlife.[417] To some degree, Gulf Shore ecosystems are recovering. Marsh grasses and animals in many areas have begun to return to pre-spill conditions.[418] Also, no contaminants have been found in the seafood industry, and people can continue to fish for red snapper. However, though some of the immediate impacts have subsided over the past five years, many scientists question BP's statement. They believe that the effects of this contamination could possibly carry over through several generations of fishes and other wildlife. Both shallow and deep water fishes continue to contain large amounts of polycyclic aromatic hydrocarbons (found in oil) that can permanently impair fish health. A May 2015 study showed that bottlenose dolphins suffered severe damage to their lungs and adrenal glands. Another study showed that a record number of stillborn dolphins have been found on shores in recent years, showing that the oil had a chronic effect on pregnant dolphins.[419] One can still find oil on the beaches of Escambia County in Florida, and any oil that settled to the bottom of the Gulf will not be recovered.[417] Scientists will continue to research the ripple effects of the catastrophe for years to come.

Regardless of any damage southwest Florida experiences in the future, its estuaries will receive federal aid to mitigate any potential harm caused by the Deepwater Horizon Oil Spill. In response to the environmental crisis, the United States Federal Government issued the RESTORE Act of 2012 (Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012). The Act enabled the U.S. Department of the Treasury to direct 80 percent of the Clean Water Act fines associated with the Deepwater Horizon Oil Spill to establish the Gulf Coast Restoration Trust Fund that provides financial assistance to affected coastal areas.[420] Florida, as one of five States eligible to receive funding, has received $572 million of the total $5.5 billion RESTORE Act Funds.[421] Priority for RESTORE Act funds will go to the following types of projects: storm water/wastewater projects, community resilience/living shorelines, water quality projects, agriculture best management practices, and fish/wildlife habitat management.[422]

The counties with estuaries in this report card—Sarasota, Charlotte, Lee, and Collier County—are all classified as Non-Disproportionately Impacted counties eligible for RESTORE Act funds.[423] Each county that receives funding is responsible for developing a Multi-Year Implementation Plan (MYIP), that establishes suitable projects and timelines to use these funds. Plans are expected to be developed with direct participation from multiple entities including individuals, businesses, Indian Tribes, and non-profit organizations.[422]

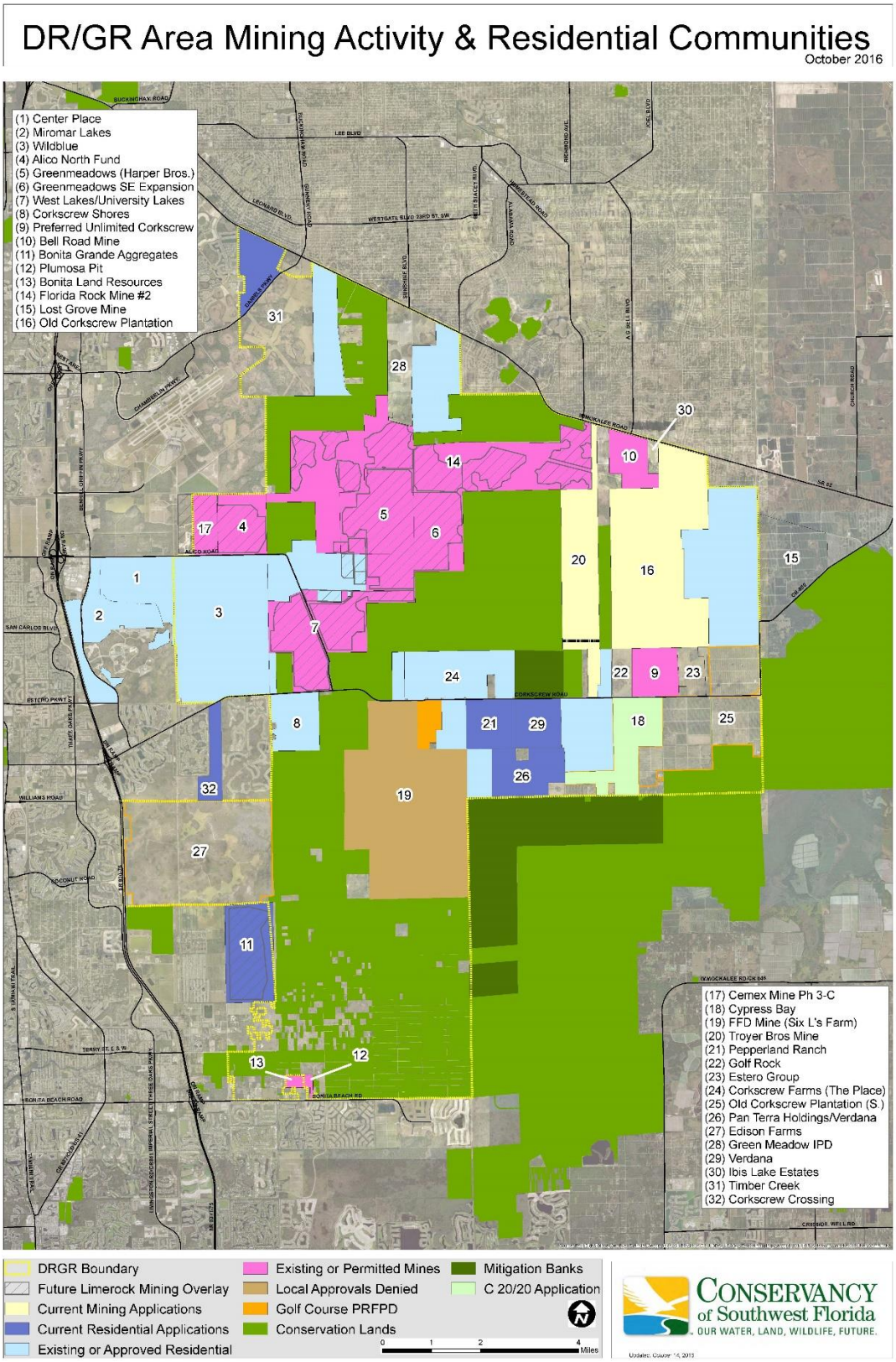
Currently, Charlotte County is the only county out of the four in this report card that has a developed and approved MYIP. The United States Department of Treasury approved Charlotte County's MYIP on

March 8, 2016.[424] The MYIP includes four projects: Harbor Walk, Fisheries Monitoring, Restoring Bay Scallops, and Restoring the Impaired Waters of Charlotte Harbor. All except the Harbor Walk project aim to restore Charlotte Harbor's estuarine health. The Fisheries Monitoring project will monitor the impact of the hydrologic restoration efforts being implemented through the Charlotte Harbor National Estuary Program Comprehensive Conservation Management Plan. The project will collect 23 samples per month in two tidal tributary systems that are vital fish nursery habitat. As hydrologic improvement projects are implemented, this monitoring will assess how these projects affect the biota and productivity of the ecosystem. The Restoring Bay Scallops project is an effort to increase the once abundant Charlotte Harbor Scallop population that collapsed in the 1960s. Imitating other successful scallop restoration projects, the county will implement controlled releases of bay scallop larvae and juveniles during two annual spawning cycles. The Restoring the Impaired Waters of Charlotte Harbor project will remove septic tanks in high density urban and coastal areas and connect these areas to the central wastewater treatment system. The purpose of this multi-phased wastewater expansion project is to reduce potential sources of pollution from septic tanks in the Charlotte Harbor estuary system.[425]

Collier County has reviewed and ranked 35 potential submitted projects and will begin developing its Multi-Year Implementation Plan with the top ranked projects.[426] One of the projects Collier County plans to propose will improve water quality in Naples Bay and Rookery Bay. Called the Golden Gate Watershed Improvement Plan, the project will divert water from the Golden Gate Canal into the Rookery Bay watershed. This diversion will only occur during the wet season, when there will be no effects on upstream water users or on the Picayune Strand Restoration Project to the east. The plan has several benefits including the following: directing water into a more historic flowway, reducing nutrient loads and improving the salinity regime in Naples Bay, improving the water depth of wetlands in Rookery Bay's contributing watershed, and improving freshwater inflows to Rookery Bay. The project will take 10 years to construct and cost approximately $31 million.[427]

Lee County and Sarasota County are still in the process of reviewing potential projects for their MYIPs.[426] Overall, the effectiveness of these restoration projects will have to be considered in upcoming report cards.

9.2 Density Reduction/Groundwater Resource (DR/GR) Map



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