DRAFT

Indian River County
Lagoon Management Plan

July 2023

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Acronyms and Abbreviations

ALA	Anchoring Limitation Areas
ArcNLET	ArcGIS-Based Nitrate Load Estimation Toolkit
BMAP	Basin Management Action Plan
BMP	Best Management Practices
DO	Dissolved Oxygen
FDACS	Florida Department of Agricultural and Consumer Services
FDEP	Florida Department of Environmental Protection
FIND	Florida Inland Navigation District
FP	Fibropapillomatosis
FWC	Florida Fish and Wildlife Conservation Commission
ICW	Intercoastal Waterway
IRC	Indian River County
IRFWCD	Indian River Farms Water Control District
IRL	Indian River Lagoon
IRLNEP	Indian River Lagoon National Estuary Program
LMP	Lagoon Management Plan
mgd	Million Gallons Per Day
MSD	Marine Sanitation Device
NA	Not Applicable
NOAA	National Oceanic Atmospheric Association
OSTDS	Onsite Sewage Treatment Disposal Systems
PLSM	Pollutant Load Screening Model
ppt	Parts Per Thousand
SJRWMD	St. Johns River Water Management District
SWIL	Spatial Watershed Iterative Loading (model)
TBD	To Be Determined
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
USACE	United States Army Corps of Engineers

1. Introduction

Goal: The Indian River County Lagoon Management Plan addresses key factors impacting the health of the Indian River Lagoon through research and the implementation of restoration projects to improve resiliency and conditions for the Indian River Lagoon and the Indian River County community.

The Indian River County (IRC) Lagoon Management Plan (LMP) identifies 17 key factors (Table 1) impacting the health of the Indian River Lagoon (IRL). The 17 key factors are divided among five focal areas, based on IRC departments: Coastal, Stormwater, Conservation Lands, Utilities, and Community Development. The Plan creates goals and objectives for the five focal areas for the management and restoration of the IRL within IRC. It provides a list of projects and best management practices (BMPs) for IRC managers and citizens. The LMP will be actively managed to fill data gaps and can be used to prioritize projects based on a cost-benefit analysis. The LMP is a living document, which can be modified based on emerging factors and research. Regular project updates will be made to the LMP on a yearly basis with an evaluation of the key factors, goals, and objectives every three years. The LMP is a necessary step in the conservation of the IRL, an ecologically and economically important habitat in Florida.

Table 1. 17 Key Factors Affecting the IRL in IRC

Factor	Description
Annual Rainfall Data	Rainfall acts as one of the major contributors of freshwater into the IRL system.
Biosolids	Biosolids are solid, semi-solid, or liquid materials resulting from the treatment of domestic sewage sludge from wastewater treatment facilities.
BMPs	BMPs are practices deemed to be effective and practicable means of preventing or reducing water pollution generated from various activities and industries.
Ecosystem Functions and Habitat Use	IRL is one of the most biologically diverse estuaries in North America and is used by approximately 4,000 unique organisms at some point throughout their lifecycles.
Harmful Algal Blooms	Imbalances in the IRL allows certain algal species to grow unchecked, some of which can release toxins into the waters that may be detrimental to the health of IRL.
Hydrology and Hydrodynamics	IRL hydrology and hydrodynamics have changed over time as human influences have modified the natural flows of the system.
Land Use Changes	Past and future land use change evaluations are important in understanding current issues in the IRL and determining resiliency for the future.
Marinas and Boat Ramps	Marinas and boat ramps are found throughout IRC, and it is the boaters' responsibility to properly to maintain and operate their vessels.
Onsite Sewage Treatment and Disposal Systems (OSTDS)	OSTDS, or septic systems, are one form of waste treatment; however, improper maintenance can lead to detrimental impacts on the surrounding environment.
Organic Material and Sediments	Muck is classified as a black, organic-rich, mud-rich, high water content sediment with a high nutrient content. Muck is prevalent throughout the IRL system and has a detrimental effect on the Lagoon health.
Sea Level Rise	Sea level rise plays an important role in the health of the IRL in IRC due to its direct connections to manmade and maintained inlets.
State and Regulatory Review of Rules	State and regulatory rules play a major role in regulating the levels and sources of nutrients that the IRL receives from upland sources.
Stormwater	Stormwater primarily flows to the IRL via the three relief canals in IRC. Stormwater carries pollutants that an affect IRL health.
Sustainability and Resiliency	Sustainability and resiliency are measures taken to ensure the future of the Lagoon, its shoreline, and the surrounding infrastructure within the watershed.

Factor	Description
Total Nitrogen and Total Phosphorus	Nitrogen and phosphorus concentrations are essential for a productive and diverse ecosystem but excess concentrations can be detrimental to the system.
Water Consumption	Water supplies need to be sustainable for future needs as populations and demand continue to increase throughout IRC and state-wide.
Water Quality	Degraded water quality negatively impacts IRL health and diversity, leading to widespread seagrass habitat die-offs and triggering of harmful algal blooms.

A. State of the IRL in IRC

Natural History of the IRL

The IRL is a shallow 156 mile-long bar-built estuary covering one-third of the east coast of Florida and provides multiple benefits to the region and state (Figure 1). It is an Estuary of National Significance, one of 28 in the nation. There are four Florida Department of Environmental Protection (FDEP) aquatic preserves: Banana River, Malabar to Vero Beach, Vero Beach to Fort Pierce, and Jensen Beach to Jupiter Inlet. Two of these aquatic preserves are present in IRC, and are also designated as Outstanding Florida Waters. The IRL is part of the Intracoastal Waterway (ICW) running from Massachusetts to Miami, and the channel is maintained by the U.S. Army Corps of Engineers (USACE) and Florida Inland Navigation District (FIND). The depth of the ICW channel is approximately 3 meters (12 feet), but outside the channel, the average depth of the IRL is 1.2 meters (4 feet).

Figure 1. IRL Statistics and Benefits

Six counties border the IRL (Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach), and the IRL watershed also includes Okeechobee County. Currently 1.6 million people live within the watershed. In 1916, the IRL watershed was 572,000 acres; however, by 2013, development of the region and an intricate series of canals draining water to the east, increased the watershed to 1.4 million acres (Figure 2). These canals were designed to drain wetlands for agriculture and have been maintained to now allow residential and commercial development in historic wetlands. The hardening of the landscape and shifting of water to the east has increased the freshwater discharge to the IRL to five times the historical volume.

Historically, the natural exchange of water between the IRL and the Atlantic Ocean occurred through wash-over of the barrier islands and the opening and closing of inlets from hurricanes and other severe storms. This shifting of the flow of fresh and salt water has impacted the health of the Lagoon even before human management of inlets. Fish kills are documented as far back as 1894, which "killed tens of thousands of fish in such quantities that local residents shoveled them into wagons for fertilizer. The stench from the fish kill lingered for more than one year" (Newman 1953). Today, three man-made inlets (Sebastian, Fort Pierce and St. Lucie), two natural inlets (Ponce De Leon and Jupiter), and one controlled lock system

(Canaveral Lock) connect the IRL to the Atlantic Ocean. The inlets are stabilized and maintained to allow for vessel traffic. While the Lagoon is connected to the Atlantic Ocean through the five inlets, it is a wind driven microtidal system.

The IRL spans two distinct biogeographical provinces, the temperate Carolinian and the subtropical Caribbean, which lends to its high biodiversity. At one time it was labeled the most biologically diverse estuaries in the United States. The IRL has 4,300 species dependent upon its ecosystem for some point of their lifecycle, of which approximately 50 are listed as threatened or endangered. In 2016, the economic value of the IRL was estimated to be $7.6 billion dollars with $30 million in revenue generated from IRL fisheries. The high biodiversity and economic benefits of the IRL are a driving factor in the importance of conservation of this estuary.

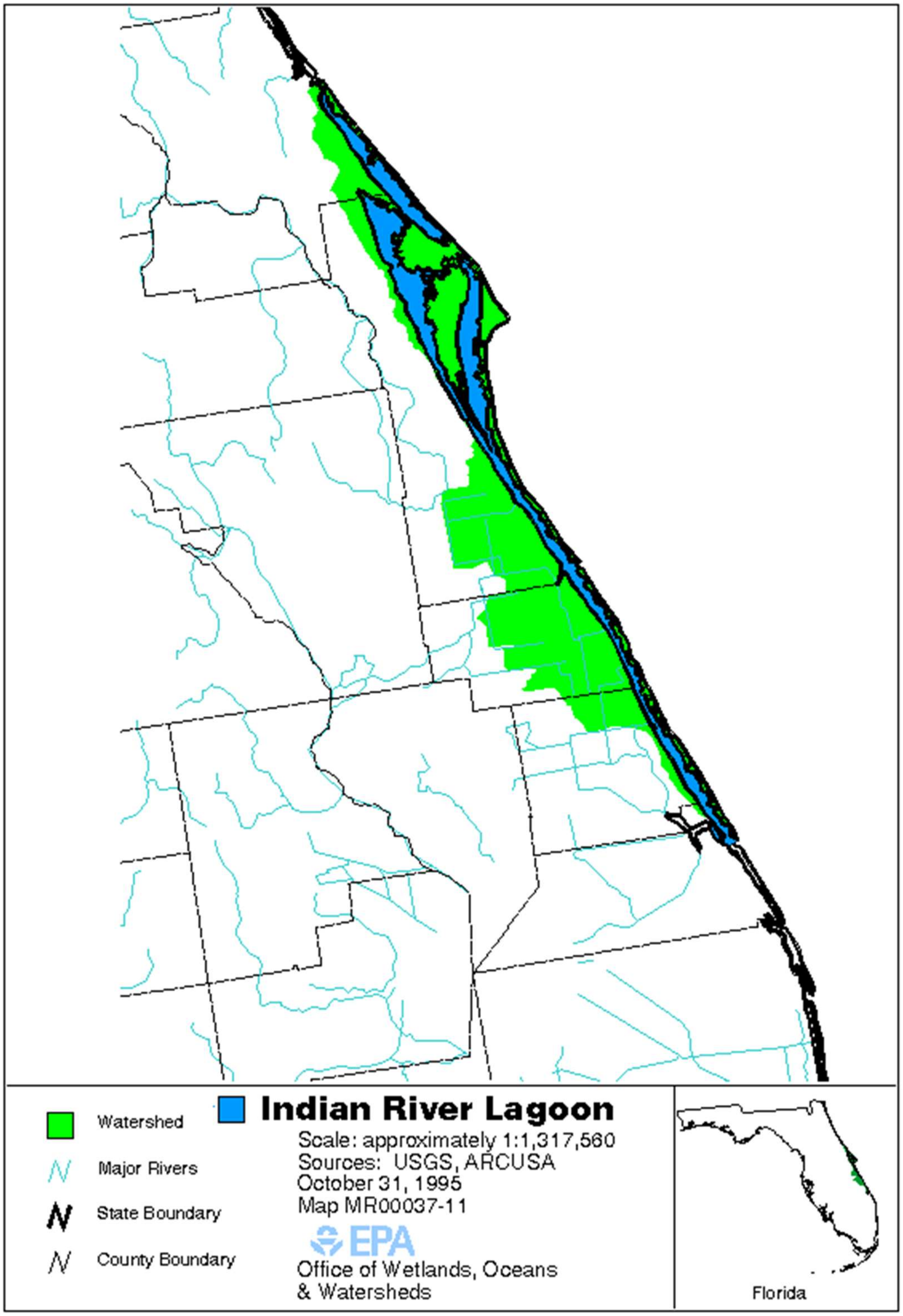


Figure 2. Location of the IRL and its Watershed

Unique Location

IRC is located in the central portion of the IRL. IRC has an intricate series of drainage canals that historically drained the internal portions of the county for agriculture. There are three relief canals discharging freshwater from the west to the IRL, which are managed by the Indian River Farms Water Control District (IRFWCD). The St. Sebastian River, located in the northern part of IRC, and the ditches and stormwater outfalls connected to the river, are additional major sources of freshwater to the

IRL. Lands adjacent to the IRL and groundwater flows also provide freshwater inputs. The Sebastian Inlet connects the IRL in northern IRC to the Atlantic Ocean. The Fort Pierce Inlet, located in St. Lucie County, is approximately six miles south of IRC. The proximity to the Fort Pierce Inlet to the south and Sebastian Inlet to the north and lack of earthen causeways in IRC allows for free water exchange with reduced residence times. Current residence times for IRC are estimated to be 2 to 16 days (Kim 2003), where other areas of the IRL have residence times as high as 148 days. This low residence time has a significant effect on improved water quality. Seawater exchange does not reduce nutrient loads to the IRL, but it can be beneficial to the denitrification process. It improves oxygenation, stabilizes temperatures, and maintains a consistent salinity.

Impacts facing the IRL in IRC are similar to other regions, but the hydrology and hydrodynamics are different when compared to the North IRL, Banana River Lagoon, and Southern IRL. The North IRL and Banana River Lagoon have reduced circulation and increased resident times, whereas the Southern IRL is impacted by Lake Okeechobee discharges. The lack of major structural hydrological issues in this region is a major benefit to the IRL water quality within IRC.

Current Conditions

Concerns regarding the health of the IRL began as early as the late 1970s. In 1990, the IRL System and Basin Act was created to protect the IRL from package plant wastewater discharges, investigate the feasibility of reuse water, and centralize wastewater collection and treatment facilities to prevent sewage spills. In 2006, the U.S. Environmental Protection Agency and FDEP designated portions of the IRL as an impaired waterbody because water quality parameters did not meet standards set by the state of Florida. FDEP determined that all the IRL and Banana River Lagoon segments are impaired for nutrients due to impacts to seagrass. In March 2009, FDEP adopted the total maximum daily loads (TMDLs) for the IRL and Banana River Lagoon, which include the portions of the Central IRL within IRC. The TMDLs were established to address the seagrass losses associated with excessive nitrogen and phosphorus loads to the IRL. The TMDLs were determined from linear regression models that relate seagrass depth limits to annual nitrogen and phosphorus loading, and seagrass losses were determined based on review of a composite of seagrass maps from 1943 to 1999. A basin management action plan (BMAP) was created to establish local commitments for nutrient load reduction to restore water quality in the Central IRL. This BMAP was adopted in 2013 and was based on the Pollutant Load Screening Model (PLSM) and did not include loading reductions for IRC. Unfortunately, in 2011, 2012, and 2016, excessive loading of nitrogen and phosphorus led to extensive algal blooms. Both events led to fish kills, widespread seagrass die off, and raised concerns regarding the effects on wildlife dependent on the habitat.

As a result of the reduced water quality and loss of seagrass, FDEP updated the BMAPs using the results from the Spatial Watershed Iterative Loading (SWIL) model in 2020 that included nutrient load reductions for IRC, and the BMAP released in 2021 provided different IRC load reductions. Load reductions assigned to IRC have been adjusted multiple times in recent years, as a result of changes to the SWIL model, and are still not fully updated. Current load reduction allocations for IRC are 210,695 pounds of total nitrogen (TN) and 29,649 pounds of total phosphorus (TP), as shown in Figure 3.

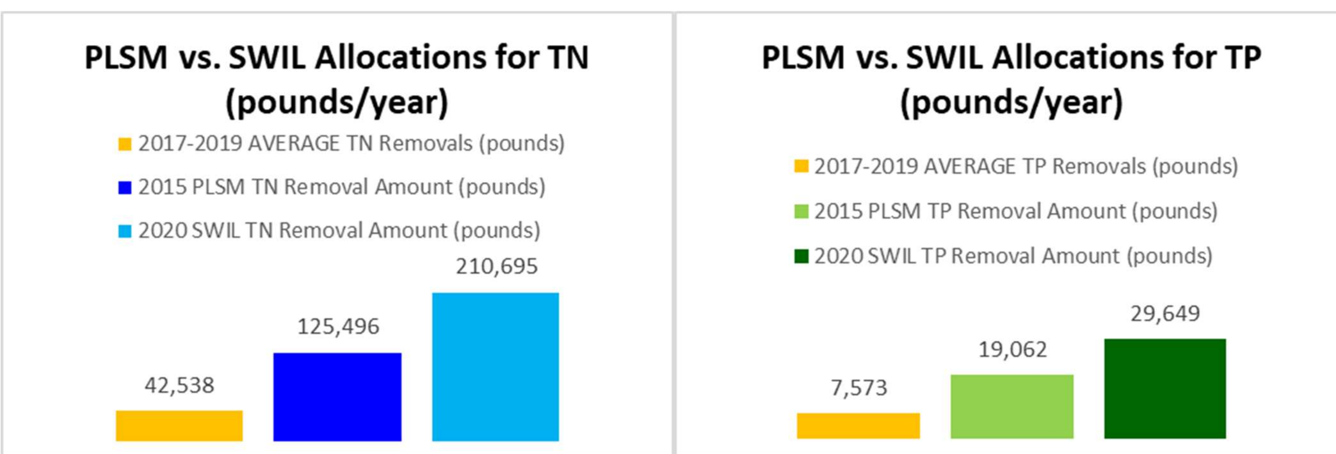


Figure 3. Summary of IRC BMAP Required Reductions Over Time for TN (left) and TP (right)

In addition to water quality concerns, the IRL has experienced a benthic habitat shift. Historically, the Lagoon was dominated by a sandy bottom, but excessive organic matter, nutrients, and fine sediments from erosion has created deposits of muck in the tributaries and in areas of the IRL. Researchers estimate muck has accumulated on approximately 10% of the Lagoon floor, reducing the sediment quality for seagrass growth and allowing for fluxes of nutrients from the sediments to the water column. The reduction of sediment and water quality has resulted in massive and in many areas total loss of seagrass in the IRL. While the IRC areas of the IRL are holding some of the most abundant areas of seagrass in the entire IRL system, the seagrass loss in IRC remains staggering.

The issues affecting the IRL can be linked to a culmination of anthropogenic influences on the ecosystem. The excessive nutrient loading and shift in benthic habitat was not sudden, but a decades long build-up. The legacy loading of nutrients to the system increased stress and reduced resiliency, causing further degradation from both natural and anthropogenic triggers. The restoration and conservation of the IRL will not be a rapid process, but with proper management strategies to reduce nutrient loading it will be possible to reduce stress and increase resiliency, while improving conditions.

B. Plan Funding

This list represents a portion of grant funding sources available and is by no means a comprehensive list. As new funding sources become available, they will be added to the plan.

Funding Sources for Research

- FDEP Grants
- IRL National Estuary Program (IRLNEP)
- St. Johns River Water Management District (SJRWMD)
- Protecting Florida Together Resilient Florida Planning Grant
- Partnerships with universities and research entities.

Funding Sources for Projects

- FDEP Grants
- Florida Fish and Wildlife Commission (FWC) Derelict Vessel Removal Grant Program
- Derelict Vessel Grant FIND Cost Share Grant
- FIND Grant Program
- Cooperative Assistance Program FIND
- Small-Scale Spoil Island Restoration and Enhancement Program
- Building Resilient Infrastructure and Communities grant through Federal Emergency Management Agency
- IRLNEP
- SJRWMD
- Florida Department of Economic Opportunity
- Protecting Florida Together Grants
- National Oceanic and Atmospheric Association (NOAA) Transformational Habitat Restoration and Coastal Resilience Grants
- Florida Department of Transportation
- Restore America’s Estuaries National Estuary Program Coastal Watershed Grant
- Restore America’s Estuaries National Estuary Program Watershed Grant
- Resilient Florida Grant Program
- American Rescue Plan Act of 2021
- Additional funding opportunities are welcome, including research partnerships with universities and research entities.

C. Plan Organization

This plan is organized by the IRC divisions and associated key factors. Some factors are the purview of multiple divisions and will require shared duties. Actions are provided for each key factor and a project list is provided in Section 7 detailing active, under construction, designed, and conceptual projects to achieve these actions.

2. Coastal

A. Goals and Objectives

The goals and objectives for the Coastal key factors include:

a) Improve water quality, which is linked to algal blooms and declining seagrass.
b) Improve ecosystem function through the protection of existing habitats and the restoration of declining habitats.
c) Determine areas of muck accumulation for mitigation and management.
d) Monitor sea level rise and its impacts on spoil islands, saltwater marshes and mangrove marshes.
e) Increase boater education and awareness.

B. Key Factors

Water Quality

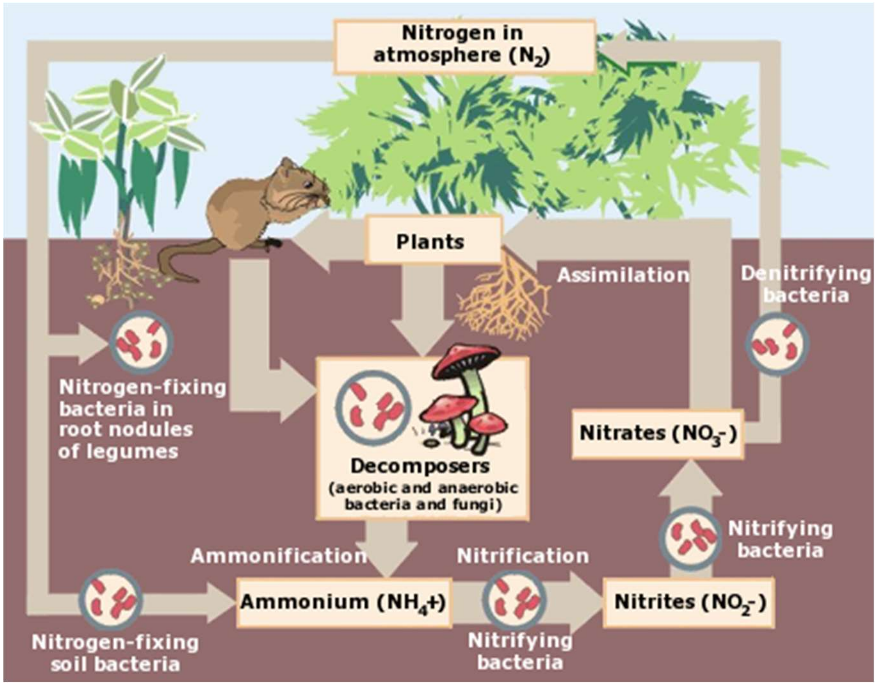
In portions of the IRL, trends in nutrient levels have been increasing over historical values. The increase in nitrogen, phosphorus, and heavy metals has been linked to anthropogenic influences. Several organizations monitor water quality in the open waters of the IRL; IRL tributaries; and in stormwater, surface water, and groundwater in the IRL watershed. These entities include IRC Stormwater and Utilities, FDEP, SJRWMD, Florida Atlantic University, and Ocean Research & Conservation Association. The parameters measured include salinity, temperature, dissolved oxygen (DO), nitrogen, and phosphorus. Coastal eutrophication is a risk in areas with increased urbanization and rapid population growth (Howarth 2008, Rabalais et al. 2009, Malone and Newton 2020). This risk is due to hardening of the coastline, runoff of lawn waste (fertilizer, sediment, pesticides, and herbicides), and increased wastewater discharge volume and strength.

Nitrogen and Phosphorus

Nitrogen and phosphorus are important nutrients in an ecosystem, but when the nutrients are overabundant or out of balance there is a risk for the development of algal blooms, which leads to a seagrass die off and low DO. Freshwater systems are typically limited by phosphorus since freshwater microorganisms are effective at fixing nitrogen from the atmosphere. Marine waters are typically nitrogen-limited. Estuaries, like the IRL, are locations where freshwater and marine waters mix, making the system a more complex system for determining the root cause of eutrophication. Anthropogenic sources of nitrogen and phosphorus include agriculture, fertilizer, pet waste, wastewater (septic), detergents and stormwater runoff. Reducing anthropogenic sources of nitrogen and phosphorus to the IRL is paramount to achieving a healthy ecosystem.

Nitrogen exists as atmospheric nitrogen gas, ammonia, ammonium, nitrite, and nitrate. Ammonia, nitrite, and nitrate are often anthropogenic sources of nitrogen entering the environment. During nitrogen fixation planktonic, bacteria, cyanobacteria and some algae convert atmospheric nitrogen to ammonia (Figure 4). Nitrification occurs when ammonia is converted to ammonium, nitrite, and subsequently nitrate. During this process bacteria consume oxygen from the water column, which can lead to low oxygen levels and an accumulation of ammonia and nitrate in eutrophic systems. Plants and algae will take up ammonium and nitrate to grow mass. Under eutrophic conditions, algae can out complete plants for the available nitrogen and cause algal blooms.

Phosphorus is an essential nutrient for all living organisms. In the environment, phosphorus naturally occurs as phosphate in sediments and rocks, slowly leaching into ground and surface waters. Florida is naturally high in phosphates, but additional phosphate may enter the water column as a result of human activity. Phosphorus is one of the main ingredients in fertilizers used in agriculture and is common in detergents. When phosphorus enters the water, it is taken up by aquatic plants and algae. Excessive phosphorus can lead an increase in algae causing the phosphorus to be released back into the system when the algae die.



From: https://www.epa.gov/caddis-vol2/ammonia#tab-4

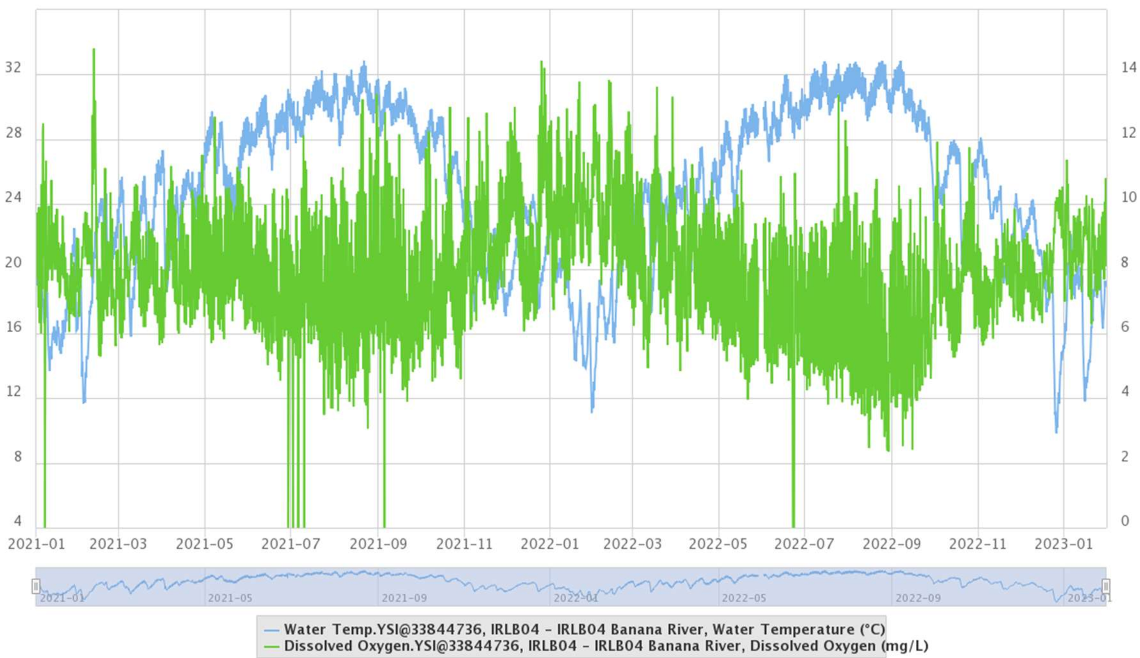
Figure 4. Nitrogen Cycle

Dissolved Oxygen

The quantity and forms of nitrogen present in the IRL is closely related to DO, which is consumed during nitrification. DO is the amount of oxygen in the water available for use by aquatic organisms. Some species are adapted to lower levels of DO, but generally aquatic species require greater than 2 milligrams per liter for survival. Therefore, the DO concentration in water can be a measure of the health of the aquatic environment. DO has both a daily and seasonal cycle. Oxygen is produced by plants in the presence of sunlight via photosynthesis. DO concentrations tend to decrease at night when photosynthesis is not occurring. Light availability determines the daily cycle, but the seasonal cycle can be linked to light and temperature (Figure 5). Temperature, salinity and atmospheric pressure determine the amount of DO that can dissolve in water. When temperatures increase, the amount of DO the water can hold decreases. The same is true for salinity. Saltwater holds 20% less oxygen than freshwater. Wind, waves and currents mix the water column, mixing DO throughout and allowing for the dissolution of atmospheric oxygen into the water. This increases DO availability when winds and currents are high, while stagnant water will experience a decrease in DO and will often have hypoxic conditions at the lowest stratification. When a system is consistently depleted of DO, the hypoxic waters are referred to as a “dead zone.” A rapid or widespread decrease in DO is often the cause for fish kills.

Salinity

Salinity is the measurement of dissolved salts in the water and is often expressed as parts per thousand (ppt). Many aquatic plants and animals are sensitive to fluctuations in salinity including seagrass and oysters. Freshwater has a salinity of 0.5 ppt or less. Estuaries can have salinities from 0.5 ppt to 30 ppt depending on freshwater inputs, flow and proximity to the ocean. Freshwater inputs to the IRL will lower salinity levels, while periods of drought will create hypersaline conditions. The proximity to the inlets stabilizes the salinity in IRC’s region of the IRL, but major storm events may create pulsed events of low salinity. These changes in salinity are temporary, often recovering within days. On average, the IRL portion within IRC has a salinity ranging from 20 ppt to 30 ppt.



Note: Graph provided by SJRWMD

Figure 5. Example of the Relationship Between DO and Temperature

Coastal Acidification

Atmospheric carbon dioxide is absorbed by the ocean and other bodies of water, lowering the natural pH of the system. Estuaries are not only influenced by atmospheric carbon dioxide, but by excess nitrogen and organic carbon runoff from land and freshwater inputs creating coastal acidification. The pH scale is a logarithmic, a pH of 5 is 10 times more acidic than a pH of 6 (Figure 6). Because of a ten-fold increase, slight changes in pH can have a large impact on water chemistry and marine life. The pH of ocean water is 8.2 at a salinity of 35 ppt. The pH of estuarine water is influenced by the salinity. In areas with lower salinity levels the pH can range from 7.0 to 7.5. Areas with increased salinity will have a range in pH of 8.0 to 8.6, because of the alkalizing capability of saltwater. A 2018 study examined pH, DO, temperature and salinity from 10 estuaries in Florida over a 28-year period. The results from the IRL indicated decreasing pH levels and increasing coastal acidification (Robbins and Lisle 2018).

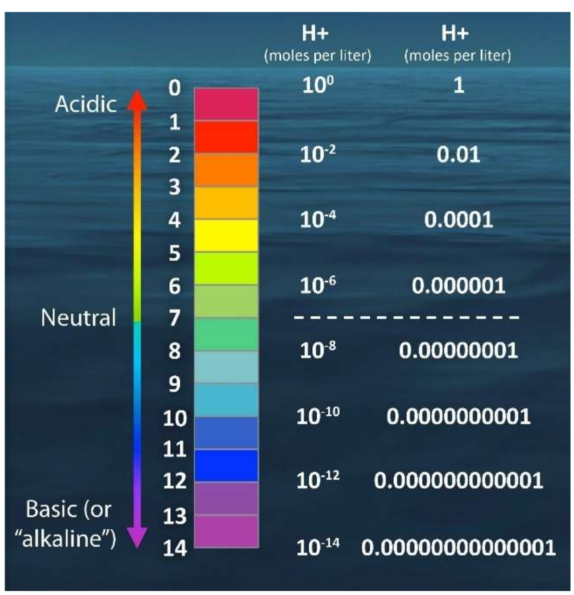


Figure 6. Logarithmic pH Scale

Changes in pH level impact marine organisms including fish and calcifying taxa. Under decreasing pH levels, invertebrates are unable to mineralize their exoskeletons. The shellfish may experience a slower growth rate, thinning shells and an increase in mortality. The impacts to fish are not as direct and many researchers believed fish species would not be impacted, because they do not rely on calcium carbonate. However, decreases in pH affect water chemistry. Studies have shown fish can experience metabolic stress, impacts to skeletal mineralization from acidosis and impacts to their sensory system. While some species are capable of adapting to changes in water chemistry, some studies have shown impacts to their olfactory system changing larval behavior including settlement. Coastal acidification is also implicated in the die off of coral reefs across the globe. The economic impacts of coastal acidification are unknown at this time, but tourism and recreation, which includes fishing and diving, contribute $2 billion dollars annually to the region.

Heavy Metals

Copper, mercury and lead have been found at elevated concentrations in sediments and clams near marinas and urban areas adjacent to the IRL (Trefry and Trocine 2011). These trace elements are naturally found in water and sediments. However, anthropogenic sources of heavy metals are increasing to potentially toxic levels. Anthropogenic sources of heavy metals include agriculture, manufacturing, sewage sludge, pesticides, antifouling paints, galvanized metals, and chromated copper arsenate treated lumber. High levels of heavy metals such as copper and lead can impact survival, growth, reproduction and brain function in marine organisms. Copper is the main component in antifouling paints used to prevent organisms from settling on ship hulls. While its use is beneficial to the marine industry, it is a biocide impacting marine organisms including oysters, which are beneficial filter feeders in the IRL. Additional antifouling paints without copper and other heavy metals, which are capable of inhibiting bioaccumulation, have proven successful and cause less damage to marine organisms.

Emerging Contaminants

Concerns regarding other contaminants remain unknown. Research by Florida International University found caffeine, opioids, antibiotics and other common drugs in redfish collected from the IRL. The impact these medications have on fish, human consumption and other marine life remains in question.

Another emerging contaminant of concern is microplastics. Plastic materials can take anywhere from 20 to 500 years to break down, creating microplastics, which are plastics measuring less than 5 millimeters. Microplastics have been found in the stomach content of fish and in the tissues of oysters in the IRL. Little is known about the impact plastics are having on the health of these organisms. There is evidence of dehydration and malnutrition in marine organisms ingesting plastics, which often leads to death.

While nitrogen and phosphorus have been linked to degraded water quality leading to algal blooms and eutrophication, there are other factors impacting IRL water quality. Heavy metals; coastal acidification and emerging contaminants such as plastics, perfluoroalkyl substances and glyphosate have been linked to anthropogenic sources. There is increasing concern regarding their impacts on the IRL, especially since they have often been overlooked by regulatory agencies. To successfully improve IRL water quality, it is necessary to address all pollutants and contaminants from anthropogenic sources.

Water Quality Actions

The following actions are proposed to help improve water quality in IRC's portion of the IRL:

- Improve wastewater treatment facilities and eliminate disposal to the IRL.
- Continue education and outreach for pollution reduction including the fertilizer ban.
- Continue to encourage regulatory oversight agencies to improve and ensure proper BMPs are in place for agricultural facilities.
- Continue to improve BMPs for County facilities.
- Reduce freshwater inputs to the IRL.

Harmful Algal Blooms

The IRC HAB Response Plan sets objectives, partners and response actions for the County during a HAB event. Response efforts include sampling, public messages and cleanup of deceased organisms.

Algae is a normal component of a healthy ecosystem, but often goes unnoticed. An increase in nutrient inputs to the system can lead to excessive growth in algal species, known as an algal bloom. Algal bloom persistence is dependent upon the species and nutrients available. A limiting nutrient controls the growth of the algae or plant when it is at low levels in the ecosystem. Nitrogen is often the limiting nutrient in marine and estuarine environments, while phosphorus has been considered the limiting nutrient in freshwater ecosystems. However, in an algal bloom, the limiting nutrient is also dependent upon the species of algae present. *Pseudo-nitzschia* is a diatom commonly found in the Central IRL. Under bloom conditions, the algae produce the biotoxin domoic acid, which causes amnesic shellfish poisoning. Unlike other algae, the limiting nutrient for diatom blooms is silicon. Throughout history, the IRL has experienced periodic algal blooms, but in recent years there has been an increase in frequency and duration as well as a shift in the dominant taxon making up the bloom. In 2011 and 2012, there was a persistent algal bloom, which impacted seagrass beds and caused widespread fish kills. The 2011 bloom was caused by a green microalga, while the 2012 bloom was dominated by *Aureoumbra lagunensis,* a brown alga previously unknown to the region. These algae species had not been identified in previous blooms and their size (6 micrometers) made it difficult to identify them with a standard microscope. As the seagrass beds began to rebound in the IRL, another algal bloom was experienced. In 2016, the IRL experienced a wide-spread algal bloom of *Aureoumbra lagunensis* as well as the cyanobacteria species *Microcystis aeruginosa*, which flowed from Lake Okeechobee through the St. Lucie Estuary.

Many algal species produce biotoxins, which are dangerous to aquatic organism and humans. These toxins can cause neurological, respiratory and liver issues depending on the species. However, not all algal species produce toxins. Yet an algal bloom is still harmful to the aquatic environment. Extensive and persistent algal blooms block light from reaching seagrass beds, leading to seagrass loss. As the algae die and settle to the Lagoon bottom, decomposition begins. Bacteria and other microbes take up oxygen during the decomposition process leading to low DO and fish kills. In addition, the decomposition of the algae causes muck accumulation on the Lagoon bottom. The best action taken against a harmful algal bloom event is prevention of excess nitrogen and phosphorus by IRC and citizens.

Harmful Algal Blooms Actions

The following actions are proposed to help reduce harmful algal blooms in the IRL:

- Monitor real time data to identify possible harmful algal blooms.
- Work with local stakeholders to provide increased monitoring when there is a potential for health concerns.
- Reduce freshwater and nutrient inputs.

Organics and Sediments

Historically the IRL had a sandy benthic habitat. The sandy material consisted of 7% clay and 2% organic matter. As the population along the IRL began to boom in the 1900s, an increase in runoff carried organic matter, silty sediments and nutrients. In addition, increased nutrient loads lead to algal blooms, which increase the organic material to the Lagoon floor. These inputs have caused a shift in the IRL benthic community. Sandy sediments have now been replaced with muck, which is primarily composed of water and has the consistency of mayonnaise (also known as “black mayonnaise”). The sediments are comprised of 59% clay and 10% organic matter. This high organic matter content produces hydrogen sulfide and creates an anoxic benthos. The high-water content and the fine silty material increase turbidity and smother the benthic habitat inhibiting seagrass growth. Muck accumulates nutrients allowing for fluxes of nitrogen and phosphorus to the water column creating a feedback loop for potential algal blooms.

Deep muck pockets are often isolated to specific sites including the ICW and other deeper holes and channels. Other regions of the IRL may contain smaller, thinner layers of muck over natural Lagoon sediments. At this time, there is limited understanding of muck locations and content within the IRL in IRC. To better understand muck locations and content, it is necessary to map the current muck locations, determine their depth and measure their nutrient fluxes. Extensive muck pockets can be managed by dredging, dewatering and disposal of the muck material at the landfill or an upland site. Muck removal by dredging is suitable for navigable areas of the IRL. Muck has also been successfully managed by trapping the material under a clean layer of sandy sediments compatible with the IRL natural sediments. Dredging and capping muck is beneficial in preventing nutrient fluxes to the water column. While these methods are available to manage the current muck within the IRL, it is necessary to prevent further accumulation of muck, as it is easier and more cost-effective. Ways to help prevent the accumulation of muck include keeping a native buffer along IRL shorelines to reduce erosion, reduce the use of fertilizer and keep lawn trimmings and plants out of canals and drains.

Organics and Sediments Actions

The following actions are proposed to help improve organics and sediments in IRC's portion of the IRL:

- Identify areas of muck impact.
- Determine muck flux rates.
- Remove and/or cap muck as necessary.

Hydrology and Hydrodynamics

The IRL is influenced by rain, surface water, groundwater and ocean inputs. The total flow entering the IRL and water movement within the system are important factors influencing its health. Hydrology is the study of the movement, distribution and properties of the Earth's waters, which includes surface and ground waters. Hydrodynamics is the study of the internal circulation of water and its effects on water quality. Historical records have shown human habitation along the IRL for over 7,000 years, but it was not until the late 1800s that human activity began to drastically shift the hydrology and hydrodynamics. The alteration of natural system flows includes hardened shorelines, drainage canals, dredging, mosquito impoundments, causeway development, and creation of artificial islands and inlets, which occurred over time as humans populated the region.

The demand for agricultural land required the drainage of wetlands, creating three relief canals and ultimately increasing the freshwater drainage to the IRL. The amount of freshwater flow has continued to increase through additional navigable canals for property owners and continued development.

In 1912, the ICW was completed creating a 10 to 12-foot deep channel for vessel navigation. The spoil from the dredging of the channel created 43 spoil islands in IRC (Figure 7), which shifted the wind-driven flow. In addition to dredging and spoil deposition, the need for access across the IRL increased as the region continued to develop. The filling in of land masses and creation of causeways caused a narrowing of open water and affected wind-driven circulation. Along with channelization and man-made canals, the creation of dead-end spaces has increased retention time in specific regions, making the system more vulnerable to pollutants, the trapping of sediments and anoxic conditions.

In 1925, the IRC Mosquito Control District was established. To control the mosquito population, mosquito impoundments were created through the channelization and diking of high marshes westward of the fringing marshes of Spartina and red mangroves. By the 1960s, 2,600 acres out of 4,500 acres of IRC coastal marsh habitat were impounded along the IRL. Impoundments created several issues relating to nursery connectivity, shifts in biodiversity and allowed for an overgrowth of both native and invasive species eliminating the high marsh habitat. These impoundments prevent connectivity from the marsh to the IRL, which isolates important sport fisheries from critical nursery habitat. In addition, the consistent flooding of impoundments can create hypersaline conditions and a loss of vegetation. Management practices for mosquito impoundments have changed with increasing knowledge regarding the impacts to important sport fisheries. Many mosquito impoundments remain open for extended periods of time to allow for greater connectivity and are only flooded during a small period of the year. The extensive drainage for development and agriculture, as well as the creation of impoundments for mosquito control eliminated natural wetlands and changed the natural water flow, as well as the connectivity between important nursery habitat and the IRL.

The IRL had two natural inlets, Ponce and Jupiter, with temporary inlets over narrow areas of the barrier island. Temporary inlets allowed for the movement of sand from the east to the west bank of the IRL, creating a shallow sandy bottom. Temporary inlets would persist for days to years, but the often shallow and narrow inlets prevented vessel traffic from moving between the IRL and the Atlantic Ocean. To increase navigable access from the IRL to the Atlantic Ocean, three man-made inlets and Port Canaveral and locks were created in the IRL. The natural movement of sand continually fills in the inlets, which requires managed dredging to remain open. Even with five inlets, the tidal nature of the IRL is limited to a few miles north or south of an inlet limiting saltwater flow and making the IRL sensitive to fluctuations in land-based discharge. IRC is bordered by two inlets, Sebastian and Fort Pierce, which help to stabilize salinities in the Central IRL and reduce residence times when compared to more isolated regions of the IRL.

The development on and along the IRL has changed circulation patterns, impacting coastal marsh habitat, influencing salinity and altering flushing rates. The IRL hydrodynamic changes ultimately impact water quality and sedimentation within the system. While having two inlets in close proximity benefits the IRC region of the IRL, increased development has altered shorelines reducing resilience and impacting water quality and sedimentation rates.

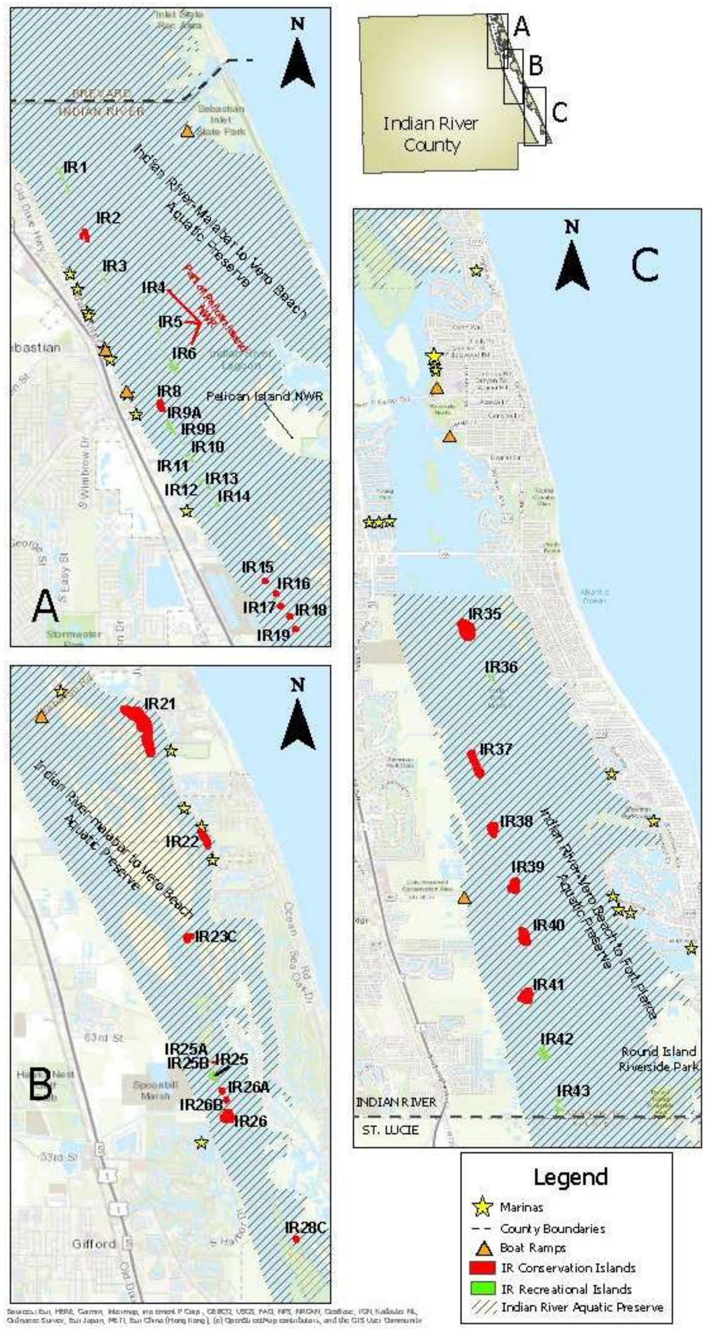


Figure 7. Locations of the IRC Spoil Islands

Hydrology and Hydrodynamics Action

The following action is proposed to improve the hydrology and hydrodynamics in the IRL:

- Reduce freshwater flows to the IRL.

Sea Level Rise

Sea level rise is a concern for all coastal communities. It is caused by the melting of ice sheets and glaciers and the expansion of water as it warms (Lindsey 2022) (Figure 8). Most of the coastal areas in IRC are less than 25 feet above sea level. Since the 1970s, seas have been rising at approximately 4.03 millimeters per year, which is equivalent to 1.32 feet in 100 years (Figure 9). This puts coastal areas of the IRC at greater risk for potential flooding and inundation from sea level rise. Sebastian Inlet to the north and Fort Pierce Inlet to the south create a tidal influence within the IRL in IRC. As sea level rises, tides will also become more extreme increasing IRL water levels. The USACE Projection Summary anticipates seven of the 50 stormwater outfalls in IRC will be underwater by 2040 and IRL elevation will reach between 5 to 8.5 feet by the end of the century (USACE 2013). In addition to sea level rise, climate changes will increase storm frequency and intensity leading to an increase in potential inundation of upland areas, placing homes and infrastructure at risk.

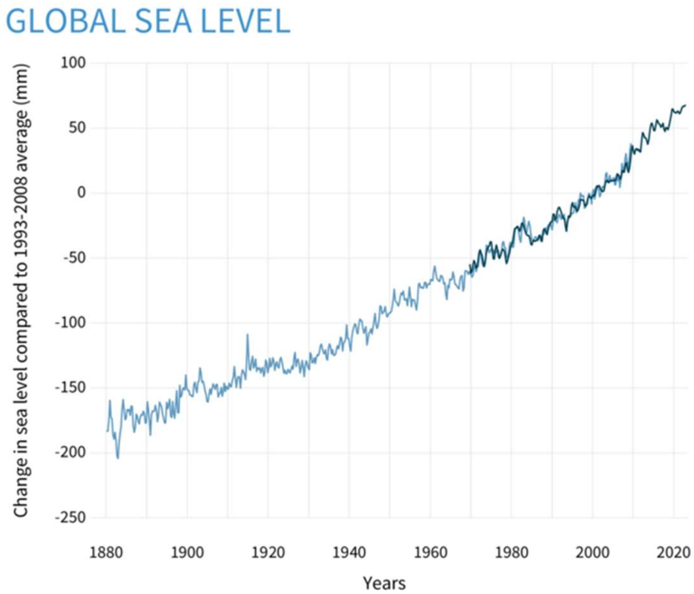


Figure 8. Global Sea Level Rise

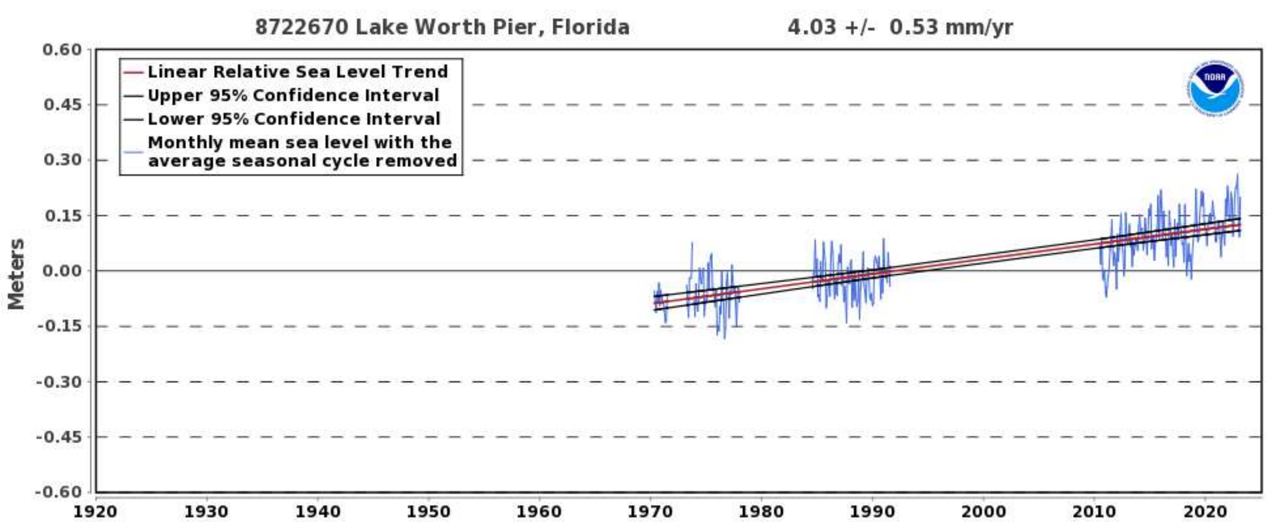


Figure 9. Sea Level Rise at Lake Worth Pier, Florida

Sea level rise will have ecological implications on the distribution of seagrass, the migration of marshes, increased shoreline erosion, oyster reefs and saltwater intrusion. High marshes positioned above mean high water levels naturally protect upland structures from water inundation, prevent pollution and are an important habitat for numerous organisms. With the loss of high marsh habitat, sea level rise will increase sedimentation and nutrient releases to the IRL. Many of the remaining mangrove fringe habitat will be unable to retreat. Mangrove fringe habitats act as a carbon sink, filter nutrients, stabilize sediments and provide a vital nursery habitat within the IRL. With limited ability to retreat, mangrove fringe habitats will eventually be destroyed, releasing stored carbon creating negative feedback for climate change drivers. The IRLNEP Climate Ready Estuary Technical Report (2021) lists sea level rise as a major stressor for impaired waters. In a risk analysis it was determined sea level rise in the IRL will increase pollutant loadings, decrease water clarity, decrease DO, reduce suitable marsh habitat and decrease biodiversity while increasing the risk of exotic and invasive species spread. Sea level rise will negatively impact habitats and organisms within the IRL. In addition to those impacts, homes and infrastructure will be at risk of flooding. To gain a better understanding of the risks to the IRL and the community, it is necessary to understand the rate of sea level rise in the IRC. While data are available from NOAA, the closest station is 90 miles south in Lake Worth.

Sea Level Rise Actions

The following actions are proposed to help address sea level rise in IRC:

- Improve resiliency and shoreline protection.
- Encourage engineering sea level rise risks and scenarios into new infrastructure.

Aquatic Ecosystem Functions and Habitat Use

The IRL is a biologically diverse estuary. It is home to over 4, 000 species of flora and fauna. Estuaries play an important role as a nursery habitat for many marine organisms spending their larval and juvenile stages in a protected shallow environment. While some species only use the IRL for a portion of their lifecycle, there are many residing within the Lagoon for their entire life. Several species in the IRL have experienced ecological changes linked to the degradation of the ecosystem. Declining water quality and sediment degradation can be implicated to the many issues these organisms have experienced.

Seagrasses

Seven species of seagrasses inhabit the IRL, but the most dominant species, and particularly within the IRC region, are *Halodule wrightii* (shoal grass), *Syringodium filiforme* (manatee grass) and *Thalassia testudinum* (turtle grass). Seagrasses provide essential ecosystem services to the IRL. Seagrasses stabilize the benthic habitat, provide shelter for invertebrates, fish, take up nitrogen and phosphorus and are an important food source for herbivorous organisms, including manatees. Because of the importance of seagrass in the IRL, it is widely studied with the most extensive dataset collected by SJRWMD. SJRWMD began mapping seagrass the IRL every two years since 1986. The agency conducts both aerial surveys and transect surveys throughout the IRL. For the purposes of seagrass mapping, SJRWMD breaks the IRL into reaches. IRC is located within Reach 6 and SJRWMD monitors 15 transects in the County (Figure 10).

Through their extensive mapping efforts, SJRWMD is able to determine the areal change in seagrass within each reach. From 1970 to 1992 seagrass coverage in the South Central IRL relatively remained the same. Some regions saw an increase in seagrass coverage, while areas with increasing development saw a decrease (Fletcher and Fletcher 1995). However, a decrease in the maximum depth of seagrass beds was observed, which was linked to low light conditions. This has remained true for seagrass beds within IRC. SJRWMD continues to see the maximum depth of seagrass beds shrinking. Since 1998, the mean percent cover of the three-dominant species of seagrasses in IRC has steadily declined. Seagrass loss was accelerated in 201, 2012 and 2016 with extensive losses in areal coverage as well as density caused by widespread algal blooms (Figure 11). Seagrass loss throughout the IRL has been linked to decreased photosynthetic active radiation, which is required for survival and growth. Since 2016, seagrass beds have begun to show patchy recovery in IRC. It is important to understand that seagrass recovery will not occur rapidly. It is estimated it will take up to 16 years for areal coverage and density to return to pre-2011 coverage, but this will require continued improvement to water quality. It is not feasible to plant all the lost seagrass beds within IRC. However, to boost natural recovery efforts, restoration projects at historically known seagrass sites with viable water quality, clarity, sediment quality and protection from wave action may be beneficial.

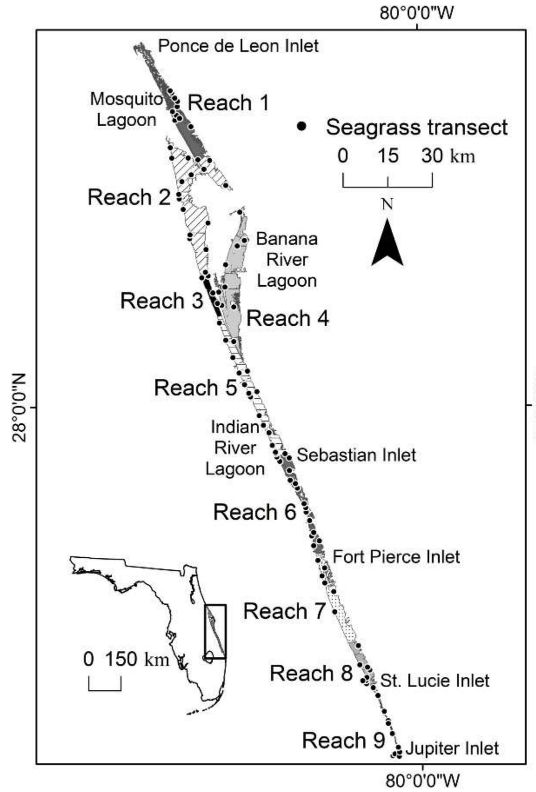


Figure 10. Locations of SJRWMD Seagrass Transects

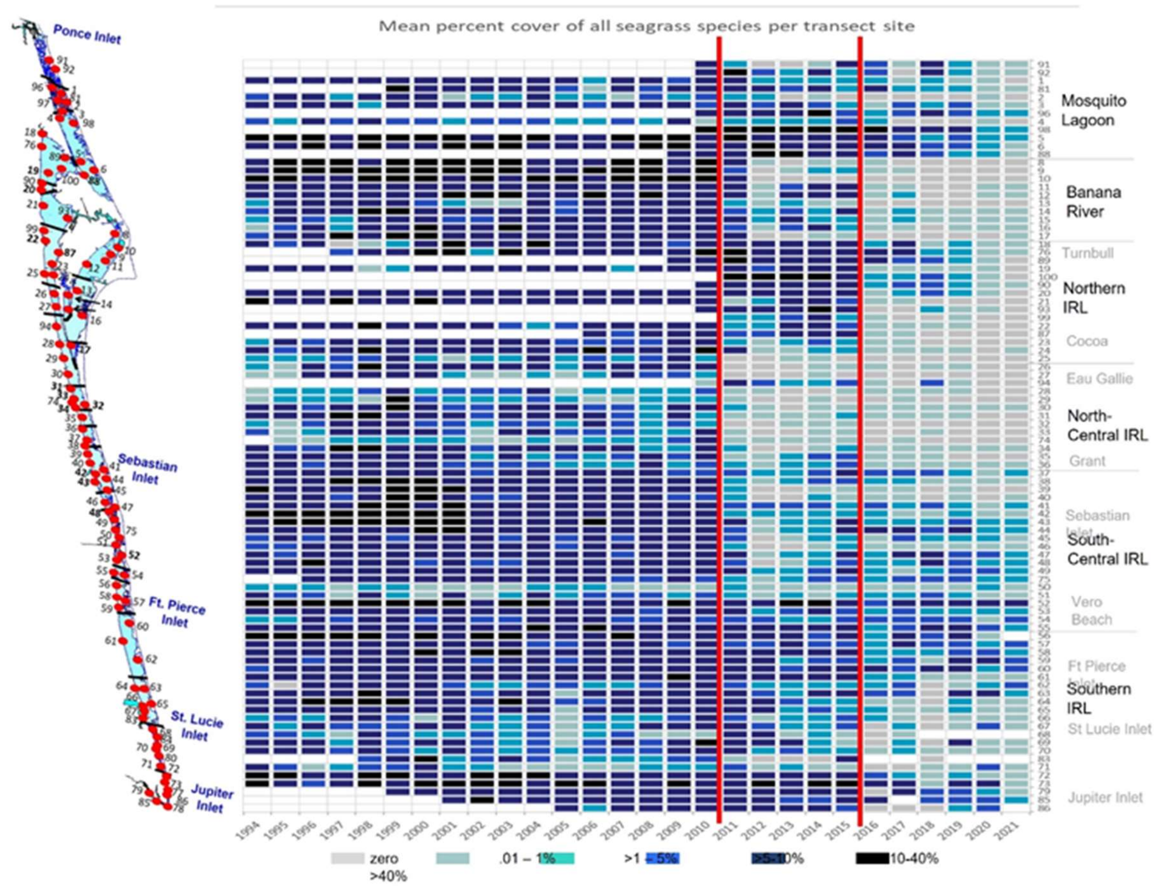


Figure 11. Changes in Seagrass Coverage over Time Throughout the IRL

Mangroves

Three mangrove species can be found along the shorelines of the IRL: red, black and white. In many regions of the world, mangroves often grow in succession indicating flood tolerance (Figure 12). However, mangroves in the IRL do not follow the typical progression from red mangrove in the intertidal, to black at the mean high tide line and white growing in upland less flooded areas. Mangroves create a nursery habitat and shelter for numerous organisms, including important commercial and recreational fish species. They offer protection against tidal and wave forces, offering protection to upland structures. Mangroves stabilize and trap sediments along shorelines and have been shown to outperform seawalls and bulk heads (Timm 2017). In addition to the habitat and protection mangroves offer, they are a nutrient and carbon sink, removing excess nutrients and carbon from the environment. The greatest threat to mangroves is development. FWC estimates the IRL has lost 85% of its mangrove forest. To protect mangroves in Florida, FDEP regulates the removal and trimming of mangroves, setting guidelines and permit requirements for such activities (https://floridadep.gov/sites/default/files/Mangrove-Homeowner-Guide-sm_0.pdf). IRC is currently working with the University of Central Florida to complete a shoreline characterization study within the county. The study will help managers better understand current shoreline conditions and establish strategies for shoreline restoration and management.

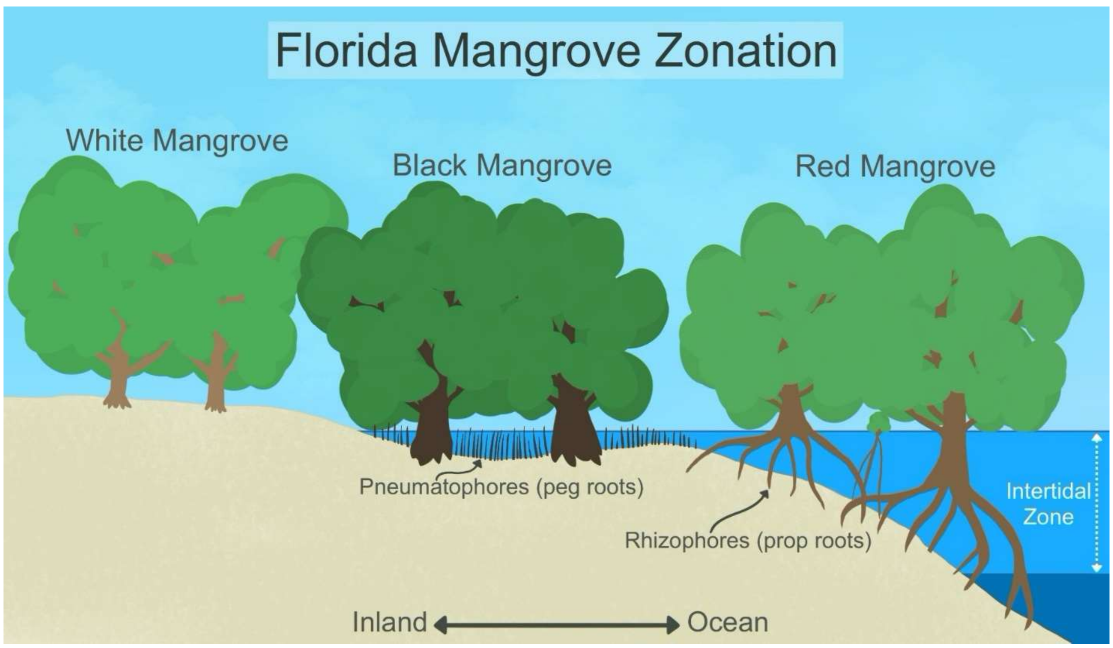


Figure 12. Florida Mangrove Zonation

Suspension Feeders

There are approximately 160 species of bivalves inhabiting the IRL. Bivalves are suspension feeders and include clams and oysters. Historical bivalve populations are not well understood in the Lagoon, although shell middens indicate oysters and clams were part of a sustainable fishery for the Ais Native Americans. World-wide, bivalve populations are declining. This decline can be contributed to disease, changes in water quality, suitable settling habitat and overharvesting.

IRC has oyster reefs near the North Relief Canal, Spoil Island 43 (IR-43) and at the mouth of the St. Sebastian River. Oyster growth also occurs in abundance on red mangrove prop roots, dock pilings and shallow rocky areas throughout IRC. An adult oyster is capable of filtering 30 to 50 gallons of water per day, removing sediments, small phytoplankton and particulate bound nitrogen and phosphorus. Oysters release ammonia as biological waste, but bacteria and microbes associated with established oyster reefs fix the ammonia through denitrification; therefore, the oysters do not contribute additional nitrogen loading. Estimates of oyster reef denitrification efficiency range from 20% to 100% (Piehler and Smyth 2011, Ray et al. 2019). While oysters can improve water clarity and quality, they need good water quality for growth and survival. Oysters have varying requirements of salinity, temperature and flow at different stages of their lifecycle. Minor fluctuations in these requirements can increase mortality and reduce settlement rates. In addition to their ability to improve water quality, oysters are ecosystem engineers. Oyster reefs act as breakwaters, dissipating wave energy and decreasing shoreline erosion. Oyster reefs are readily used in living shoreline construction projects in the IRL. IRC currently has loose oyster shell ready to be used in shoreline restoration projects.

Mercenaria mercenaria is a large hard-shelled clam, burrowing in soft sediments including sand and mud flats throughout Florida. Similar to the benefits of filtration by oysters, *Mercenaria* also filter out particulate matter and phytoplankton. The waste by-product is passed directly to nitrifying bacteria found in the sediments. The hard clam was an important commercial fishery in the IRL. Between 1987 and 2001, 10.5 million pounds of *Mercenaria* were harvested from Volusia County to Martin County in the IRL. The commercial fishery was valued at $70.3 million, ranking the hard clam the most valuable commercial fishery in the IRL. Unfortunately, the commercial fishery has seen a drastic decrease in the number of harvestable clams because of overharvesting, sediment quality and declining water quality. Currently, hard clams are farmed commercially from Volusia County to IRC. Clam seeding has taken place throughout the IRL to increase the density of clam and reestablish clams, including IRC. Clams are reared by the University of Florida's Whitney Lab using spawning stock referred to as "super clams." The stock is believed to be superior and able to survive the changing conditions experienced by the Lagoon. The Brevard Zoo has established *Mercenaria* clam beds in the north end of IRC. In the pursuit of improving Lagoon water quality and habitat restoration, IRC should consider partnering with organizations working toward the establishment of clams in the IRL.

The Florida Department of Agriculture and Consumer Services (FDACS) has two aquaculture leases in the northern end of IRC with conditionally approved harvesting (Figure 13). Harvesting from this area is closed when two-day cumulative rainfall measured by NOAA exceeds 2.54 inches. An additional approved bivalve harvesting area is #70, spanning from IRC to St. Lucie County. The area within IRC is currently closed to harvesting year-round (Figure 14).

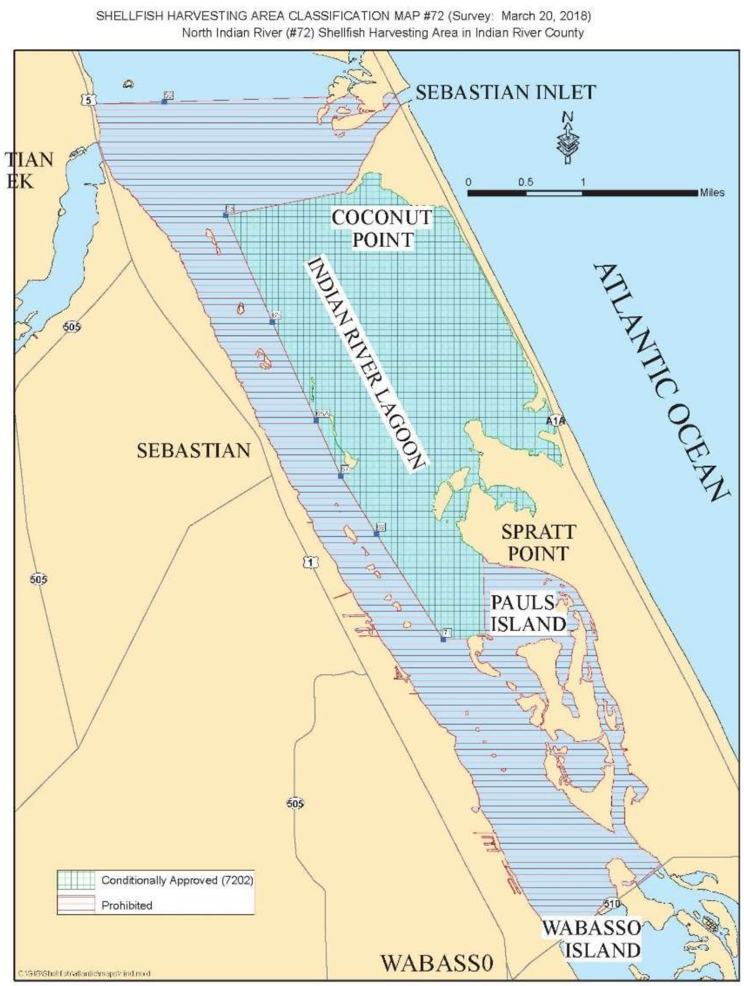


Figure 13. FDACS Aquaculture Leases in IRC

SHELLFISH HARVESTING AREA CLASSIFICATION MAP #70 (Survey: November 10, 2015)
Indian River/St. Lucie (#70) Shellfish Harvesting Area in Indian River and St. Lucie Counties

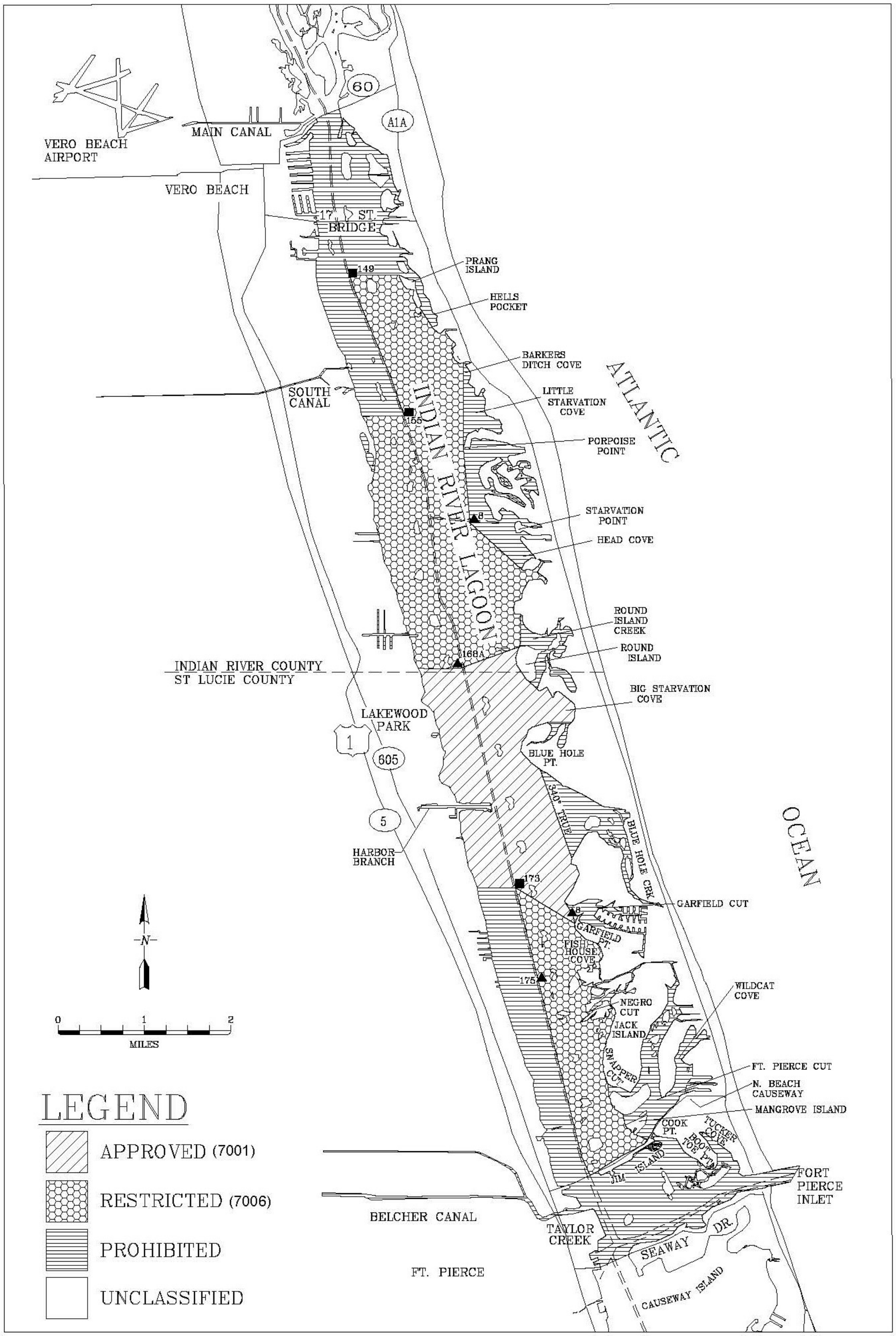


Figure 14. FDACS Approved Bivalve Harvesting Area in IRC

Fisheries

The IRL supports a valuable recreational fishery with tourism and recreation contributing $2 billion annually to the economy. The fish population biodiversity of the IRL provides a wide variety of species including snapper, sea trout, black drum and sheepshead, in addition to big gamefish such as snook, tarpon and redfish. FWC conducts both fisheries dependent and independent monitoring in the IRL. According to the fisheries independent monitoring, fishing stocks appear stable, but overall fish length is decreasing. The economic importance of fish to the region cannot be ignored. Fish are susceptible to changes in water quality, decreased DO and algal blooms. The algal bloom of 2016 led to lagoon-wide fish kills linked to low DO. Larger gamefish are dependent upon forage fishes to thrive, and forge fishes are more susceptible to fish kills linked to low DO. Many commercially and recreationally valuable fish species use the IRL as a nursery habitat. They are dependent on seagrass, saltmarsh and mangrove habitats for their survival. Increasing development and habitat loss will impact these species and the economy. Preventing further habitat loss will be beneficial in maintaining fish stocks.

Megafauna

Several species of charismatic megafauna inhabit the IRL, drawing visitors to the region. Dolphins, manatees and marine turtles contribute to the local tourism economy, they are also federally protected species. Habitat loss including seagrass, water quality degradation from emerging contaminants and human recreation activities are impacting their health and survival.

The common bottlenose dolphins found in the IRL have strong site fidelity, only migrating an average of 17 miles. Unlike other coastal populations of common bottlenose dolphins, IRL dolphins rarely form strong family pods except during calving. While dolphins may enter the IRL through the inlets, they remain in the Lagoon for their entire lifecycle and do not migrate to the Atlantic Ocean. Hubbs Sea World estimates there are approximately 1,032 dolphins residing in the IRL. This number has remained relatively stable over the last decade.

Research on the IRL dolphin populations has identified environmental stressors as an indicator of dolphin health. In recent years, IRL dolphins have experienced an unusual mortality event. Researchers found even in the absence of a harmful algal bloom, saxitoxin, a neurotoxin associated with the bioluminescent dinoflagellate *Pyrodinium*, was present in their systems. In addition to known pollutants, such as mercury impacting dolphin health and immune function, emerging contaminants are an increasing concern for the health of the populations in the IRL. A study by Florida Atlantic University found that 88% of the dolphins tested contained antibiotic resistant bacteria. The most common antibiotic identified was erythromycin, which is used in human and veterinary medicine (Schaefer 2019).

On average 3,000 manatees use the IRL annually. Manatees are slow moving marine mammals. They are vulnerable to cold stress, thermal pollution, seagrass loss and boat strikes. FWC monitors the IRL manatee population, including mortality. From 2000 to 2020, with the exception of two cold stress events in 2010 and 2011, manatee mortality in IRC ranged from 5 to 19 per year. During 2021 and 2022, manatees in the IRL experienced an unusual mortality event caused by starvation. IRC experienced an increase in manatee deaths with 25 in 2021 and 21 in 2022, but neither year came close to the cold stress mortality event in 2010. Seagrass has steadily declined in the IRL, including in IRC, but areal coverage of seagrass in IRC has been sufficient to maintain the current manatee population. While manatees have been blamed for seagrass loss, it is important to note that manatees do not pull seagrass up by the root system. Manatees grasp the upper blades of grass similar to bovine grazing. Low light availability from decreased water clarity along with algal bloom events has led to seagrass decline in the IRL.

IRC created a Manatee Protection and Boating Safety Comprehensive Management Plan in 2000, with revisions in 2002 and 2004. Since its adoption, additional objectives and policies addressing the general aspects of manatee protection, boating safety and marina facility siting have been incorporated. The IRC Community Development Department uses this plan to review proposals for new and expanded multi-slip docking. The plan is available for the public to review. To further assist the protection of manatee population in IRC, the County should continue to support the work of FWC, assisting in rescue and stranding efforts of injured or sick manatees, assisting in the release of rehabilitated manatees and encourage the regulation of designated manatee speed zones.

The Lagoon provides food and protection for juvenile loggerhead and green sea turtles. Juvenile green sea turtles consume macro algae and seagrasses, while loggerheads consume crustaceans and mollusks. Growth rates of juveniles in the IRL are greater than other areas of southeast Florida. The IRL provides significant feeding opportunities important for juvenile marine turtles. However, sea turtle health in the IRL concerning. Sea turtles can suffer from fibropapillomatosis (FP), a disease-causing cauliflower-like tumors to form on the body, including internal organs. However, green sea turtles are most commonly and severely affected (NOAA n.d.). FP is caused by Chelonid Herpesvirus 5, but the development of tumors has been linked to aquatic pollution. Approximately 22% of green turtles suffer from FP statewide. In comparison, approximately half of the green turtles in the IRL suffer from FP. FP is a serious condition impacting juvenile green turtles in the IRL, but sea turtles in the IRL face additional threats including boat strikes, harmful algal blooms and emerging contaminants. IRC's Habitat Conservation Plan assists in the protection of sea turtles on IRC beaches. It does not address sea turtle populations in the IRL. However, IRC does play an important role in FWC's permitted stranding network. In addition to the participation in the stranding and salvage network, IRC participates in sea turtle education and awareness to educate the public on the implications of their actions on sea turtle populations within the IRL.

The IRL is also home to a brackish aquatic turtle, the diamondback terrapin. Little is known about the diamondback terrapin population in the IRL. At one time the terrapin was commercially overharvested for turtle soup. The commercial harvest was closed in the 1940s and populations have slightly recovered. The International Union for Conservation of Nature's Red List classifies the diamondback terrapin as vulnerable, the equivalent of a threatened listing under the Endangered Species Act. However, terrapins are not covered under the act. State laws do govern the collection and possession of terrapins. Current populations are experiencing anthropogenic impacts with the greatest threat being habitat loss caused by coastal development. Protecting sandy and natural vegetative shorelines is important for the nesting habitat of the terrapin.

Aquatic Ecosystems Functions and Habitat Use Actions

The following actions are recommended to help protect aquatic ecosystems functions and habitat use in IRC's portion of the IRL:

- Continue to work with local law enforcement to enforce speed restrictions for boating.
- Establish nurseries for future seagrass and mangrove plantings.
- Identify and install seagrass beds in viable locations to initiate recovery
- Preserve natural shorelines and plant living shorelines.

Marinas, Boats and Boat Ramps

Boating

IRC has 10,494 registered recreational boating vessels and 313 registered commercial vessels for a total of 10,807 registered boats, with an unknown number of transient boats to the region throughout the year. Most boat owners are responsible, maintaining their vessels, following safe boating practices and minimizing damage to the IRL habitat. However, boating in the IRL is not without its impacts. There are measures in place to minimize environmental impacts to the water, but education should be at the forefront to keep boaters informed, as well as those in the marine industry.

There are four primary impacts from recreational boating: habitat damage from propellers, petroleum products, pollutants from boat maintenance and wastewater. Florida Statute 327.53 requires vessels 26 feet or longer with an enclosed cabin and berthing facilities, any houseboat used primarily as a residence and any floating structure with enclosed living space with berthing facilities and public access to have a toilet and Marine Sanitation Device (MSD). MSDs are designed to receive, retain, treat or discharge waste. MSD I is a flow through device treating sewage by chemical or thermal means (required for vessels 26 to 65 feet). MSD II treats waste by biological means using bacteria (required for vessels over 65 feet). MSD III holds waste to prevent direct overboard discharge. Vessel sewage is highly concentrated with up to 40 times as many nutrients as raw municipal sewage (Florida Sea Grant n.d.). MSD I and II devices only reduce bacteria and solids, not nutrients. Federal law requires all vessels with a Y-valve must be closed while operating in all inland and coastal waters. However, vessels without a Y-valve with MSD I and II devices on board are able to discharge outside of No Discharge Zones, freshwater bodies with shallow entrances and exits and river not navigable by interstate vessel traffic. The Clean Vessel Act of 1992 provides funding for the construction of pumpout facilities to ensure proper disposal of human waste from recreational vessels. The act is administered by FDEP. Since 1994, FDEP had awarded more than $7 million funds for the construction of pumpout stations. There are currently 14 pumps located in IRC. Ten of the pumps are in Sebastian, while four are in Vero Beach. A recent survey of the pump out locations determined there was limited access to facilities for transient boaters and several locations were currently out of service. Pumpout Nav is a mobile app allowing boaters to search for pump out stations throughout the state.

FDEP also administers the Clean Marina Program. This is a voluntary program encouraging marinas to implement FDEP's BMPs. The focus of the program is on the protection of sensitive habitats, waste management, stormwater control, spill prevention and emergency preparedness. For a marina to receive the designation, the marina must implement 60% of the BMPs and meet the legal regulatory requirements. There are 13 marinas located in IRC of which, 10 have received the Clean Marina Program designation (https://floridadep.gov/rcp/clean-marina/content/designated-clean-marinas).

Mooring

Florida law allows boaters to moor in the IRL, outside of the ICW and mooring fields. Florida Statute 327.4109 prohibits mooring within 150 feet of a marina, boat ramp or boatyard, within 500 feet of a superyacht facility or within 100 feet from a marked boundary of a public mooring field unless the vessel suffers from mechanical failure or there are imminent weather conditions in the vicinity. In addition to the listed mooring restrictions, counties may establish Anchoring Limitation Areas (ALAs) under Florida Statute 327.4108. ALAs require an anchored vessel be moved at least one mile away every 45 days. An ALA must not be greater than 100 acres and may not exceed 10% of the navigable-in-fact waterways.

Derelict Vessels

The establishment of an ALA is designed to prevent the abandonment of vessels, which can increase the risk of derelict vessels. Derelict vessels have negative ecological impacts on the IRL damaging the benthic habitat, scattering debris, discharging contaminants and creating navigation hazards. Potential contaminants include fiberglass and chemicals such as paints, polystyrene, fuel and oil. Law enforcement officers follow protocols established by Florida Statute 46, Chapter 823 to determine if a vessel is derelict or at risk. If a vessel is deemed at risk, the owner is notified and given 72 hours to provide proof of repair to remove the vessel. An at-risk vessel must be ticketed three times in 18 months before it can be approved for removal. Once a vessel is cited, the owner may choose to hand over the vessel to FWC through the Vessel Turn in Program. If the vessel remains in the water, it will be at greater risk of becoming a derelict vessel. Derelict vessels are investigated by law enforcement. Once an owner has been notified a 21-day count begins. If the owner does not remove the vessel with in the 21-day period or request an administrative hearing, the vessel will be released for removal. IRC is currently the lead organization coordinating efforts to remove derelict vessels from the IRL and adjacent waters. County staff works directly with FWC to monitor at risk and derelict vessels, meeting monthly to have vessels removed promptly.

Marinas, Boats and Boat Ramps Actions

The following actions are recommended to improve IRC's marinas, boats and boat ramps:

- Increase the number of pump out facilities.
- Promote the FDEP Clean Marina Program.
- Provide education to marinas and boaters on BMPs for boat care and maintenance.
- Continue to encourage local law enforcement to patrol IRL waters to ensure compliance with mooring and waste disposal.

3. Stormwater

A. Goals and Objectives

The goals and objectives for the Stormwater key factors include:

a) Reduce nitrogen and phosphorus loading from the IRFWCD's three main relief canals to meet the TMDLs and BMAP requirements for the Central IRL.
b) Reduce the amount of organic material entering the IRL contributing to nutrient loading and muck accumulation.
c) Educate the public on point and nonpoint sources of stormwater runoff including what they can do to prevent nutrients and contaminants from entering the IRL.
d) Enforce BMPs at construction sites to prevent materials and sediments from entering storm drains.

B. Key Factors

Annual Rainfall

The amount of rainfall IRC receives is decreasing by 0.27 inches per year, but the region receives on average 52 inches per year making it an important source of freshwater to the IRL. Rainfall enters the IRL through stormwater runoff directly from land, canals and groundwater flow, which impacts the IRL by carrying sediments, nutrients and contaminants. IRC has been proactive through the creation of two stormwater parks designed to remove excess nutrients and trap sediments from the IRFWCD canals. Egret Marsh and Osprey Marsh use algal turf scrubbers to remove nitrogen and phosphorus from water in the IRFWCD canals, which includes both stormwater and groundwater discharge. It is estimated IRC removes 80,170 pounds per year of TN and 12,123 pounds per year of TP, based on projects provided for the Central IRL BMAP. A third nutrient removal system came online in 2023. Moorhen Marsh uses water lettuce basins to remove nutrients before the water is discharged back to the North Relief Canal. In addition to the stormwater parks, IRC actively removes water lettuce, trash and debris from the Main Relief Canal using the PC Main Screening System, which began operating in 2008. The removal of water lettuce from the canals before discharging into the IRL is important because water lettuce is capable of rapidly growing by fragmentation, it is a nonnative aquatic plant and while it is beneficial in the removal of nutrients, it releases nutrients back into the ecosystem upon its demise and contributes to muck accumulation as it settles to the IRL benthos.

The three relief canals, St. Sebastian River and groundwater discharge in IRC represent most of the freshwater flow to the IRL. Freshwater flow can directly impact the salinity levels lowering or raising them. The freshwater flow from the St. Sebastian River remains relatively consistent with the exception of major storm events. However, rainfall in Florida is often seasonal and can be influenced by climate patterns. Low levels of rain can lead to increases in salinity, while increased rainfall leads to lower salinity levels. Lower salinity levels have been observed in the region but are often associated with storm events and are transient in nature. As previously stated, salinity levels can influence DO levels impacting marine life and salinity is an important water quality parameter for both seagrass and oysters.

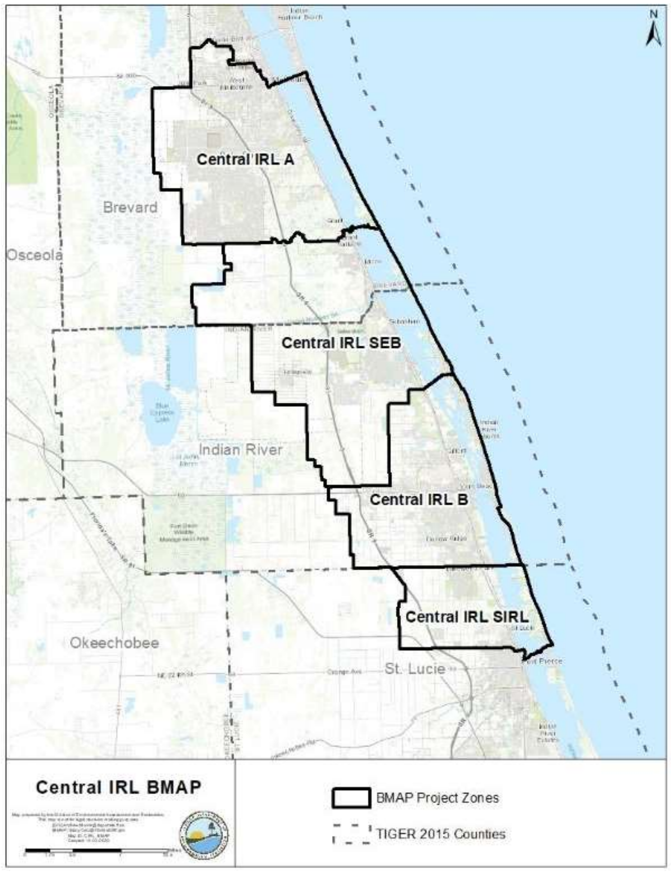
IRC is proactive in reducing nutrient inputs from stormwater through the operation of nutrient removal stormwater parks and mechanical removal of water lettuce. Weekly water quality monitoring of the three relief canals has shown the effectiveness of the parks at removing TN and TP and reducing nutrients from entering the IRL. However, it is important to note that IRC does not maintain the three main relief canals or control water flow through them. The canals are the property of IRFWCD who, through an agreement with IRC, allows the County to pull water from the canals for the three stormwater parks and mechanically harvest water lettuce. It is important to maintain this partnership for the benefit of the IRL.

Basin Management Action Plan

In 2009, FDEP established TMDLs for the IRL using years of water quality data collected by SJRWMD and in accordance with the Clean Water Act, which was established in 1972 setting national water quality criteria for surface water pollutants. A TMDL represents the maximum amount of pollutant a surface water can assimilate without exceeding water quality standards. Once waters are declared impaired and TMDLs are established, FDEP develops a BMAP. A BMAP is a framework for water quality restoration for the state and local entities to reduce pollutant loading through current and future projects. BMAPs are designed to be implemented in multiple phases to meet the restoration goals for a particular waterbody.

For the purposes of the IRL BMAPs, the IRL is divided into three sub-basins. IRC is located within the Central IRL BMAP. The Central IRL BMAP is further divided into project zones. IRC is located in two project zones: SEB, from Grant Farm Island to the Wabasso Causeway, and Central B, the Wabasso Causeway to the IRC and St. Lucie County line (Figure 15). The initial Central IRL BMAP was adopted by FDEP in 2013. IRC was not required to make any reductions, because the median seagrass depth limit for the area was in compliance with the parameters set by FDEP when the BMAP was created. Even though the County did not receive reduction requirements, IRC was actively pursuing projects, reducing nutrient loading to the IRL. IRC continues to make strides through multiple departments to meet to load reductions. As a stakeholder in the Central IRL BMAP, IRC submits all applicable projects and data to FDEP's Statewide Annual Report. FDEP compiles the data collected into a summarized report of accomplishments including restoration projects and management strategies. The public may view the report and story map on the FDEP website (https://floridadep.gov/dear/water-quality-restoration/content/statewide-annual-report).

In 2020, the Central IRL BMAP underwent a remodeling effort shifting from the previous PLSM to a new SWIL model. The model includes the acreage, land use and loading estimates, including groundwater and atmospheric deposition, to determine the reduction requirements for each entity located in the BMAP area. Under the PLSM, the draft reductions for TN and TP were 125,496 pounds per year and 19,063 pounds per year, respectively. Under the SWIL model, the draft reductions for TN and TP increased to 251,097 pounds per year and 29,960 pounds per year, respectively. The newly established reductions must be met by 2035 with a five-year milestone of 35% and a ten-year milestone of 70%. Upon review, it was determined several parameters set within the model were not accurately depicting soil type and land use within IRC. The SWIL model is currently under review by FDEP. The model revision was expected to be completed by April 2023, but at this time, the modeling efforts are still underway. IRC faces challenges in meeting the requirements set forth by the current BMAP using the SWIL model. The greatest challenge will be the costs associated with the design and construction of projects. To meet the new BMAP reductions, it would benefit IRC to study the groundwater flow and nutrient loading of groundwater in the County since FDEP places considerable weight on groundwater in their modeling efforts. In addition, for IRC to received BMAP credits for septic-to-sewer projects, it is necessary to develop an ArcGIS-Based Nitrate Load Estimation Toolkit (ArcNLET) model of TN loading to the IRL.



Note: From the FDEP Central IRL BMAP (2021)

Figure 15. Central IRL BMAP Project Zones

Best Management Practices

Stormwater is an important conveyance of nonpoint source freshwater and pollutants to the IRL. Water flow from urban areas, suburban neighborhoods and agricultural lands can carry nitrogen, phosphorus and heavy metals. To reduce the impacts of stormwater on the IRL, BMPs have been identified by FDEP and FDACS. BMPs are practices deemed by the scientific community to be an effective means of preventing or reducing water pollution generated by various activities and industries. When BMPs are effectively implemented, they should reduce nutrient loading and achieve the TMDLs. IRC has been proactive in the implementation of BMPs in the Stormwater Division, including several local ordinances such as the fertilizer ordinance established to reduce nutrients and improve the health of the IRL.

Stormwater is regulated under the National Pollutant Discharge Elimination System Stormwater Program. Under the municipal separate storm sewer system permit, IRC has adopted a stormwater management program including treatment, enforcement and education. IRC has three large scale regional stormwater facilities designed to remove nutrients from the IRFWCD canals before discharge to the IRL. The design, construction and implementation of two of these projects began before mandatory reductions were implemented in IRC. The third stormwater treatment facility began operating in the summer of 2023.

Stormwater enforcement monitors illegal discharge, construction sites and fertilizer application with the authority to issue citations, which can lead to fines or a site shutdown if standards are not met. IRC has a full-time Stormwater Educator handling public outreach and education through public events, mailings, in school education lessons and summer camps. Education and community outreach are important aspects, which are often overlooked when making a beneficial impact on the health of the IRL. These educational opportunities not only inform citizens of the efforts being undertaken by IRC, but also provide them with proactive measures they can make at home and in their daily lives to reduce their impacts on the IRL.

FDACS develops and adopts BMPs for the agricultural industry. If an agricultural business is located within a BMAP, BMP enrollment is required by Florida Statute 373.4595 and 403.067. Farmers are required to retain fertilizer records showing they are following the BMPs set for their agricultural commodity, or they must demonstrate compliance through water quality monitoring at the owner's expense. FDACS is responsible for conducting onsite inspections at least every two years of all enrolled agricultural operations within the BMAP. Site visits require a review of the nitrogen and phosphorus fertilizer application or water quality monitoring results. FDACS reports the TN and TP results to FDEP for use in the BMAP assessments and for enforcement of non-compliance issues. As of April 2023, current agricultural enrollment in the Central IRL BMAP is 25% with enrollment in project zones SEB at 30% and Central B at 11%. FDACS is making efforts to transmit enrollment notifications to producers and landowners identified as agricultural lands in the BMAP to increase compliance levels. FDEP anticipates additional enrollment and the implementation of frequent site visits by FDACS to ensure BMPs are met and reduce nutrient loading from agricultural nonpoint sources. The Central IRL BMAP states the reductions under FDACS BMPs may not be adequate to achieve the TMDLs, but FDACS is committed to regularly updating BMPs based on scientific research and review.

Stormwater Actions

The following actions are recommended to improve stormwater within IRC:

- Continue to work with regulatory agencies to ensure compliance with FDACS BMPs.
- Identify conceptual projects to reduce nutrient loading to achieve BMAP compliance.
- Identify opportunities to improve sorption of rainwater to recharge aquifers and reduce freshwater flows to the IRL.

4. Conservation Lands

A. Goals and Objectives

The goals and objectives for the Conservation Lands key factors include:

a) Protect, restore and sustain vital habitat within the IRL watershed.
b) Protect threatened and endangered species in IRC.
c) Create buffers and reduce sheet flow of nonpoint source stormwater directly to the IRL.
d) Maintain living shoreline buffers, which outperform sea walls and bulk heads during storm events.
e) Create buffer zone allowing for retreat from sea level rise and flooding.
f) Create education and natural spaces for the public to enjoy and observe.

B. Key Factors

Terrestrial Ecosystem Function and Habitat Use

IRC began an effort to restore and preserve vital habitats in 2004 with the issue of the County's initial Environmental Bond Referendum and development of the Environmental Lands Program Guide. Since 2004, IRC has worked with local partners to acquire 11,900 acres of sensitive habitat. The County's Conservation Lands manages 2,600 acres, while 5,622 acres are managed through leases and management agreements. IRC manages 27 conservation areas with 13 conservation areas adjacent to the IRL, totaling 12 miles of shoreline (Figure 16).

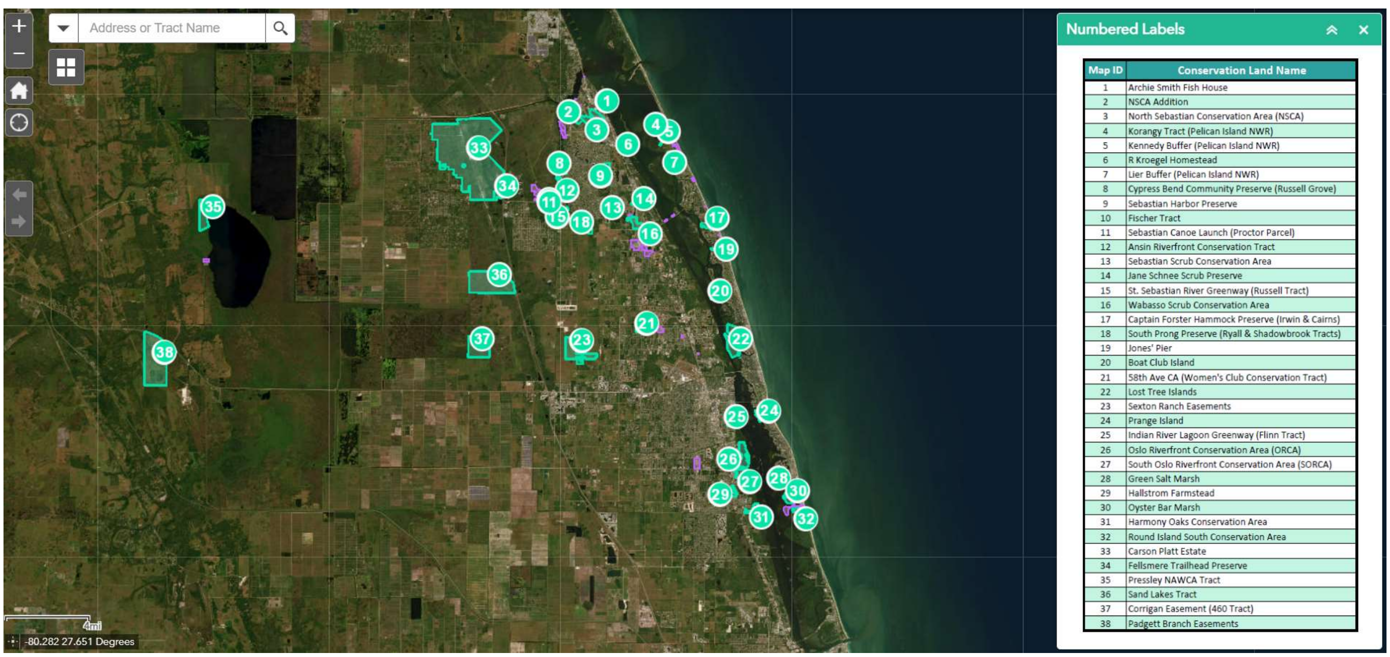


Figure 16. IRC Conservation Lands

Not all the acreage acquired or managed by IRC is along the IRL, but a large percentage of the land is located within the IRL watershed. Conservation lands acquisition is a crucial aspect of IRL restoration and management. As IRC has seen exponential population growth since the 1970s, so has the watershed, increasing stormwater flow, nutrient loading and loss of natural buffers and shoreline habitat. Natural habitats allow for the absorption of nutrients and metals by plant communities, as well as the percolation of water through the soil (Figure 17). This is necessary as much of the wetland habitats in Florida have been altered or lost through development. Wetlands slow the flow of stormwater, allowing for retention of stormwater leading to the abatement of nutrients. In addition, the 12 miles of shoreline from development ensure the protection of salt marsh and mangrove marsh communities. Natural shorelines are an important habitat for many juvenile species. They create a buffer from runoff and lead to sediment accretion, reducing erosion developed shorelines experience. Research by the University of Miami has shown natural shoreline or living shorelines outperform sea walls and bulk heads during storm events (Timm 2017).

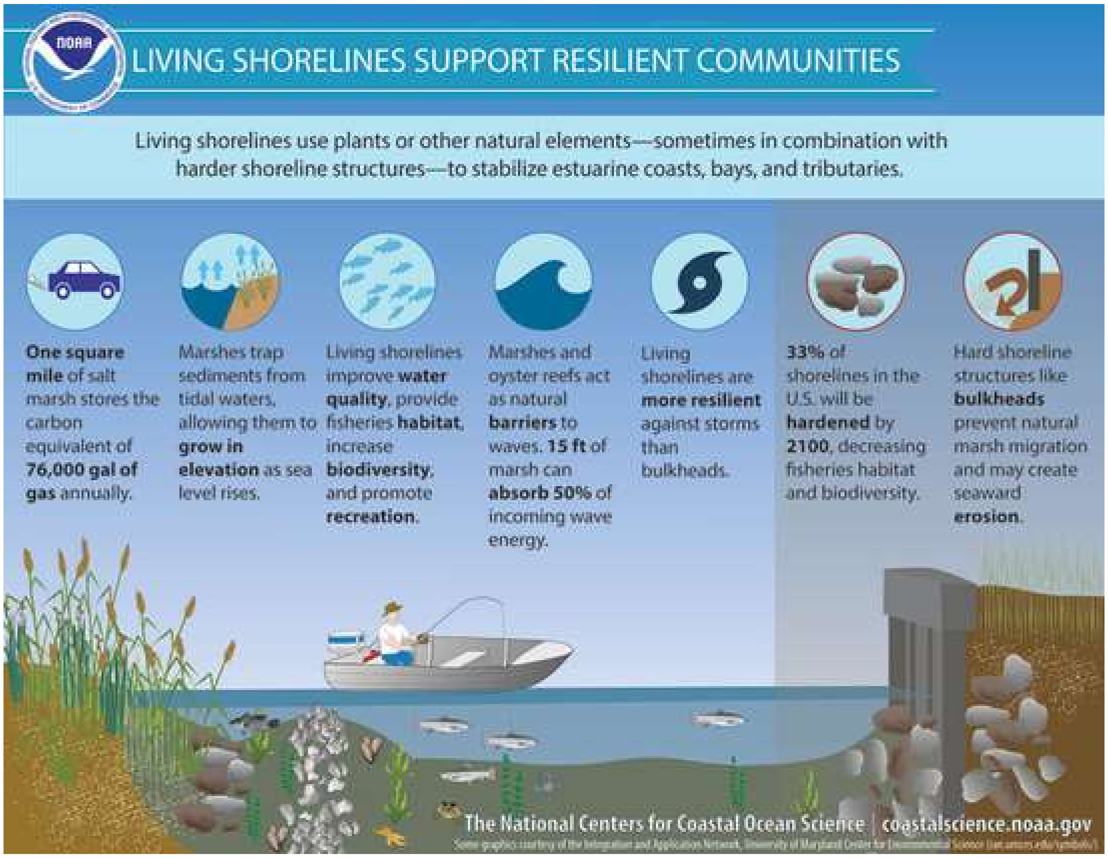


Figure 17. Benefits of Natural Shorelines

An additional bond referendum was passed in 2022 and the Environmental Lands Program Guide is currently under revision as part of the process. The guide is a suite of policies and guidelines set forth in the acquisition of environmentally sensitive land and management activities. The guide incorporates numerous aspects of the IRC 2030 Comprehensive Plan coastal and conservation elements, which will continue to benefit the protection of essential habitat, species and the IRL. In addition to the acquisition, restoration and management of critical habitats, Conservation Lands plays an important role in the education and engagement of IRC citizens. The Conservation Lands community outreach and education events engage citizens through cleanups, restoration and maintenance of habitats. Engaging citizens promotes stewardship and citizen involvement, ultimately leading to lifestyle changes benefiting the environment and improving their quality of life.

Islands

The IRL has numerous natural and spoil islands, many of which are important rookery habitats. Located within IRC is the Pelican Island National Wildlife Refuge, which contains both natural and spoil islands in the IRL. Pelican Island National Wildlife Refuge is a mosaic over more than 5,400 acres. IRC owns or shares ownership of approximately 200 acres with the refuge working closely with the U.S. Fish and Wildlife Service to manage the areas. Conservation Lands also owns and manages Lost Tree Islands Conservation Area, Prange Island Conservation Area and Green Salt Marsh, which are natural islands in the IRL. There are additional natural islands in IRC. Some of the natural islands are owned by private entities, while others are owned by the Indian River Mosquito Control District or Indian River Land Trust, a habitat conservation-based nonprofit located in IRC.

A unique characteristic of the IRL is the spoil islands, which were created from material dredged during the creation of the ICW channel. IRC has 55 spoil islands created between 1951 and 1961. Most of the spoil islands are located along the longitudinal axis of the IRL and are often less and one acre is size. Although the islands were created from the left-over spoil, they have become important habitats for native species. Most of the spoil islands are owned by the state of Florida and managed by the FDEP Aquatic Preserves. The islands are only accessible by boat. However, not all of the islands are available for recreational use. Some islands are designated as conservation areas to preserve the habitat and protect vulnerable species. Islands open for recreation use are available for boaters to enjoy for activities such as picnicking, camping, fishing and exploration. The FDEP Aquatic Preservers promotes a Leave No Trace program, encouraging users of the spoil islands to remove all waste created on the island.

Spoil island are important ecological communities, including as shore bird nesting habitat. In addition, they are used by reptiles, invertebrates and small mammals. However, many have been colonized by invasive plants including Brazilian pepper and Australian pine trees. These invasive plants replace native species on the islands and create an overgrowth taking over essential ground space for nesting shorebirds. It leaves the islands vulnerable to erosion, because the roots of the Brazilian pepper and Australian pine do not efficiently trap sand. This is especially true on the side of the island facing the ICW. This loss of nesting habitat drives birds to nest on rooftops of business and homes. Based on this information, IRC should continue to work with the IRL Aquatic Preserves to protect spoil islands and monitor nesting bird populations using them. As part of the management strategies, IRC should work with the IRL Aquatic Preserves to remove invasive species and planting of native species.

Conservation Lands Actions

The following actions are recommended to help protect critical lands and habitats along the IRL:

- Preserve natural shorelines.
- Promote the use of living shorelines.
- Work with FDEP to preserve natural and spoil islands and actively remove invasive vegetation.

5. Utilities

A. Goals and Objectives

The goals and objectives for the Utilities key factors include:

a) Implement a plan to eliminate nonbeneficial surface water discharges by January 1, 2032, in accordance with Senate Bill 64.
b) Pursue new wastewater advancement technologies as they become available.
c) Prevent the application of biosolids on vulnerable land.
d) Prioritize septic-to-sewer transitions based upon the ArcNLET model in accordance with the Clean Waterways Act.
e) Follow new guidelines for septic-to-sewer conversion and advanced septic systems.
f) Educate and promote BMPs for efficient water consumption.

B. Key Factors

Wastewater

All water leaving residential and commercial properties through the drainpipes must be treated and disposed of through one of three advanced wastewater treatment facilities operated by IRC. The Clean Waterways Act, Senate Bill 53, Senate Bill 64 and House Bill 1379 have placed new requirements on local governments. Senate Bill 53 requires utilities departments to conduct a 20-year infrastructure needs analysis for wastewater by July 31, 2022. Senate Bill 64 places restrictions on the discharge of treated wastewater, requiring the elimination of nonbeneficial surface water discharges by January 1, 2032. House Bill 1379 created the Indian River Lagoon Protection Program. Currently, treated wastewater from IRC's regional advanced wastewater treatment facilities discharges into the reclaimed water system, a treatment wetland or a rapid infiltration basin. Additional options include the increase of used of reclaimed water for irrigation, absorption fields and deep well injection. Deep well injection is used in Florida as a means of wastewater disposal, but recent studies examining deep well injection in South Florida are finding nutrients from these sites are migrating to the coastal habitat impacting nutrient loads.

In May 2023, House Bill 1379 was signed into law with sweeping implications for wastewater in the IRL. By 2033 all wastewater facilities discharging to the IRL will be required to meet advanced wastewater treatment. All existing conventional septic systems in the IRL basin must connect to central sewer or upgrade to enhanced nutrient removal septic systems by July 1, 2030. New construction within the IRL basin will be required to connect to sewer or use enhanced nutrient reducing septic systems. This bill also expanded the Wastewater Grants program, to provide a source of funding to complete these projects.

Biosolids

Biosolids result from the treatment of domestic sewage sludge from wastewater treatment facilities. There are two major classifications of biosolids allowing for land application, Class B and A/AA. Regardless of the classification of the biosolids, both contain varying levels of nitrogen and phosphorus depending on the influent of wastewater and processing steps at the treatment facility. Class B are the least processed and require a FDEP permit for land application, while Class A/AA are considered fertilizer and are allowed to be applied without a permit or tracking of the quantity applied. The most recent statistics on biosolids produced and applied in Florida are from 2018. In 2018, 412,000 dry tons of biosolids were produced with 19.5% disposed at authorized landfills, 56% processed into Class A/AA fertilizer and 24% applied to agricultural lands as Class B. There are approximately 130 permitted land application sites for Class B. Permitted sites require nutrient management plans including, setbacks, groundwater depth provisions, signage, public access, grazing and harvesting restrictions. Management plans require record keeping and reporting to track the amount of biosolids applied. On June 21, 2021, revisions were made to Chapter 62-640, Florida Administrative Code. The revisions were developed to minimize the migration of nutrients with an emphasis on phosphorus and prevention the impairment to waterbodies. Two key provisions to Florida Statute 403.0855 became effective on July 1, 2022. The provisions require all biosolid land application sites to enroll in the FDACS BMPs program and prohibit application on lands with seasonal high-water table (within six inches of the soil or depth of the biosolid placement).

Biosolid applications rates increased in the St. Johns River Basin in 2013, after restrictions were placed in South Florida by the National Everglades Protection Act. In 2017, 73% of the biosolids applied were spread across IRC, Osceola County and Brevard County. The application of biosolids introduced 740,000 pounds of nitrogen and 239,000 pounds of phosphorus to IRC. The following year, Blue Cypress Lake experienced a microcystic algal bloom. SJRWMD long-term monitoring sites within the lake showed an increasing trend in P levels. When evaluated against other factors it was determined the spike in phosphorus and the algal bloom were directly linked to the application of Class B biosolids. In response to the algal bloom, IRC passed an ordinance placing a moratorium on the application of Class B biosolids in the unincorporated County. The moratorium ceased all new and existing applications in the unincorporated County. While the application of biosolids took place within the St. Johns River Basin, the transport of runoff from biosolid application could transport nutrients through tributaries, canals and groundwater to the IRL.

The local moratorium and state regulations focus on Class B biosolids and do not address Class A/AA, which are classified as fertilizer and are exempt from regulations. Class A/AA application rates are not tracked and do not require a permit for application making it difficult to monitor. Therefore, there is a gap in the knowledge and understanding of the impact Class A/AA application has on nutrient levels and waterbodies, particularly the IRL.

Onsite Sewage Treatment and Disposal Systems

OSTDS or septic systems are a wastewater treatment utilized by homes not connected to a centralized sewer system. The Florida Department of Health has identified 30,467 OSTDS in IRC. OSTDSs consist of a septic tank and a drainfield (soil absorption field). A properly functioning OSTDS relies on the settlement of phosphorus within the septic tank and dispersion and dilution of nitrogen containing liquid effluent. While it is believed the bulk of phosphorus is trapped within the sludge, it is not 100% containment (Lowe 2007). There is increasing evidence of orthophosphate transport within drainfields located in sandy soils with high groundwater tables. In contrast, nitrogen effluent is discharged through the tank to the drainfield. The nitrogen concentration leaving the tank is significant and dependent upon the amount of wastewater moving through the system. An OSTDS generally removes 10% to 40% of the TN through dispersion, dilution and decay. FDEP estimates the IRL receives approximately 60% of its nutrient inputs from groundwater. Therefore, an OSTDS has the ability to negatively impact the IRL by increasing nutrient loads. The location and proximity of a drainfield to a conveyance or the IRL may not allow for adequate fixation of nitrogen and phosphorus in the drainfield before entering groundwater or surface water. Sea level rise, changing rain patterns and elevated water tables will reduce the denitrification capacity of the drainfield and increase the likelihood of their contribution of nutrients and pathogens to groundwater. In addition, it is estimated an OSTDS has a 10% failure rate, requiring homeowners perform regular maintenance to prevent wastewater from backing up into a household, pooling of water in the drainfield and odor. Many homeowners may not be aware of the routine required maintenance or issues with their OSTDS until it is too late.

Under the Clean Waterways Act enacted by Senate Bill 712, OSTDS regulations and permitting transferred from the Florida Department of Health to FDEP in 2021, creating a temporary septic advisory committee to review policies and regulations. FDEP was directed to revise provisions relating to setback rules and the fast tracking of permits for advanced nutrient removal septic systems. The bill directed local governments to create septic remediations plans for certain BMAP regions. Senate Bill 1632 became effective on July 1, 2023 mandating septic to sewer conversions by January 1, 2032 in areas where centralized sewer is available and the installation of advanced nutrient removal OSTDS in areas where centralized sewer is not available. Beginning on January 1, 2024, no new OSTDS will be permitted in areas where centralized sewer is available. If centralized sewer is unavailable, advanced nutrient removal OSTDS will be permitted. Enhanced nutrient removal systems permitted will be required to reduce nitrogen and phosphorus by 50%. House Bill 1379, enacted in May 2023, strengthens these requirements within the IRL Protection Program.

In 2017, IRC's Utilities Department conducted a county-wide studying of 325 communities with OSTDS. Communities were ranked based on their likelihood of negatively contributing to the IRL ecosystem using the following factors: population density, proximity to surface waters, floodplain, location of the groundwater table, soil, age of the surface water management system and age of OSTDS. Many of these homes were built before 1983 when state rules and regulations regarding OSTDSs went into effect. The estimated life span of a residential OSTDS is 19 years and a commercial system is 10 years. The cost to convert these communities to centralized sewer would be extensive and depend upon the whether or not the centralized sewer infrastructure existed in close proximity to the community. However, the cost may be supplemented with grants from state and federal agencies.

The new state regulations regarding septic-to-sewer conversions and upgrades will require extensive planning and funding sources to enact. It is also necessary to prioritize communities based upon the greatest impact to IRL water quality and BMAP requirements. To receive BMAP credits through the implementation of projects, an ArcNLET model mapping plumes of nitrogen from septic effluent for the IRC was prepared, and a draft is currently in review by the County. IRC Utilities Department has received preliminary data from an ArcNLET model, allowing the department to prioritize projects. While septic-to-sewer conversions in high priority areas are important to reduce nutrient loading to the IRL, it is necessary to point out the impact this may have on the County's advanced wastewater treatment facilities.

Water Consumption

There is growing concern regarding water supplies with increasing population growth throughout Florida. All water leaving the tap and returning through the drainpipe must be treated as wastewater, and that wastewater must be reused or discharged somewhere. As more people move to Florida, the demand for water will force agencies to seek alternative sources to meet the needs of the population. SJRWMD releases an annual report of water use within the district. In the 2021 report, the total freshwater use was 1% higher than the five-year average and 1% lower than 2020. From 2012 to 2021, public water use increased from 540.07 million gallons per day (mgd) to 569.47 mgd, an increase of 5%. This number is tied to a 22% increase in the population. While the amount of water used increased, the gallons per person per day decreased from 131 to 115. Changes in use can be attributed to economic factors, conservation strategies and increased use of reclaimed water. Figure 18 shows the change in IRC population over time and the corresponding change in water consumption.

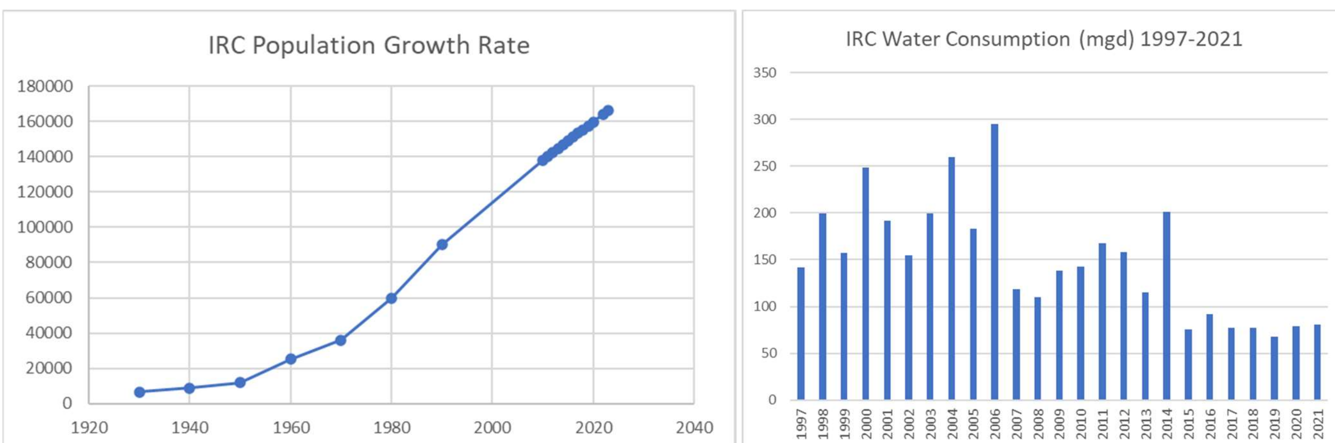


Figure 18. IRC Population Growth (left) Versus Water Consumption (right)

District-wide, decreases in use were also observed in agriculture, landscape and recreation, because of a reduced demand based on increased rainfall in 2021. However, IRC had the largest consumption for agriculture with 49.40 mgd, which is 24% of the SJRWMD total for agricultural use (Figure 19). In addition, IRC had the greatest freshwater use for landscape and recreational irrigation with 11.11 mgd. IRCs total freshwater use was 80.94 mgd, 6.18 mgd of reuse water. While much of the district experienced increased rainfall during 2021 with a mean of 52.33 inches rainfall in IRC was down 6.47 inches, which increased consumptive use in the agricultural and irrigation categories.

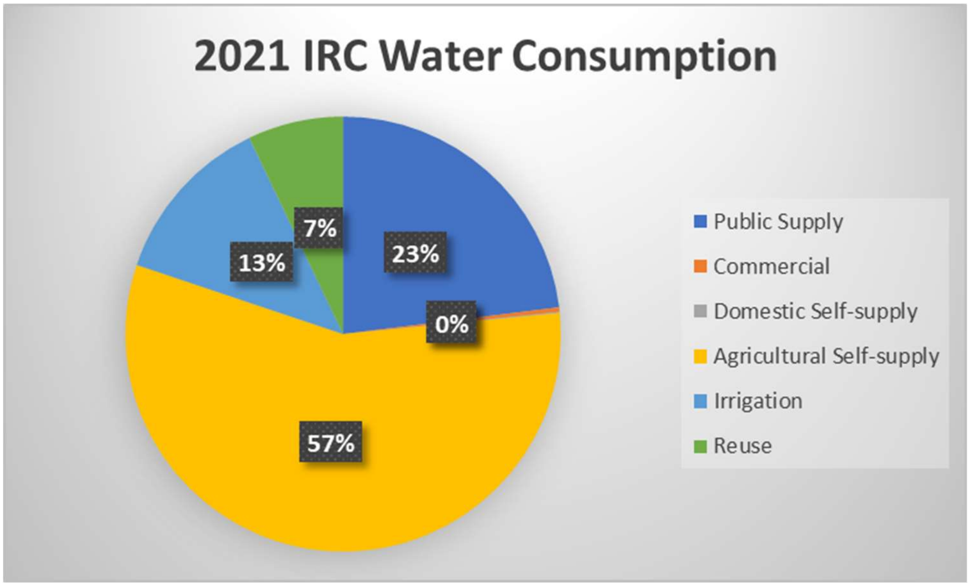


Figure 19. IRC Water Consumption by Source in 2021

IRC Utilities provides consumers with potable water acquired from the Floridan Aquifer. Water is treated through reverse osmosis plants in the South and Central portions of the County. The concentrate produced by the water treatment plant is then filtered through Osprey or Spoonbill Marsh. Osprey Marsh combines the concentrate from the water plant with water pulled from the south relief canal. The water is passed over an algal turf scrubber to remove nutrients before moving to the wetlands and ultimate the stormwater park where it passes through natural habitat before returning to the canal. Spoonbill marsh is located on a former mosquito impoundment area. The dikes and ditches remain, but the system is open allowing for direct contact with the IRL. The concentrate from the released into a pond area, which connects to inflow from the IRL. The water flows through the natural system allowing the grasses and mangroves to remove excess nutrients before flowing back to the IRL. These systems are unique ways to manage the concentrate from water treatment, while removing excess nutrients from stormwater and the IRL.

Freshwater supply and use are important to the health of the IRL. Freshwater contributes to the hydrology of the system and potential loading of nutrients and contaminants. IRC has established several programs to promote water conservation, which aligns with the BMPs (Figure 20). In 2022, IRC adopted SJRWMD's water conservation regulations to ensure efficient use of water for landscape irrigation by homeowners and businesses (Chapter 319). The regulations do not apply to agricultural crops, nurseries, cemeteries, golf courses and athletic fields. The ordinance prohibits watering between the hours of 10 am and 4 pm, which improves absorption and reduces evaporation. Irrigation days are based on the season and address number (Table 2). The ordinance not only protects the water supply by preventing excessive watering, but it also prevents excess water runoff carrying nutrients and organic material to the IRL.

Another strategy conserving water in IRC is the partnership between IRC and SJRWMD capping free flowing artesian wells. Free flowing artesian wells were once used by farmers for agricultural purposes, but Florida law requires well owners to control the discharge from artesian wells limiting the flow for its intended use. If a well cannot be controlled, it must be permanently plugged. Between 2017 to 2020, numerous wells have been plugged within IRC in the IRL basin, saving millions of gallons per year.

Water conservation begins with the property owner. The Utilities Department website provides valuable information promoting water conservation in IRC. Additional education and community outreach are valuable in changing consumptive use behaviors.

Figure 20. SJRWMD Recommendations for Water Savings

Table 2. SJRWMD Irrigation Restrictions

Time of Year	Homes with Odd Numbered or No Addresses	Homes with Even Numbered Addresses	Nonresidential Properties
Daylight Saving Time	Wednesday/Saturday	Thursday/Sunday	Tuesday/Friday
Eastern Standard Time	Saturday	Sunday	Tuesday

Utilities Actions

The following actions are recommended to improve wastewater contributions to the IRL and manage water consumption:

- Prioritize septic-to-sewer projects based on the ArcNLET report and cost benefit analysis for infrastructure.
- Identify and implement alternative reuse.
- Improve levels of treatment in water treatment plants.
- Identify new disposal options.
- Continue to promote water conservation actions by water users throughout IRC.

6. Community Development

A. Goals and Objectives

The goals and objectives for the Community Development key factors include:

a) Identify past and projected land use changes.
b) Promote low impact development.
c) Maintain current buffer zones preventing shoreline development, hardening and native vegetation.
d) Develop education and outreach on the use of native vegetation as a buffer and flood prevention.

B. Key Factors

Land Use Changes

As a widespread agricultural community, it is important to examine historical land use and potential nutrient loads remaining in the soil from previous applications. These loads are referred to as legacy loads. Legacy loads can be a source of nutrient loading to ground and surface waters. By gathering data in this area, it can be incorporated into management strategies and recommendations. In addition to understanding legacy loading and historical land use, it is necessary to identify areas of potential development and plan accordingly. The 2030 Comprehensive Plan designates the appropriate location for future land uses and establishes policies regulating growth and development, limiting the density and intensity of appropriate for land use. As the County continues to develop, making the necessary changes to meet the needs of a growing population, so does the IRL watershed leading to increased stormwater runoff.

To develop land within IRC, permits must be obtained from various agencies. There are three types of stormwater management permits administered through the Public Works Engineering Division, Land Development Section. Type A permits encompass projects not located in flood hazard zones, but Types B and C permits involve projects in flood hazard zones, as well as areas west of US 1 located between County Road 512 and State Road 60. Types B and C require the submittal of hydraulic data and calculations to ensure they meet local ordinances for protection. Staff review the application and plans to ensure appropriate nutrient levels are being removed via retention and to ensure proper water volumes are being treated by the stormwater system.

Hardened shorelines reduce habitat and increase stormwater runoff through the removal of native vegetation. IRC enforces a 50-foot shoreline protection buffer for un-platted parcels and a 25-foot buffer for existing platted lots measured from the mean high-water line. However, the buffer should not exceed more than 20% of the parcel or lot depth. The buffer zone allows for the construction of docks, boat ramps, pervious and elevated walkways. The buffer zone does not allow for additional development and native vegetation must remain unaltered protecting the shoreline from being altered. There are exceptions if it is in the best interest of the public, prevents erosion damage or provides reasonable access to the water. Hardened shorelines include seawalls, bulk heads, revetments and rip rap are the primary method of shoreline hardening. Studies have shown living shorelines outperform hardened shorelines in major storm events, in combating flooding and have a greater long-term survival compared to the life expectancy of a hardened structure. As part of the protection and restoration of the IRL, IRC staff is working with the University of Central Florida on a shoreline characterization study, prioritizing potential shoreline restoration sites to improve habitat and resiliency.

Sustainability and Resiliency

Resiliency is built into every ecological system. It is the ability of a system to absorb impacts, recover and adapt to changes (Marchese 2018). Persistent anthropogenic stressors to an ecological system can lead to a tipping point, a collapse in resiliency and the inability to recover without extensive intervention. To re-build resiliency, the stressors must be removed but recovery will be slow. To help the IRL survive in the future, measures must be taken to lessen the anthropogenic impacts. The Treasure Coast and East Central Florida Regional Planning Council’s 2016 IRL Economic Valuation Update

Report determined the economic contribution of the IRL to be $7.6 billion, with a return of $33 for every $1 invested in its recovery, an investment worth making into an economically important, diverse estuary. IRC has actively taken steps to improve IRL health and should continue when considering new projects, infrastructure development and restoration efforts. It is equally important to involve the community in the support, management and sustainability of the IRL. One way to involve the community is through the development of a sustainability action plan setting green initiative goals and implementation periods. In conjunction with the development of a sustainability action plan, community outreach and education regarding IRL initiatives and restoration will be necessary for long-term success.

Community Development Actions

The following actions are recommended to improve community development within the IRL watershed:

- Protect and preserve natural shorelines.
- Encourage the use of living shorelines for shoreline restoration.
- Enforce land use restrictions.

7. Projects

Table 3 details active, under construction, designed, and conceptual projects to achieve the LMP goals and objectives. This list of projects will be updated annually to reflect the latest information and data regarding project effectiveness and feasibility of implementation within IRC.

Table 3. Project to Achieve LMP Goals and Objectives

Department	Project	Description	Status (O Operational UC Under Construction D Designed C Conceptual)	Estimated Capital Cost	Estimated Annual Operations and Maintenance Cost	TN Reductions (pounds per year)	TN Reductions (cost per pound)	TP Reductions (pounds per year)	TP Reductions (cost per pound)
Coastal Engineering	Jungle Trail Shoreline Enhancement	This site offers the opportunity for living shoreline projects which naturally protect the historical Jungle Trail	O	$225,000	Not applicable (NA)	NA	NA	NA	NA
Coastal Engineering	Seagrass Restoration	Seagrass restoration at Big Slough at Preacher's Hole	D	$128,540-$1,400,000	NA	NA	NA	NA	NA
Coastal Engineering	Seagrass Restoration	Seagrass restoration at Big Slough, south of Sebastian Inlet	D	$128,540-$1,400,000	NA	NA	NA	NA	NA
Coastal Engineering	Muck Removal Evaluation	Muck is defined as black, organic-rich (greater than 10% organic matter), mud-rich (greater than 60% silt and clay), high water content (greater than 75% water by weight, greater than 90% water by volume) sediments. The muck sediment contains nutrients and serves as an internal "legacy load" of nutrients that releases (fluxes) nutrients back into the water column. These sediments inhibit the growth of natural benthic communities and flux nutrients to overlying water. Research will include the review of available muck mapping data to evaluate the presence and quantities of muck. Evaluate costs and benefits for additional surveys to provide a data set that will allow the County to prioritize for muck removal. Evaluate nutrient flux from muck deposits to determine the nutrient loading to the IRL.	D	$102,275	NA	NA	NA	NA	NA
Coastal Engineering	Lauren's Island Reef and Living Shoreline	Installation of an oyster reef structure around the perimeter of Lauren's Island to increase oyster density and reduce erosion.	D	$300,000	NA	NA	NA	NA	NA
Coastal Engineering	Round Island Riverside Park	To the north of Round Island South Conservation Area, the County owns two spoil islands that are part of Round Island Park. A boardwalk has been constructed to connect the smaller of the two islands to the barrier island. This approximately 7.5-acre island is dominated by exotic species and would be a potential site for habitat revitalization and water quality improvements such as creation of wetlands along the shoreline, creation of sand flats for avian habitat, and creation of native uplands.	C	To be determined (TBD)	NA	NA	NA	NA	NA
Coastal Engineering	Oyster/Benthic Community Survey (current and historical)	Identify current and historical locations and coverage of benthic organisms including seagrass, clams, and oysters. Determine the area necessary for revitalization of the lagoon and implement efforts.	C	TBD	NA	NA	NA	NA	NA
Coastal Engineering	A1A Shoreline Enhancement	Living shoreline project to naturally protect State Road A1A and the pedestrian sidewalk for approximately two miles south of Sebastian Inlet.	C	TBD	NA	NA	NA	NA	NA
Conservation Lands	Oyster Bar Marsh	Approximately 96 acres of maritime hammock and impounded wetland, located between State Road A1A and the IRL on the barrier island. The site is approximately one-half mile north of Round Island County Park. The County has been working in partnership with the Indian River Land Trust and with the Indian River County Mosquito Control District to install culverts connecting the impoundment to the lagoon that will improve flushing.	O	TBD	NA	NA	NA	NA	NA
Conservation Lands	Jones' Pier Conservation Area	The County purchased this area in 2011 and committed to implementing a management plan for the site that revitalizes ecological value, while utilizing the site for public access and display of educational and historical exhibits.	O	TBD	NA	TBD	TBD	TBD	TBD
Conservation Lands	Captain Forster Hammock Preserve	Captain Forster Hammock Preserve consists of 111 acres acquired by the County and Trustee of the Internal Improvement Trust Fund (TIITF) in 1996 and 1998. The preserve includes several different community types such as sandy dunes and coastal scrub along the eastern portions of the preserve, and maritime hammock and mangroves within the western portion. The section of the preserve abutting the lagoon was damaged from salt water inundation as a result of Hurricane Matthew and may have the potential to be Revitalized in a manner that will provide significant benefits to the lagoon.	O	TBD	NA	NA	NA	NA	NA

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Conservation Lands	Lost Tree Island Conservation Area	The Lost Tree Islands Conservation Area (LTICA) was purchased in 2003 by Indian River County with funding assistance from the Florida Communities Trust and in partnership with the City of Vero Beach (COVB) and the Town of Indian River Shores (TIRS). The 508-acre conservation area includes upland, wetland and submerged land forms located in in the central portion of the County's section of the Indian River Lagoon. The 3 larger islands (cumulative acreage of 177.4 acres) and the wetlands within the LTICA were most likely formed through natural processes, however, the topography of these islands has been modified by placement of spoil dredged from the Intracoastal Waterway channel and is dominated by Australian pines (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*). The County received a IRLNEP grant to develop a restoration and enhancement plan. The plan includes the construction of flow-through wetlands, maritime hammock, and transitional wetlands which will provide diverse wildlife habitat. baseline surveys show that there are seagrasses along the shoreline - there is a goal of expanding seagrass cover into the interior wetland areas, if feasible.	UC	TBD	NA	NA	NA	NA	NA
Conservation Lands	Archie Smith Fish House	The Archie Smith Fish House is part of the historical working waterfront in Sebastian along Indian River Drive. The property includes a small tract (0.07 acres) on the east side of Indian River Drive with two buildings and the dock structure extending approximately 240 feet into the IRL. There are several historically significant structures on the property: the historical residence just east of the public road, the dock, and the icehouse near the end of the pier. West of Indian River Drive, the property consists of approximately 1.1 acres of developed and undeveloped lands. The County plans to Revitalize these facilities as part of the management plan for the site. Part of this Revitalization may include identifying opportunities to enhance seagrass or oyster habitat in proximity to the site or evaluating the shoreline to determine if there are opportunities for creating a living shoreline.	UC	TBD	NA	NA	NA	NA	NA
Conservation Lands	South Oslo Riverfront Conservation Area	South Oslo Riverfront Conservation Area (SORCA) is a 143-acre site that abuts the IRL. the site consists of a mixture of mangrove impoundment, maritime hammock, and pine flatwoods. SORCA's eastern impoundment is no longer part of a rotational impoundment management (RIM) network. the SJRWMD has received a grant from FDEP (to be coordinated with IRC) to remove the majority of the impoundment dike to re-connect natural flow to the IRL. The project will remove 1,100-foot long perimeter dike to improve exchange between impounded mangroves and the Indian River Lagoon (IRL). Restoration of a more natural hydroperiod in the impoundment will benefit wildlife that use the mangroves, the coastal hammock, adjacent seagrass beds, and habitat for species that support fisheries.	C - Grant received for design?	TBD	NA	NA	NA	NA	NA
Conservation Lands	Spoil Island Enhancement Opportunities	Potential to create living shorelines, oyster bars, and wetland habitats.	C	TBD	NA	NA	NA	NA	NA
Conservation Lands	Round Island South Conservation Area	Approximately 65 acres of maritime hammock and impounded wetlands located between State Road A1A and the IRL on the barrier island. The southern boundary of the site is the Indian River County line. The large wetland impoundment contains a mixture of herbaceous saltmarsh flats and mangroves and is one of the more diverse estuarine wetlands in the area. There are potential opportunities for establishment of a more diverse living shoreline along some sections of the impoundment, there also is potential for increased connection between the impoundment and the IRL, which would improve habitat and water quality within the impounded wetlands. This area is known to be extensively used by manatees; therefore, all proposed activities would need to be consistent with manatee protection guidelines.	C	TBD	NA	NA	NA	NA	NA

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Conservation Lands	Prange Island Conservation Area	Located in the lagoon just south of the 17th Street Causeway Bridge, and immediately north of the southern Vero Beach city limit, there are two undeveloped islands that comprise the project: the larger (southern) island, known as Prange Island, containing approximately 16.6 acres above mean high water, and the smaller (northern) island, known as Little Prange Island, containing approximately 5.8 acres above mean high water. Prange Island is located near an Ais Indian village site called Jece on the adjacent barrier island. A prehistoric shell-midden is reported on Prange Island, but the precise location of the site is unknown at this time. The island's name comes from the Prange family who homesteaded there in the later 1800s. In areas where there is heavy exotic invasion, there is potential to create a mixture of upland and wetland communities that may benefit the lagoon from both a habitat and a water quality perspective.	C	TBD	NA	NA	NA	NA	NA
Conservation Lands	Pelican Island National Wildlife Refuge	The Pelican Island National Wildlife Refuge contains a mosaic of over 5,400 acres of wildlife habitat along the barrier island in northern Indian River County. The refuge is designated as a National Historic Landmark, a Wetland of International Importance, and a candidate Marine Protected Area. The original holdings within the refuge have expanded over time through acquisition efforts by the United States Fish and Wildlife Service (USFWS), state of Florida, and local governments. Indian River County owns, or shares ownership, on approximately 200 acres within the refuge. The County works closely with the USFWS to ensure that management of the areas is targeted at maximizing the potential wildlife habitat. The County intends to continue this collaboration to identify opportunities for projects that can enhance conditions within the lagoon.	C	TBD	NA	NA	NA	NA	NA
Stormwater	System Maintenance	The Road & Bridge Division provides maintenance throughout the county in support of a healthy Indian River Lagoon. This maintenance includes street sweeping and a ditch cleaning program. Increase street sweeping and O&M to capture nutrients.	O/C	TBD	TBD	TBD	TBD	TBD	TBD
Stormwater	Stormwater Education	The Stormwater Educator conducts many methods of education and outreach to Indian River County to inform students and adults about the importance of pollution prevention including fertilizer, pet waste, illicit discharge of chemicals, erosion, construction pollution, agricultural runoff, litter, and more. Currently the Stormwater Division presents to students throughout the school district, the Audubon Afterschool Advocates, Environmental Learning Center visitors, County employees, homeowner associations County-wide, and local professional groups such as Kiwanis and Rotary.	O	NA	NA	NA	NA	NA	NA
Stormwater	PC Main Screening System	This project removes freshwater plants and trash from the Main Relief Canal before the canal empties into the Lagoon.	O	$5,331,908	$63,260	1,456	$3,662	351	$15,191
Stormwater	Osprey Acres Flowway and Nature Preserve	The flowway continues to filter water from Osprey Marsh along with unfiltered water from the South Relief Canal. Filtering occurs through a system of treatment cells using aquatic plans to remove nutrients and then to a serpentine flowway for final polishing, eventually released further down the canal and into the Lagoon	O	$7,500,000	$87,000	5,221	$1,437	1,029	$7,289
Stormwater	North Relief Canal LEAPS™	The unique LEAPS™ will remove nutrients through a system of plants that absorb nutrients from the canal water, filtering the stormwater before returning it to the canal and IRL.	O	$12,000,000	$85,000	4,900	$2,449	690	$17,391
Stormwater	Egret Marsh	This project removes nutrients from approximately 10 mgd of canal stormwater. The filtered stormwater flows through a large polishing pond and shallow marsh and returns to the canals and flows through the Main Relief Canal, eventually emptying into the Lagoon.	O	$7,563,274	$200,189	8,550	$885	1,732	$4,367
Stormwater	County Fertilizer and Landscape Management Ordinance	In 2013, the Indian River County Board of County Commissioners passed the Fertilizer and Landscape Management Ordinance that restricts the use of fertilizer and helps prevent excess nutrients (nitrogen and phosphorous) from entering the lagoon. The ordinance states that no fertilizer containing phosphorous is to be used and no fertilizer containing nitrogen can be applied during the rainy summer season. The ordinance also includes other best management landscape practices such as blowing grass clippings back into the yard.	O	$100,000	$100,000	21,434	$5	3,114	$32
Stormwater	Stormwater Masterplan	Create a stormwater masterplan to evaluate water quality in each basin and identify areas where funding opportunities would be most advantageous. Inform decision making for conceptual projects.	C	$500,000	NA	NA	NA	NA	NA
Stormwater	Rockridge	Install Backflow prevention devices to protect the Subdivision from tidal influences.	C	$150,000	$5,000	TBD	TBD	TBD	TBD

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Stormwater	Outfall Upgrades	Upgrade outfalls to the Indian River Lagoon with baffles, screens or infiltration media to ensure that the runoff reaching the lagoon has been pretreated to remove sediment, debris and possible nutrient loads depending on funding and measurable loads in those areas.	C	$5,000,000	$200,000	TBD	TBD	TBD	TBD
Stormwater	North and South Relief Canal Mechanical Water Lettuce Removal Systems	This project will use a long reach excavator to remove water lettuce from the North and South Relief canals to prevent excess nutrient loading to the lagoon. Two locations in these canals have already been identified for accumulating a large amount of water lettuce annually	C	$400,000	$40,000	5,900	$68	1,400	$286
Stormwater	Historical Subdivision Retrofits	After a Flood Study has been performed, design and construct improvements to prevent future flooding and damage in older subdivision created prior to master drainage systems.	C	$10,000,000	$25,000	TBD	TBD	TBD	TBD
Stormwater	Flood Studies	Analysis of flooding areas to determine best solutions to prevent repeated substantial damage.	C	$500,000	NA	NA	NA	NA	NA
Stormwater	CRS Rating Evaluation and Improvement	Improving Community Rating System (CRS) class can reduce flood insurance premium rates and make community infrastructure more resilient.	C	TBD	NA	NA	NA	NA	NA
Stormwater	Baffle Boxes	Baffle boxes could be installed in areas with a lot of organic material, such as leaf litter, or trash to capture those materials before they enter the stormwater system. Baffle boxes could also be installed on County, municipality, and FDOT outfalls to major tributaries, canals, and the lagoon to reduce the amount of pollutants discharged to surface waters.	C	TBD	TBD	TBD	TBD	TBD	TBD
Stormwater	8th St Parcel	Stormwater Management and Treatment pond to store large influxes of canal water to slowly release in times when flows are low. Protects the lagoon from large releases of flow.	C	$16,000,000	$100,000	163	$98,160	37	$432,432
Stormwater, Utilities, Parks	4th St Nutrient Reduction	Providing nutrient reductions from WWTP effluents and canals. Also providing additional storage of canal pulse discharges while providing water quality improvements.	C	$15,000,000	$25,000	TBD	TBD	TBD	TBD
Utilities	Spoonbill Marsh Wetland Treatment System	This 67-acre man-made habitat uses nature's own treatment techniques for the removal of both nitrogen and phosphorus from the demineralization concentrate by-product and from the waters of the Indian River Lagoon itself. The vegetation and aquatic organisms seen throughout the marsh play an active role in efficiently removing the nitrogen and phosphorus from the blended waters.	O	$4,200,000	$667,442	7,129	$589	357	$11,765
Utilities	Osprey Marsh	This project is an algal nutrient removal facility system that removes dissolved nutrients from up to 10 million gallons per day (mgd) of stormwater and from up to 1.5 mgd of reverse osmosis reject water known as demineralization concentrate. The algal turf scrubber system uses a water treatment technology that was developed specifically to enhance water quality of polluted waters through the active cultivation of attached algae upon an engineered surface.	O	$10,000,000	$740,000	10,392	$962	1,301	$7,686
Utilities	Sebastian Septic-to-sewer - Phase I	The Sebastian Septic-to-sewer – Phase 1 area is presently served by an arterial sanitary sewer collection and conveyance system constructed in the early 1990s. However, there remains a large population of residential and commercial entities that use septic systems. The project includes an area of 73 acres with an assumption of one septic system per acre.	O	TBD	NA	TBD	TBD	NA	NA
Utilities	ArcNLET Modeling	Identify priority areas/neighborhoods and evaluate the potential for septic system removal or upgrade in the highest priority areas using the ArcGIS-Based Nitrate Load Estimation Toolkit (ArcNLET). Prepare and implement a plan for prioritized septic system removal or upgrades. Use ArcNLET data to obtain grant funds and TMDL/BMAP credits.	UC	$65,000	NA	NA	NA	NA	NA
Utilities	West Wabasso Septic-to-sewer Phase III	Convert approximately 31 septic systems to central sewer and construct approximately 61 stubouts for current and future connections.	UC	$3,700,000	NA	2,219	$1,667	18	$205,556
Utilities	ArcNLET Modeling	Identify priority areas/neighborhoods and evaluate the potential for septic system removal or upgrade in the highest priority areas using the ArcGIS-Based Nitrate Load Estimation Toolkit (ArcNLET). Prepare and implement a plan for prioritized septic system removal or upgrades. Use ArcNLET data to obtain grant funds and TMDL/BMAP credits.	UC	$65,000	NA	NA	NA	NA	NA
Utilities	North County (Roseland) Septic-to-sewer	Project has the potential to connect up to 200 residents to the sewer system. A little over 40 residents have already connected.	UC	$7,141,291	NA	3,881	$1,840	NA	NA

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Utilities	West Wabasso Septic-to-sewer Phase II	Convert 57 septic systems to central sewer and construct stub-outs for 47 vacant properties for future connection.	C	TBD	NA	3,224	TBD	520	TBD
Utilities	Sebastian Septic-to-sewer - Phase II	This project will connect the existing septic systems to the sewer system which will allow for environmentally sound infrastructure growth to the area and lagoon. It will include an area of 73 acres with an assumption of one septic system per acre. There is an estimated concentration of 30 pounds of TN per year per system and 5 pounds of TP per year per system removed from the environment, with a total estimated reduction of 2,190 pounds per year of TN and 365 pounds per year of TP will result from this project.	C	TBD	NA	TBD	TBD	NA	NA
Utilities	Hobart Landing Unit 2	Septic-to-sewer 26 homes	C	$681,725	NA	965	$706	NA	NA
Utilities	Orchid Island No. 1	Septic-to-sewer 14 homes	C	$407,869	NA	473	$862	NA	NA
Utilities	Orchid Island No. 2	Septic-to-sewer 22 homes	C	$634,157	NA	738	$860	NA	NA
Utilities	Hobart Landing Unit 3	Septic-to-sewer 07 homes	C	$135,951	NA	270	$503	NA	NA
Utilities	Hallmark Ocean Subdivision	Septic-to-sewer 03 homes	C	$197,013	NA	116	$1,701	NA	NA
Utilities	Ambersand Beach Sub No. 1 & 2	Septic-to-sewer 73 homes	C	$1,838,644	NA	2,802	$656	NA	NA
Utilities	Floravon Shores Subdivision	Septic-to-sewer 36 homes	C	$379,142	NA	949	$399	NA	NA
Utilities	Naranja TR Shellmound Bch Replat of POR	Septic-to-sewer 08 homes	C	$330,674	NA	327	$1,011	NA	NA
Utilities	Sebastian Highlands Unit 02 Collier	Septic-to-sewer 27 homes	C	$576,305	NA	1,028	$561	NA	NA
Utilities	River Shores Estates Units 1-4	Septic-to-sewer 120 homes	C	$2,933,294	NA	1,663	$1,764	NA	NA
Utilities	Rain Tree Corner Subdivision	Septic-to-sewer 16 homes	C	$468,796	NA	445	$1,054	NA	NA
Utilities	Sebastian Highlands Unit 05	Septic-to-sewer 404 homes	C	$8,623,235	NA	13,577	$635	NA	NA
Utilities	Hobart Landing Unit 1	Septic-to-sewer 17 homes	C	$447,727	NA	136	$3,282	NA	NA
Utilities	Orchid Isles Estates Subdivision	Septic-to-sewer 63 homes	C	$1,345,995	NA	2,429	$554	NA	NA
Utilities	Kanahwah Acres	Septic-to-sewer 12 homes	C	$485,688	NA	165	$2,949	NA	NA
Utilities	Verona Estates Subdivision	Septic-to-sewer 07 homes	C	$199,287	NA	106	$1,882	NA	NA
Utilities	Indian River Heights Units 1-9	Septic-to-sewer 772 homes	C	$10,492,885	NA	5,759	$1,822	NA	NA
Utilities	Diana Park Subdivision	Septic-to-sewer 21 homes	C	$599,085	NA	588	$1,020	NA	NA
Utilities	Dales Landing Subdivision	Septic-to-sewer 07 homes	C	$247,302	NA	169	$1,460	NA	NA
Utilities	Stevens Park Unit 1&2	Septic-to-sewer 303 homes	C	$4,582,060	NA	1,658	$2,764	NA	NA
Utilities	Pine Tree Park Units 1-4	Septic-to-sewer 488 homes	C	$7,136,717	NA	6,222	$1,147	NA	NA
Utilities	Little Portion Subdivision Replat OF	Septic-to-sewer 21 homes	C	$582,324	NA	201	$2,895	NA	NA
Utilities	Sebastian Highlands Unit 01	Septic-to-sewer 754 homes	C	$9,552,456	NA	17,256	$554	NA	NA

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Utilities	Sebastian Highlands Unit 04	Septic-to-sewer 432 homes	C	$5,473,025	NA	10,019	$546	NA	NA
Utilities	Winter Grove Subdivision	Septic-to-sewer 25 homes	C	$709,615	NA	632	$1,123	NA	NA
Utilities	Tropic Colony Subdivision	Septic-to-sewer 145 homes	C	$3,065,568	NA	1,115	$2,750	NA	NA
Utilities	Halleluiah Acres	Septic-to-sewer 06 homes	C	$306,376	NA	232	$1,323	NA	NA
Utilities	Sebastian Highlands Unit 13	Septic-to-sewer 574 homes	C	$8,107,515	NA	5,988	$1,354	NA	NA
Utilities	Sebastian Highlands Unit 02	Septic-to-sewer 1052 homes	C	$13,327,830	NA	17,845	$747	NA	NA
Utilities	Sebastian Highlands Unit 03	Septic-to-sewer 155 homes	C	$1,963,701	NA	4,570	$430	NA	NA
Utilities	Sebastian Highlands Unit 02 Replat page 2	Septic-to-sewer 66 homes	C	$836,157	NA	1,268	$659	NA	NA
Utilities	Sebastian Highlands Unit 02 Replat page 3	Septic-to-sewer 129 homes	C	$1,634,306	NA	3,320	$492	NA	NA
Utilities	Sebastian Highlands Unit 02 Replat page 4	Septic-to-sewer 56 homes	C	$709,466	NA	893	$794	NA	NA
Utilities	Heritage Trace at Hobart	Septic-to-sewer 07 homes	C	$209,629	NA	TBD	TBD	NA	NA
Utilities	Central WWTF Nutrient Reduction (Permit No. FLA010431)	Nitrogen and phosphorus project in effluent which goes to the County's Reuse Program.	C	$300,000	NA	5,673	$53	1,871	$160
Utilities	West WWTF Nutrient Reduction (Permit No. FL0041637)	Nitrogen and phosphorus project in effluent which goes to the County's Reuse Program.	C	$300,000	NA	19,239	$16	3,106	$97

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