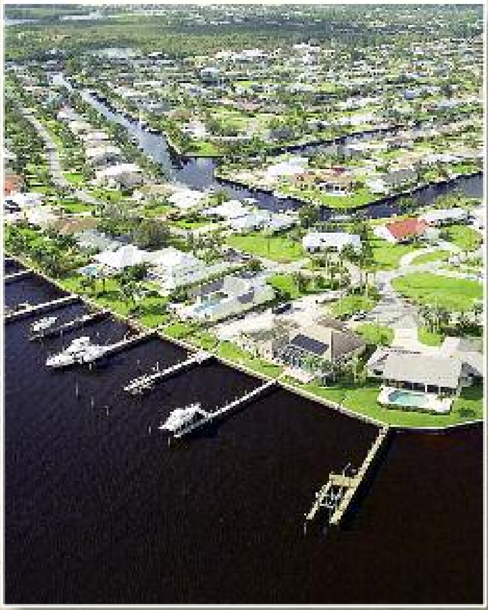
Indian River Lagoon

An Introduction to a Natural Treasure



Sebastian Inlet

This publication was produced by the St. Johns River Water Management District and the Indian River Lagoon National Estuary Program.

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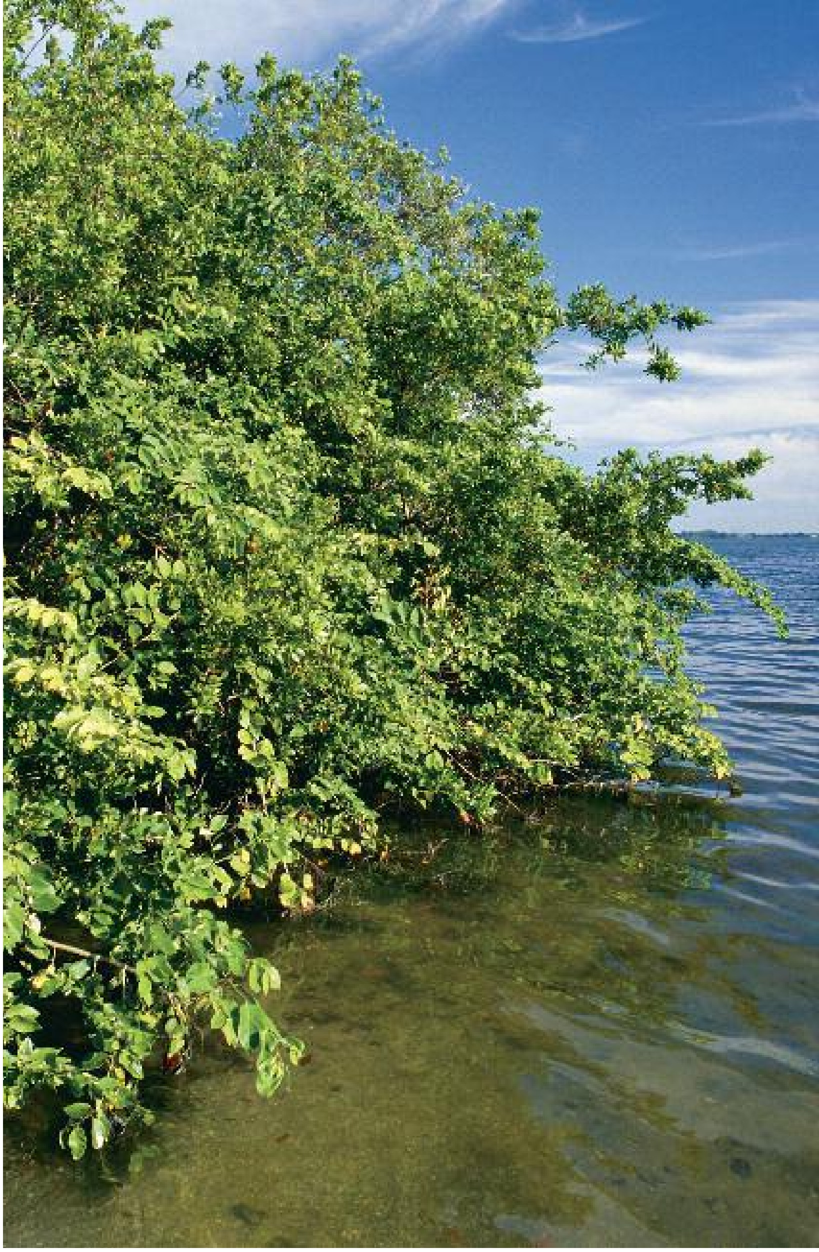
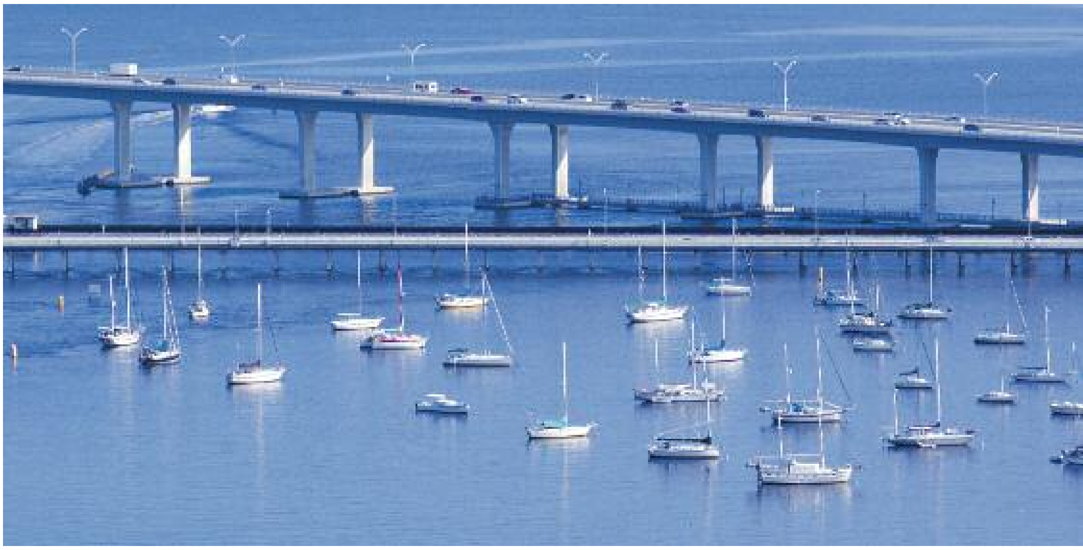


MEETING PLACE

Lagoon represents a meeting place for people, wildlife and waters



The Indian River Lagoon is remarkable — it is a complex and dynamic estuarine system. Throughout the length of the lagoon, the various segments that comprise the whole system are influenced by the locations of inlets connecting the lagoon to the Atlantic Ocean and by freshwater entering the system through an extensive network of streams, rivers, canals, ditches and overland runoff.

The lagoon is home to a rich array of plants and animals that depend on its water quality for their existence. Humans also are dependent on the lagoon for the many recreational and commercial opportunities it provides. At the same time, silt, sediments, nutrients, chemicals, oils and metals find their way into the lagoon as the result of human activities in the watershed. Additionally, the lagoon's bottom has been selectively dredged, filled or otherwise altered. Thus far the lagoon system has been able to adapt to these challenges and still remain a relatively healthy environment.

Throughout its recorded history, there have been occasions when unusual amounts of pollutants have entered the system and resulted in fish kills, algal blooms and changes in water clarity. The lagoon system has the natural capability to absorb a certain amount of these pollutants; however, when overloaded, the lagoon suffers. The primary questions become: How does the system respond to accumulated impacts through time? What assimilative capacity does it have before dramatic and permanent changes occur? How will these changes affect the long-term environmental health and future of the Indian River Lagoon?

We are already witnessing the ways in which the lagoon is adapting to adversity. Fishery populations are reduced, salt marshes and mangrove wetlands are lost, and shellfish harvesting areas grow smaller and are closed. While the plants and animals that call the lagoon home strive to exist and flourish, many cannot readily adapt to change. Their population numbers begin to decline and, over time, populations may become extinct as habitat loss and ecosystem degradation take their toll.

Directly or indirectly, we are all responsible for maintaining the health of the Indian River Lagoon system. As residents, as government leaders, as visitors and as responsible individuals we can each do our part to effect positive changes within the lagoon.

The information contained in this publication provides only brief highlights of the major issues facing the lagoon and the state of its resources. Many technical documents are available that discuss the lagoon in greater detail, and for those who are interested, you may request more information.

With your understanding of the issues and a sharing of knowledge to address the problems, a positive shift in the fragile balance of the lagoon ecosystem may result. For future generations in east Florida, we must act in unison to achieve results for the lagoon to remain a unique and precious resource. Your involvement is needed now to help protect and restore this natural treasure.

The Indian River Lagoon is 156 miles long and makes up 40 percent of Florida's eastern coast.

FAST FACTS

Quick lagoon info

Watershed

- The watershed is 2,284 square miles with a surface water area of 353 square miles.
- Six counties border the lagoon, however, portions of seven counties are within the watershed.
- Five inlets connect the lagoon with the ocean. There is a sixth connection at Port Canaveral, however, navigation locks that separate the port basin from the lagoon limit the exchange of waters.

Not a river

The lagoon is an estuary where salt water from the Atlantic Ocean mixes with freshwater from the land and tributaries. The resulting brackish (slightly salty) water is moved more by the wind than by the tide and does not flow from headwaters to a mouth like a river. The width of the lagoon varies from one-half mile to 5 miles, with an average depth of 4 feet.

Supporting the economy

The lagoon is responsible for one-seventh of the region's economy. The lagoon supports a world-renowned citrus industry, with an estimated annual value of $2.1 billion. The lagoon also generates more than $300 million in boat and marine sales annually.

Fisheries

The lagoon is the cradle of the ocean, serving as a spawning and nursery ground for ocean and lagoon fish. An estimated $30 million is derived from lagoon fishery revenues annually. The lagoon provides an estimated 50 percent of the east Florida fish catch annually.

Highway of the East Coast

The Indian River Lagoon is located along the Atlantic Flyway, a key biological highway for many migrating species of birds.

Wildlife

- The lagoon basin contains more species than any other estuary in North America.
  - Number of fish species — 685
  - Number of bird species — 370
  - Number of plant species — 2,100
  - Number of animal species — 2,200
- Ocean beaches in the lagoon region provide one of the densest sea turtle nesting areas found in the western hemisphere.
- The lagoon is the only location in the world to find the Atlantic salt marsh snake.

Plant life

- The northern limit of mangroves is within the lagoon boundaries.
- Maritime hammocks, which include a number of tropical and subtropical trees and other plants, are found in the region, but not further north.
- The lagoon contains 27 percent of Florida's eastern coastal salt marshes.

Getting outside

State parks, federal wildlife refuges, a national seashore and other public lands offer a range of opportunities for recreational enjoyment and environmental learning and appreciation.

RESOURCES

Lagoon's resources are diverse, plentiful

Biodiversity

Maintaining biological diversity (the existence of many different types of plants, animals and habitats) is a key part of maintaining the health of the earth's ecological systems and its future resources. The same can be said for the Indian River Lagoon.

In addition to 2,100 species of plants, the lagoon basin is home to more than 2,200 animal species — the most of any North American estuary. Included in the list of plants are seven species of sea grasses, a greater number of seagrass species than most estuaries in the northern hemisphere. One of these, Johnson's sea grass, is found primarily in the Indian River Lagoon.

Why does the lagoon support such a diversity of plants, animals and habitats? The answer is largely in the unique combination of its north-south orientation along the U.S. East Coast and the lagoon's long, narrow configuration.

The lagoon is located in the zone where tropical and temperate climates meet. Between the southern and northern ends of the lagoon the temperature differs as much as it does between the northern end of the lagoon and North Carolina, 500 miles to the north. Thus, the flora and fauna include tropical and subtropical species that cannot survive cold weather, as well as temperate species that can thrive in cooler climates. As a result, more species and a wider range of species are found in the Indian River Lagoon than any other North American estuary.

Fifty-three species of animals classified as threatened or endangered live within the lagoon's diverse watershed. Merritt Island National Wildlife Refuge, in the north-central section of the lagoon, contains more species of threatened and endangered animals than any other national wildlife refuge in the United States.

Habitats and communities

Habitats, the environments in which plants and animals live, result from physical conditions, as well as from the effects of the plants and animals themselves. Communities are the assemblages of plants and animals that live together, sharing the same habitats.

Complex interactions occur among habitats and the surrounding environment, so that actions that affect one habitat or community, ultimately, can affect conditions in another, even distant, habitat.

Habitats within the lagoon range from inlets, which are like the open ocean, to the dry upland oak scrub ridges. Because these habitats are so diverse, so specialized and so unique, they have limited tolerance to change, and changes in the region have resulted in the loss of a great deal of these natural environments and the species that inhabit them.

The major habitats within the Indian River Lagoon and its associated tidal zone can be described as

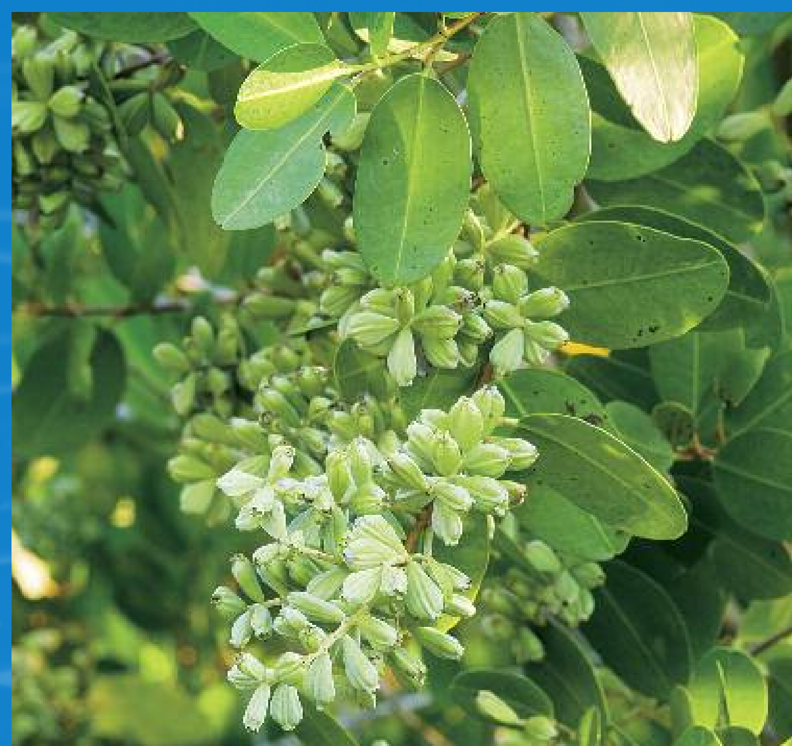
- Seagrass habitats
- Open-water habitats
- Mangrove forest and salt marsh habitats
- Spoil island and shoal habitats

Seagrass habitats

Unlike the simple plants called algae, sea grasses are underwater plants that have roots and flowers, just like the trees and grasses that live on land. The location and concentration of any variety of sea grass is determined by its response to environmental factors, such as light, salt content of water and temperature. In the lagoon, the primary factor that affects the health of the seagrass community is the availability of light.

Turtle grass, manatee grass and shoal grass are the three most dominant species of sea grasses in the lagoon. In some cases, they form large beds, or meadows, that cover the entire bottom of large areas of the lagoon, with dense grass up to 3 feet high. These beds become home to a highly diverse group of other plants and animals — everything from microscopic bacteria to animals, such as copepods and blue crabs. Juvenile fish also find food and shelter in these beds.

Sea grasses, along with the microscopic algae that cover their leaves, convert solar energy to plant tissue, making seagrass habitat very productive. Sea grasses form the basis of the food



Opposite page
A green heron calls out from atop a mangrove.

Top
An ibis feeds in a tidal flat.

Above
A white mangrove.

Above
A red mangrove flourishes in the lagoon.

Opposite page
One of the lagoon's 137 spoil islands.

web for many of the animals in the estuary. The lagoon is sometimes known as a "seagrass-based ecosystem," rather than a "phytoplankton-based ecosystem," meaning that these rooted plants, rather than free-floating microscopic plants (algae), provide most of the food for animals of the system.

Open-water habitats

Open-water habitats include all of the submersed parts of the lagoon that are not covered by sea grasses and which encompass both the water column and the bottom of the lagoon. Although the productivity of the lagoon is based on sea grasses and other large plants, open water habitats comprise about 65 percent of the lagoon's area.

The bottom may be sandy, muddy or even rocky. Most animals that live on the bottom of the lagoon are invertebrates (having no backbone). These include large mollusks, such as clams, and also tiny polychaete worms, amphipod crustaceans, sponges, bryozoans, oysters and blue crabs.

Phytoplankton play a major role by forming one of the key bases of the food web. Small, free-floating animal species of plankton known as zooplankton feed on this algae. Phytoplankton and zooplankton are in turn eaten by larval forms of such important species as the spotted sea trout and by small fish, such as the bay anchovy and black mullet, which are major foods for the prized red drum (redfish) and tarpon, as well as other sport and commercial fish.

However, in this delicate environment, too much phytoplankton can kill both sea grasses (due to shading) and fish (due to a lack of oxygen caused by dying or decaying phytoplankton). When high levels of nutrients are combined with high summer temperatures and light, "blooms" of algae may occur. This overabundance of algae can upset the delicate balance of the lagoon, causing fish kills, odors, decreased water clarity and other problems.

Mangrove forests and salt marshes

Areas alongside the lagoon's shoreline are often flooded during seasonal high tides, but are exposed during seasonal low tides. Mangroves are tropical trees that have adapted to this habitat. Primary species are the red mangrove, found at the water's edge and black mangrove and white mangrove, which are generally found at or above the average high-water line.

Salt marshes are dominated by nonwoody plant species, such as grasses or rushes. Most salt marshes in the lagoon are found from Merritt Island north, where periodic winter freezes limit the spread of mangroves. Many of the salt marshes of the lagoon differ from marshes found elsewhere in Florida because natural elevations restrict flooding to only the highest seasonal tides, limiting the vegetation to a few species capable of tolerating extended drought conditions.

Mangrove and salt marsh habitats are also home to a large number of other plants and animals, including some that could not survive elsewhere. For example, the salt marshes of Mosquito Lagoon are the only habitat of the threatened Atlantic salt marsh snake. Prior to impoundment of the marshes for mosquito control, the salt marshes of Merritt Island were once prime habitat for the dusky seaside sparrow. Habitat loss caused by impoundment contributed to the extinction of the species. Large numbers of wading birds forage for small fish and insects in creeks and ponds within the marshes and mangroves. The mangrove forests also provide roosting and nesting areas for many of these birds. Additionally, 80 percent or more of the recreational and sport fish spend at least a part of their lives in these tidal wetlands.

Mangrove forests and salt marshes are not just important habitats. They also play a key role in the protection of water quality. The tidal wetlands of the lagoon serve as a filter, removing sediments, nutrients and other pollutants from the runoff before they reach the open waters of the lagoon. These same wetlands buffer the impacts of waves from storms or boats, helping to protect the shoreline from erosion.

Spoil island and shoal habitats

Seemingly the least-appreciated habitats in the lagoon, spoil islands and shoals are the man-made islands created by depositing dredged bottom material. Most of the 200-plus islands in the lagoon were created in the 1950s from the dredging of the Intracoastal Waterway.

When these islands were constructed, many environmental impacts resulted. One impact was the destruction of seagrass beds by filling, which created large areas of turbid (cloudy) water as the islands were constructed. Over the years, the islands have stabilized, and sea grasses have colonized portions of the shallow submersed areas surrounding many of these islands. Mangroves often become established in intertidal areas, with trees and shrubs on the upland portions of many islands, providing roosting and nesting sites for wading birds. Bare sections provide nesting sites for terns and other shorebirds when natural nesting sites on other beaches have been disturbed by humans.

While the older spoil islands have become a valuable habitat in the lagoon, creating new islands would likely have far greater negative impact to lagoon resources.

Fisheries

The fisheries of the lagoon have played a major role in human use and development of the region. The remains of fish and shellfish found in Timucuan and Ais Indians shell mounds and campsites show that these early settlers depended heavily on fishing as a source for food.

Commercial fisheries became an important component of the regional economy starting in the mid-1800s. Many commercial anglers took advantage of the long docks at places like Cobb's Store and Landing in Fort Pierce. Large racks were used to dry miles of nets. Mule-drawn carts hauled the catches from the piers on rail lines that ran to the shore.

Today commercial fisheries-related employment represents only a small fraction of the lagoon's economic impact, but the value of the resource is measured in other terms. Sport fishing and abundant fresh fish in local restaurants and markets attracts visitors and residents alike, contributing millions of dollars to local economies. Many people are employed in related fields, such as boat construction and sales, bait and tackle, and restaurants.

Wood storks are a common sight near the Indian River Lagoon. This group was photographed at Sebastian Inlet.

Fisheries were abundant in the 1800s and early 1900s, as illustrated in many old photographs of catches of large snook, goliath grouper, redfish and even sawfish. Other reports show that huge schools of mullet and other important fish were in the lagoon at this time.

Today the sawfish and goliath grouper are virtually gone from the lagoon. Other fish species are present, but many older fishermen will tell you that today's fish are fewer and smaller.

What happened to these fish? Are claims of fewer fish in the lagoon substantiated? Researchers from the Florida Fish and Wildlife Conservation Commission (FWC) and other organizations are trying to find the answers.

Catch data from the last 30 years show that catches of some species, such as the snook and spotted sea trout, have declined severely. In recent years, the snook has been designated as a game fish, is listed as a protected species by the state, and it is no longer caught and sold commercially. Reports of more and bigger snook caught by anglers have appeared in recent magazines and newspapers, which may indicate that this species is responding favorably to management techniques.

The spotted sea trout is one of the most popular species of sport fish in the lagoon. It is also an important commercial species. Declines of significant species like the spotted sea trout have hurt both recreational and commercial anglers. Since 1953, the recorded sea trout commercial catch has declined by more than 50 percent in the region. Sport anglers also have caught fewer sea trout. According to the National Marine Fisheries Service, the average time to catch a sea trout has increased from two hours to four hours since 1980. Because the sea trout depends on the lagoon throughout its life, factors within the lagoon are believed to be related to its decline.

Overfishing has been cited by some as a cause of declining fish populations. Another major factor is a loss of productive habitat. Sea trout use seagrass beds during significant portions of their lives. Since the 1940s, seagrass beds have decreased by more than 70 percent in some portions of the lagoon. Other changes in productive habitat have included the isolation of salt marsh and mangrove communities and the filling of productive shallow areas for development.

Seagrass decline is related not only to physical destruction, but also to chemical and physical changes in the water caused by pollutants and runoff into the lagoon. In particular, sediments and other materials that decrease water clarity can affect sea grasses by reducing the amount of sunlight that reaches them, thus, decreasing growth rates. Pollutants may have caused some of the decline in fish populations, but the evidence is not conclusive. The presence of certain metals in the lagoon can affect reproduction and growth in fish. Although levels appear to be low in much of the lagoon, elevated levels of metals, such as zinc, lead and copper, have been found in isolated areas. High copper levels have been found in the sediments of the St. Lucie Estuary. Sources of copper have not been determined, but may include pesticides used in the region's abundant agriculture and anti-fouling paints used on the hulls of boats.

Fish populations may even be affected by clean freshwater entering the lagoon. Sea trout eggs float or sink depending on the salinity of the water. Thus, their distribution may be dependent on salinity patterns and freshwater discharges. Oysters, clams, many fish and the larvae of a variety of lagoon species are sensitive to salinity, and their populations' distribution and survival may be linked to the wide range of salinity levels found in the lagoon.

Wildlife

The Indian River Lagoon itself contains more than 2,200 species of animals, including nearly 700 fish, 68 reptile and amphibian, 370 bird and 29 mammal species. Among the birds — the most readily noticed wildlife — more than 125 species breed in the lagoon, while another 170 species winter there. When additional species found in the watershed are included, more than 4,300 species make up this diverse and productive ecosystem.

The estuary is located along the Atlantic Flyway, the route used by millions of birds to migrate from eastern North America to South America and the Caribbean. More than 200,000 ducks and other waterfowl have been counted in the Merritt Island National Wildlife Refuge. Wading birds and shorebirds are also abundant year-round in the lagoon, home to more than 50 communal nesting areas, most of them on the spoil islands or mangrove forests.

One of the major rookeries is the Pelican Island National Wildlife Refuge. This refuge is the first National Wildlife Refuge, established in 1903 by President Theodore Roosevelt in response to a severe decline in the brown pelican population in the United States, particularly in south Florida in the early 1900s. Establishment of the refuge marked the first time that the federal government set aside land for the sake of wildlife. The protection of Pelican Island, a significant nesting site in south and east Florida, may have saved the region's pelican population.

When brown pelican populations dipped again in the 1960s and 1970s, reportedly because of the use of the pesticide DDT, the lagoon was affected only slightly because less DDT was used for mosquito control there. Mangrove forests and salt marshes that bred mosquitoes were either ditched and drained, or impounded and flooded, to prevent mosquito breeding. This approach was adopted as a less expensive yet highly effective alternative to pesticides and because mosquitoes had developed a resistance to DDT.

Although the ditching, draining and impounding of marshes to control mosquitoes prevented pesticide poisoning of pelicans, it disturbed the fragile ecology of the lagoon system. Changes in salt marsh habitat contributed to the extinction of the dusky seaside sparrow and the disappearance of the Smyrna seaside sparrow from the lagoon marshes. Changes in feeding and nesting patterns resulted for many other bird species and use of wetlands by fish was restricted.

Among marine mammals, the manatee (also known as the sea cow) and the Atlantic bottle-nosed dolphin (or porpoise) are frequently found in the lagoon. While many of these animals are full-time residents of the lagoon, some use the lagoon only seasonally or as a migratory route to other feeding grounds or refuge areas.

The manatee is a large, plant-eating mammal that swims slowly through shallow coastal waters, grazing on sea grasses and other plant life. The lagoon is used by at least one-third of the U.S. manatee population, with nearly 700 manatees being counted during one survey in the north end of the Banana River.

During warmer weather, manatees are often found throughout the lagoon. In the winter, some manatees migrate south to seek out warmer waters, while many remain in the lagoon, depending on the warm waters discharged by power plants for their survival. Manatees are quite susceptible to injury from watercraft, and this remains the leading human-related cause of manatee death and injury.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The Atlantic bottle-nosed dolphin is most commonly found in the central and southern parts of the lagoon system. As many as 300 dolphins may live permanently within the lagoon, while others move between the lagoon and the Atlantic Ocean.

Many other species of wildlife depend on the lagoon at various times in their life cycles. All of these species contribute to the biodiversity of the lagoon, but their continued presence requires suitable habitats. Many species have become threatened or endangered and will require special care and attention if they are to remain part of the lagoon ecosystem.

Recreational use

The lagoon has been a magnet for recreational activities since the late 1800s, when steamboats and railroad lines first provided access to the lagoon and hotels in New Smyrna Beach began catering to hunters, fishermen and boaters. Today, more than 15 percent of Florida's restaurants and hotels are in the lagoon region. Nearly 100 resorts, fish camps, and bait and tackle stores are at least partially supported by the lagoon's recreational fishing.

Fishing and boating are the primary recreational uses of the lagoon. More than 100,000 pleasure boats were registered in the lagoon region in 2005, with more than 5,000 dock and storage spaces for these boats along its shores. It has been estimated that more than $54 million was spent on recreational fishing in the lagoon in 1990, with $87 million possible by 2010.

Recreational use of the lagoon contributes substantially to the local economy. The average sales tax from tourism and recreation in 1991 ranged from $98 to $177 for each resident of six counties bordering the lagoon. By contrast, the average figure in Okeechobee County, which does not border the lagoon, is $59 per resident.

Although many of the recreational boat and fishing trips that occur in the lagoon may also occur in the Atlantic Ocean, virtually all of these trips start from launch ramps, docks and marinas within the lagoon. An estimated 400,000 fishing trips by boat occurred from these sources in 1970. This figure more than doubled by 1990. By 2010, boat trips could approach 1.5 million annually.

Opposite page
The Indian River Lagoon is an angler's paradise.

While recreational use of the lagoon is important for the economy of the region, as well as for the enjoyment of its residents and visitors, such heavy uses can strain the sensitive, natural resources of the lagoon.

While most boaters use great care in the operation and maintenance of their vessels, some boaters' use may affect the health of the lagoon. Water pollution and sediment contamination can result from even minor spills of gasoline or oil, from leaching of metals or other chemicals in anti-fouling paints used to keep boat hulls clean and from bacteria and nutrients from improper disposal of sanitary wastes.

Boat traffic itself can disturb the lagoon. If care is not taken to avoid shallow areas, a boat's propellers may dig into the lagoon bottom. In addition to possible damage to the boat, this prop-dredging can damage important seagrass beds and stir up bottom sediments, cutting off light to the sea grasses and releasing nutrients and contaminants that are trapped in the sediments. Boat wakes erode shorelines and stir up sediments from shallow water. Other recreational impacts can include littering or the improper disposal of trash. Manatees, sea turtles, dolphins, fish and birds can be injured and killed by ingesting or becoming entangled in discarded fishing line, nets, plastic bags and other debris, such as plastic six-pack rings.

Some have described the increasing recreational use of the lagoon as "loving the lagoon to death." The lagoon is an important resource for recreation and for the well-being of area residents. But as human use increases, minimizing harmful impacts to the lagoon may become an even greater challenge for the people who love it, use it and wish to conserve it.

One way to help protect and conserve the lagoon is through the purchase of an Indian River Lagoon license plate for your vehicle and boat trailer. Proceeds from the sales of the "snook tag" are returned to the lagoon to pay for restoration projects.

Restore a Florida Treasure

Hook up now at your local tag office

LAGOON BASICS

The science of how the system works

In an estuary such as the Indian River Lagoon, waters from several sources mix to become the essence of a beautiful and unique water body. The main freshwater sources for the lagoon are rainfall and runoff that flows from the land surrounding the lagoon to creeks, rivers, canals and ditches to the lagoon system. Ocean water enters through ocean inlets.

The lagoon is a system composed of several smaller components known as segments. Individual segments function or have a slightly different character than surrounding segments. The size of a segment can vary for different characteristics and functions. While general management strategies, or objectives, can be developed for the lagoon as a whole, specific management strategies are developed segment by segment, as a result of these differences in characteristics and functions.

The hydrology of any segment of the lagoon is dependent on a complex relationship between saline (salty) waters entering the lagoon through inlets connected to the Atlantic Ocean; freshwater discharges to the lagoon from streams, creeks, rivers and canals; the physical shape of the lagoon (water depth, width) and the degree of mixing of the waters within the lagoon. All of these processes and others make up the plumbing of the lagoon and determine the ecology of each main segment of the lagoon system.

The lagoon is unique among Florida estuaries because of its limited exchange of water with the open ocean. There are only five inlets along the lagoon's 156-mile length, and the inlets are broadly spaced along the lagoon's length. The lagoon's depth averages only 4 feet. These features result in a water body that is sensitive to the amount and timing of freshwater discharged to it from the lagoon's watershed, the amount of pollutants carried by these freshwater discharges, and saltwater tidal exchange through ocean inlets. All of these features help to determine the characteristics of water quality in any given part of the lagoon.

To predict the long-term cumulative impacts from watershed alterations and pollutant loads to the lagoon, knowledge of how the system works is also necessary for the development of management strategies and the implementation of effective management actions for restoration of the lagoon's watershed.

Circulation and mixing

Circulation and mixing within the system are quite complex. While the tidal currents that drive circulation and mixing in a typical estuary are important in the lagoon, there are several additional forces that are unique to this system.

Within a given segment of the lagoon, circulation and mixing are primarily influenced by the distance of that segment to an ocean inlet. Other influences include freshwater discharges, wind-generated currents and evaporation processes. With increased distance from an ocean inlet, these other influences increase in importance.

In the vicinity of ocean inlets, tidal currents dominate and control mixing and circulation. Where tributaries discharge to the lagoon, freshwater flows drive these processes. In many segments of the lagoon that are not near an ocean inlet or tributary, wind-driven currents provide the primary energy for circulation or mixing.

When evaporation exceeds the amount of freshwater entering the lagoon from rainfall or runoff, water will move into the lagoon from the ocean. This process contributes to mixing and circulation in sluggish areas of the lagoon.

In the south Indian River Lagoon, evaporation seldom exceeds freshwater inflow in an average year. This is due to the large watershed and extensive drainage systems that deliver large amounts of freshwater to the lagoon.

The circulation and mixing processes of the lagoon are further complicated by factors such as climatic season, alterations to the shoreline and by modifications to the lagoon's bottom as the result of dredging and filling. For example, circulation is restricted in the Vero Narrows area, reducing tidal action. Ultimately, changes in circulation can affect water quality in certain sections of the lagoon.

Top
Fort Pierce Inlet was dredged in the 1920s.

Middle
The St. Sebastian River flows east to the Indian River Lagoon.

Bottom
Jupiter Inlet connects the ocean and lagoon.

Opposite
The state park at Sebastian Inlet is a popular spot.

Salinity

Salinity distribution in the lagoon system is another example of how water is circulated. High-salinity ocean water is carried into the lagoon by tides and currents through the openings (inlets) of the barrier island. This saline (salt) water mixes with freshwater entering the lagoon from runoff or rainfall. The result is a distribution of salinity that ranges from freshwater to high-salinity ocean water.

Mosquito Lagoon, Banana River and north Indian River have limited inflows of freshwater, which when combined with evaporation losses, result in higher salinities in these areas of the lagoon. By contrast, lower-salinity waters are found in the portion of the lagoon between Melbourne and Vero Beach. This is mostly due to the large amounts of freshwater entering the lagoon from the Eau Gallie River, Crane Creek, Turkey Creek, St. Sebastian River and Indian River Farms Water Control District canals in the Vero Beach area, especially during the wet season. Another factor contributing to lower salinities in this area is Sebastian Inlet, which although relatively small, is the only connection to the ocean in the central part of the system. The resulting lower, but highly variable, salinity levels in this area may be a factor in determining the type and extent of certain biological resources such as sea grasses, clams and oysters.

In the southern portion of the lagoon, the mixing and blending of freshwater and ocean water are affected by different factors. Because the area has more inlets, it is more closely interconnected with the ocean, and tidal currents dominate in driving the circulation. Tidal effects and circulation diminish with distance from an inlet, however.

As lagoon salinity distribution and the influence of ocean tides indicate, circulation and mixing varies within the different segments of the system. These differences are very important to habitat established within each part of the lagoon system. Although seasonal changes can alter salinity distribution patterns, long-term changes in salinity can result in ecosystem changes.

Watersheds

A watershed is the area of land from which water drains to a receiving surface water body. The Indian River Lagoon watershed covers 40 percent of Florida's east coast. Since 1916, human activities have increased the lagoon's watershed from 572,000 acres to more than 1.4 million acres, an increase of 146 percent. The creation of drainage canals, to make land agriculturally productive while reducing flooding, has artificially enlarged the watershed to the west, to include land that did not historically drain to the lagoon. Waters once destined for the St. Johns River or Lake Okeechobee now flow to the lagoon. As a result, substantially more freshwater now flows into the lagoon, sharply affecting water quality.

This network of canals has substantially altered drainage in the lagoon. In many areas, these drainage features are so dense that an aerial photograph looks like a street map.

Over time, changes to drainage patterns and increases in freshwater discharges have meant the lagoon's ecosystems have had to adapt to changes. This adaptation has had a price: Seagrass distribution has changed, resulting in losses in some places, and fish populations have declined. Change occasionally comes quickly and dramatically, sometimes causing visible impacts, such as algal blooms, fish kills or shellfish area closures.

Sources of pollution — Point sources versus nonpoint sources

In general, pollutant sources are divided into two categories — point-source and nonpoint source. Point sources of pollution are generally the byproduct of a process such as manufacturing, water or wastewater treatment, or other similar process, that discharges at an identifiable point. Nonpoint source pollution is generated over a wide area with no single identifiable source. Stormwater discharges are an example of nonpoint source pollution.

In the past, point sources, particularly domestic wastewater treatment plants, were a major source of pollutant loadings to the lagoon. Virtually all of these treatment plants discharged their effluents to the lagoon. Recognizing the impact of these discharges, the Florida Legislature passed the Indian River Lagoon Act in 1990, requiring domestic wastewater treatment plants to stop discharging their effluents to the lagoon by July 1996. Today, most domestic wastewater treatment plants in the lagoon basin are in compliance with the act, which has significantly reduced the amount of pollutants discharged to the lagoon.

Nonpoint pollution sources in the lagoon are primarily storm water and contribute significant pollutant loadings. On average, the lagoon watershed receives about 50 inches of rain each year. Roofs, highways, parking lots and other impermeable surfaces now cover areas that were once natural vegetation. These impermeable surfaces prevent rainwater from soaking into the ground, resulting in large volumes of storm water runoff into creeks, streams, canals and ditches, which ultimately discharge to the lagoon. Uses of the land, from which runoff originates and flows through, determine the types and concentrations of pollutant loads picked up in the runoff and carried to the receiving water. Pollutant loads include sediments, decomposed organic matter, nutrients, heavy metals, viruses and bacteria, and other pollutants.

Sediment entering the lagoon can influence water clarity, which also affects the ability of light to penetrate the water. Reduced light penetration interrupts photosynthesis and can diminish productivity of sea grasses. Decomposing organic matter feeds oxygen-demanding processes. This can result in lower oxygen levels, which in turn, can cause fish kills. Nutrients contained in runoff from fertilizers and agricultural operations may cause algal blooms. Storm water often contains heavy metals, such as lead, zinc, copper, cadmium and chromium, and when discharged to surface waters, these substances can be toxic to plankton, fish and other aquatic organisms, affecting their ability to reproduce. Viruses and bacteria in storm water can cause closure of shellfish harvesting areas and even result in restrictions on swimming and other water sports.

Addressing nonpoint discharges will be a continuing challenge in the lagoon's management. It is estimated that future increases in nonpoint source loadings resulting from new development will nearly equal the reductions in point-source pollutant loadings unless action is taken. Armed with the knowledge about the lagoon's workings and probable future pollutant loadings, scientists can predict where its capacity to assimilate pollutants will be overloaded and target these locations for additional management efforts to address these loadings.

Water quality

The quality of the lagoon's water and sediment is dependent on the quality of freshwater inputs entering a particular segment and the degree of mixing with ocean water. Water and sediment quality characteristics are important factors in maintaining healthy lagoon habitats.

Some key parameters measured within the lagoon include dissolved oxygen, color and turbidity. As with land-based systems, oxygen is a necessity for aquatic life. While many estuarine creatures have little tolerance for low concentrations of dissolved oxygen, others manage to survive quite well in these conditions. To maintain a well-balanced biological community made up of both sensitive and tolerant species, dissolved oxygen should not be less than four parts per million over a prolonged period. There are, however, considerable natural daily and seasonal variations of dissolved oxygen concentrations. On a daily basis, the lowest dissolved oxygen concentrations usually

Large sediment traps like this one, near International Drive, have been installed throughout the city of Cape Canaveral to capture pollutants in the water before they reach the Indian River Lagoon.

Sea grasses provide food and habitat for juvenile fish.

occur in the early morning hours. Higher concentrations, due to plant and phytoplankton productivity, are generally seen in the late afternoon.

Seasonal variations in dissolved oxygen concentrations are related to water temperature, which can limit the amount of oxygen that will dissolve in water. In warmer months, the average concentration of dissolved oxygen is usually at its lowest levels, while during cooler weather, average concentrations are generally at their highest. Under certain conditions, such as in discharges of pollutants, during algal blooms or in areas of poorer water quality, extremely low-oxygen concentrations can occur at any time of the year.

Color is a measure of other dissolved substances in the water column, while turbidity indicates the level of suspended particles. The concentration distribution of each of these is an indication of freshwater impacts to the lagoon, which helps to determine how clear the lagoon's waters are and how well light will reach the bottom. The availability of light determines where and how well sea grasses will grow. Both color and turbidity tend to peak during the wet season when runoff is greatest. The wet season also corresponds with the period of greatest growth for sea grasses. As a result, the waters of the lagoon are at their cloudiest when sea grasses need sunlight the most.

Metals

Metal contamination in the open waters of the lagoon is generally very low, but elevated levels have been found in tributaries and sheltered harbors, including areas around Titusville and Cocoa, Eau Gallie River, Crane Creek, Turkey Creek, Taylor Creek and Manatee Pocket. For example, copper concentrations for some areas are much greater than normal for the lagoon and appear to be related to the leaching of anti-fouling paints from watercraft. The highest copper levels in the harbors are still within state water quality standards for recreation, fish and wildlife, but exceed limits for shellfish harvesting by almost 60 percent.

Sediments

Most sediments in the lagoon are sands, silts and shell fragments. However, about 10 percent of the lagoon bottom is covered with loose, black, organic-rich mud commonly referred to as muck. This muck may harm fish, shellfish and sea grasses. Not only does the muck cover important habitat bottom areas, it also can be stirred up by boats and storms, decreasing water clarity.

Major muck deposits are generally found in the deeper areas of the lagoon, especially in areas that have been dredged. These dredged areas include the Intracoastal Waterway and other channels, as well as borrow pits where fill to construct causeways and other developments was mined from the bottom of the lagoon.

Muck deposits are also found at or near the mouth of most of the lagoon's major tributaries. The mouths of these tributaries often act as traps, capturing large volumes of the muck before it enters the lagoon.

Elevated concentrations of copper, lead and zinc have been noted at several locations where muck deposits have been found. The largest of these areas is in Manatee Pocket near Stuart.

Various water quality studies over the years indicate that much of the lagoon system generally meets minimum state and federal water quality standards. However, certain areas have experienced more impacts associated with human activities and may experience periods when they do not meet these standards.

Sea grasses and water quality

One of the fundamental objectives for the St. Johns River Water Management District's Indian River Lagoon Program is the recovery and maintenance of a healthy and productive seagrass ecosystem. The primary prerequisite to accomplishing this objective is the improvement of water quality to the point where adequate light, to support a healthy and productive seagrass community, reaches target depths.

Sea grasses are submersed aquatic plants that require relatively high levels of light to thrive. Not to be confused with algae, which lack both leaves and roots, the occurrence of sea grass is restricted to shallow areas having sufficiently clear water to allow light penetration.

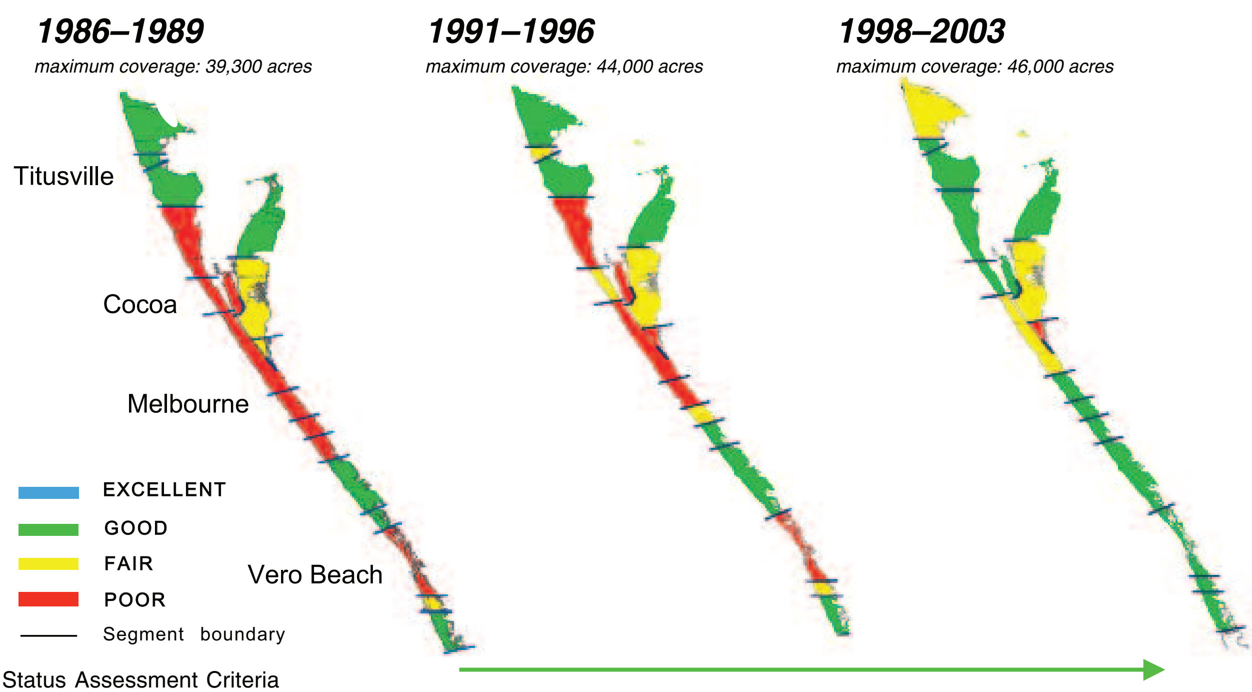
Sea grasses are extremely important to the ecology and productivity of the lagoon for their sediment-trapping ability and for their ability to provide habitats for fish and other species. Seagrass productivity is also a good indicator of water quality and the overall health of the lagoon. Poor water quality can result in losses of seagrass beds.

Analysis of lagoon water quality data indicates that inadequate light is the dominant factor limiting seagrass growth in the lagoon. While other factors, such as salinity, sediment stability, hydrology, and physical disturbance, affect seagrass growth and health, nearly half of the variability in the depth and extent of seagrass coverage can be explained by differences in the amounts of light reaching the bottom.

This same analysis found that certain water quality parameters are the principal factors affecting water clarity in the lagoon. These parameters include turbidity, chlorophyll *a* and, in some areas, color. Turbidity is a measure of water clarity, influenced by the amount of total suspended solids in the water column. Chlorophyll *a* is a measure of the phytoplankton, or algal concentration, which is influenced by nutrient (nitrogen and phosphorus) concentrations in the water column. Color is a measure of dissolved organic matter, largely tannins from decaying plant material. The primary factor affecting water

Seagrass coverage

Progressive improvement in light penetration and seagrass coverage from Titusville to Vero Beach



Status Assessment Criteria

- percent surface light — indicator of clarity
- percent of seagrass depth-limit target
- percent loss of seagrass since 1943

No segment was considered "excellent" or as having fully met its seagrass resource targets. The single-year seagrass target for Brevard and Indian River counties is about 60,000 acres.

St. Johns River Water Management District
Seagrass mapping years 1986, 1989, 1992, 1994, 1996, 1999, 2003

clarity can vary from segment to segment and is dependent on land cover and land uses within the watershed.

Seagrass resource assessment

Evaluation of seagrass resources in the lagoon is based on the following three measurement indices:

- Changes in seagrass acreage (gain or loss)
- Maximum depth of the deep edge of the seagrass beds
- Percent of sunlight reaching seagrass restoration depth targets

In addition to changes in acreage over time, seagrass acreage is evaluated against additional targets, or goals. These targets include potential seagrass acreage and seagrass depth targets. The potential acreage (areas where sea grass has occurred in the past) and depth targets (the depth to which sea grass should grow based on "healthy" areas of the lagoon) are based on seagrass surveys done over the past 30 years, review of aerial photography dating back to the 1940s, and research on the ecological requirements of sea grasses found in the Indian River Lagoon.

General seagrass coverage distribution and trends in the lagoon can be summarized as follows:

- Segments containing the largest acreages of seagrass coverage are found around north Merritt Island, within and adjacent to the federally protected NASA/Kennedy Space Center/Merritt Island National Wildlife Refuge complex (north Indian River Lagoon and northern Banana River) and Canaveral National Seashore (southern Mosquito Lagoon). These segments have shown little change in seagrass coverage since the 1940s.
- The largest area of poor seagrass coverage extends from the Cocoa area to the Palm Bay area. This area has experienced the greatest loss of seagrass coverage since the 1940s (70 percent).
- In the northern and central portion of the Indian River Lagoon system (Mosquito Lagoon, Banana River, and the Indian River Lagoon north of Fort Pierce) surveys in 2006 found 64,434 acres of sea grass, or 63 percent of the 98,274 potential acres of sea grass. Seagrass acreage in this area in 1943 was 63,238 acres, or 64 percent of the potential acreage.
- Within the southern portion of the Indian River Lagoon system (Indian River Lagoon from Fort Pierce south and Hobe Sound), the current seagrass coverage is 7,808 acres, or 39 percent of the potential 19,799 acres. The 1943 acreage is similar (7,688 acres) and also 39 percent of the potential acreage.
- For the entire lagoon, the potential seagrass acreage is 118,000. Current seagrass acreage is 72,242 (in 2003) or 62 percent of the potential acreage.

Sea grasses appear to be recovering in some areas. Review of seagrass surveys from the early 1990s found that most segments had experienced loss of seagrass acreage since the 1940s, ranging from 16 to 81 percent. Recent mapping found that seagrass acreage, in most segements, has increased between 1996 and 2006, with some segments meeting or exceeding the acreage of sea grasses mapped from 1943 aerial photography.

Water quality/seagrass relationship and assessment

Salinity

In recent years, annual average salinities throughout the lagoon (with the exception of the tributaries) were above 20 parts per thousand (ppt), within the optimum range for seagrass growth. With the exception of wigeon grass (*Ruppia maritima*), salinity of 20 ppt appears to be the optimal growth threshold for lagoon seagrass species. Sea grasses may survive if salinity is less than 20 ppt, but growth may be impaired even if other environmental conditions are favorable. Maintaining salinities of 20 ppt, or greater, appears to be particularly important during the growing season.

The highest average salinities were found in Mosquito Lagoon and south Indian River Lagoon, followed closely by north Indian River Lagoon (north of Titusville). Areas near Sebastian and Fort Pierce inlets also have higher salinities. The lowest average salinities during the 1990s were found in the southernmost reach of the Banana River and in the Melbourne area of the central Indian River Lagoon. These areas are distant from oceanic influence and receive large volumes of freshwater discharges from tributaries and associated drainage systems. In these segments, salinities can drop below 20 ppt for extended periods.

Color

Color, a measure of dissolved organic matter, can affect light penetration in water. Color absorbs those portions of the solar spectrum that promote plant growth, resulting in reduced light availability to plants. Lack of adequate light is the primary factor limiting seagrass growth in the lagoon.

A scientist counts the blades of sea grass in a transect in the lagoon to determine seagrass bed health.

Color generally tracks salinity trends in the Banana River, and in the central and south Indian River Lagoon. In these basins, the tributaries, canals and stormwater drainage systems discharge large volumes of freshwater that, in addition to reducing salinity in the lagoon, have relatively high color.

With the exception of the central Indian River Lagoon, the average color of the lagoon ranges from 15 to 20 platinum-cobalt units (pcu). In the central Indian River Lagoon, average color ranges from 20 to 30 pcu. The highest average color was found in Newfound Harbor (Banana River), and the lowest average color was found in Hobe Sound near Jupiter Inlet (less than 10 pcu).

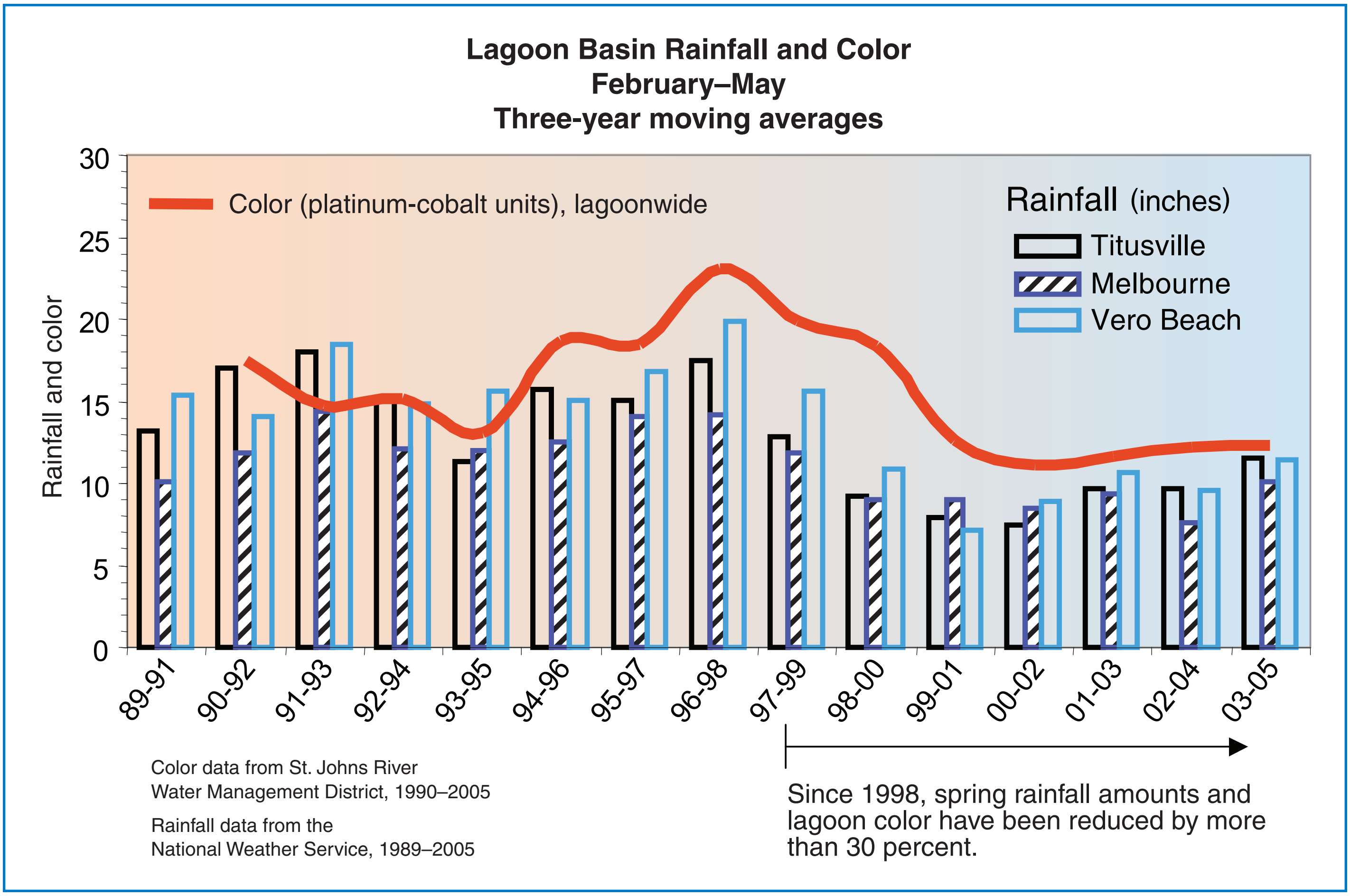
Turbidity/total suspended solids

Turbidity is a measure of water clarity and the amount of suspended solids in water. Technically, turbidity is a measure of the degree to which light traveling through the water column is scattered by suspended material. Waters with elevated turbidity reduce light penetration of the water column that, in the Indian River Lagoon, can limit seagrass growth.

Average turbidity levels in the Banana River and in the north and central Indian River Lagoon generally do not exceed 6 nephelometric turbidity units (ntu) and are typically half that level. By contrast, Mosquito Lagoon and south Indian River Lagoon frequently average above 6 ntu. Both the highest average and the highest variability in monthly turbidity were found in the south Indian River Lagoon.

These turbidity levels can generally be explained by the contributions from total suspended solids (TSS). Total suspended solids include both organic and inorganic particles suspended in the water column. While there are a few disparities, the spatial pattern of TSS levels roughly mirrors turbidity. Further analysis indicates that TSS contributes significantly to turbidity levels in several segments, especially in the Mosquito Lagoon, and in the Banana River and north Indian River Lagoon.

Average TSS levels throughout the lagoon range from 18 to 34 milligrams per liter (mg/L). The lowest average TSS (18 mg/L) was found in the Cocoa/Melbourne/Palm Bay area. This is unexpected due to the amount of development, associated drainage, the relatively small open-water area in that reach, and the loss of sea grasses in this portion of the lagoon.



Nutrients (nitrogen and phosphorus)

Nutrients indirectly affect sea grasses in the Indian River Lagoon as they promote algal (phytoplankton and epiphyte) growth, resulting in elevated chlorophyll *a* concentrations. Chlorophyll *a* is a measure of a component of phytoplankton that absorbs light and is an indicator of the algal concentration in the water column. Increased algal concentrations compete for light with sea grasses and contribute to elevated color and turbidity, factors that also reduce light penetration and subsequently affect seagrass growth.

From north Banana River and the north Indian River Lagoon through the south Indian River Lagoon, there is a general north-south decrease in total nitrogen (TN) concentrations. The average TN concentration ranges from more than 1.4 mg/L near Titusville to approximately 0.5 mg/L in Hobe Sound. Exceptions to the downward north-south trend in TN are spikes in the Palm Bay and Vero Beach areas, near the discharges of major drainage systems. The higher concentrations of TN in the northern segments may reflect the large standing pool of organic nitrogen and plant biomass in these segments. Up to 95 percent of the TN in these basins is organic. The large standing pool of organic nitrogen and plant biomass appears to result from extended residence times (months to more than a year) and reduced flushing. Distance from oceanic influence, small drainage basins, and few or small tributaries all influence residence times and flushing in these northern segments.

By contrast, TN concentrations in the Mosquito Lagoon decrease from south to north. Similar to the Banana River and the Indian River Lagoon, large amounts of organic nitrogen, long residence times and poor flushing at the southern end of Mosquito Lagoon may explain this trend as well.

Total phosphorus (TP) concentrations exhibit spikes in areas adjacent to intensively developed subbasins, large tributaries and major drainage systems in the central and south Indian River Lagoon. A major spike in TP concentrations is found in the Vero Beach area, where three large drainage systems discharge approximately 35 tons of TP per year to the lagoon. The lowest TP concentrations are found in Hobe Sound.

Phyotplankton and chlorophyll *a*

Phytoplankton response to increased nutrient levels is apparent in several segments of the Indian River Lagoon (Cocoa/Melbourne/Palm Bay, Newfound Harbor), where average chlorophyll *a* concentrations are elevated when compared to other segments. In several segments (Cocoa/Melbourne/Palm Bay, Fort Pierce and St. Lucie River), chlorophyll *a* concentrations vary widely, resulting in periodic algal blooms.

On average, the phytoplankton response to increased nutrients in the Vero Beach, Fort Pierce and St. Lucie River segments is somewhat lower, although still apparent. This reduced response may be due to the shorter residence times and increased flushing in the lagoon's southern portion as the result of greater oceanic influence via ocean inlets, a large drainage basin and larger tributaries.

Water quality, seagrass resources summary

The lagoon areas with the poorest water quality are Cocoa to Palm Bay, southern Banana River, Vero Beach, Fort Pierce and the St. Lucie River. Many of these areas have also experienced significant losses in seagrass acreage over time. Low salinities, elevated color, nutrients and chlorophyll *a* contribute to poor conditions in the Cocoa to Palm Bay segments. The southern Banana River is also impacted by low salinities, elevated color, nutrients and chlorophyll *a*. The Vero Beach segments are affected by elevated color, turbidity and nutrients. The south Indian River Lagoon, near Fort Pierce, and the St. Lucie River are impacted by elevated turbidity, TSS, nutrients and chlorophyll *a*. Areas adjacent to larger tributaries and major drainage systems, such as Crane Creek in Melbourne; Turkey Creek in Palm Bay; St. Sebastian River near Sebastian; North, Main and South canals in and around Vero Beach; Taylor Creek in Fort Pierce; and the St. Lucie River, also experience higher-than-typical levels of TSS, color and nutrients. Many of these areas also experience large and rapid changes in salinity due to large discharges of freshwater from these tributaries and drainage systems.

In summary, seagrass coverage is related to water quality. Areas with good seagrass coverage are generally located adjacent to relatively undeveloped watersheds or in close proximity to inlets, while areas of extensive losses and sparse sea grass are typically adjacent to highly developed watersheds and shorelines.

Rapid growth has imposed increasing pressures on the lagoon, compromising water quality in the process.

SOLVING PROBLEMS

Solutions available to address lagoon ills

The character of the Indian River Lagoon is changing, with much of the change occurring over the last century and particularly within the past 50 years.

The character of the Indian River Lagoon system is changing, with much of the change occurring over the last century and particularly within the last 50 years. Long-term residents of the area tell of clear waters, extensive wetlands and seagrass beds, and an abundance of fish and wildlife. To a large extent, today, these conditions only exist in memories. Less-developed portions of the lagoon may still exhibit these qualities, but many of these healthy areas are under stress as development occurs in the watershed.

Development and population growth in the lagoon region are threatening the biological diversity, integrity and productivity of the lagoon. These threats can generally be characterized as reduced water quality; loss, degradation or fragmentation of habitats or ecosystems; overuse or over-harvesting of the lagoon's resources; and the introduction of exotic species.

While there are many issues of concern for the natural resources of the lagoon, there are also key measures that may be taken for protecting the diversity and productivity of this valuable ecosystem. The following is a review of major issues, their causes and some measures that may be taken to address them.

Loss of seagrass beds

Sea grasses provide the most important habitat in the lagoon and are a key component of the lagoon's ecosystem. Typically, the seagrass community is highly productive, with growth often exceeding intensely managed agricultural lands. Seagrass beds provide crucial habitat for many fish and invertebrates, including many species of commercial and recreational importance. Sea grasses also provide sediment stabilization and shoreline protection.

Over the years, seagrass beds have experienced significant decline. By the early 1990s, it was estimated that seagrass acreage had been reduced nearly 20 percent, when compared to maps of sea grasses in 1943. In some areas of the lagoon, it was found that sea grasses had nearly disappeared.

Recent years have seen sea grasses appear to rebound, with increased acreage in many lagoon segments. While the removal of wastewater treatment plant discharges, reduction of the volume of freshwater discharges from several of the major drainage systems, and the construction of numerous stormwater treatment system upgrades certainly played a major part in improving water quality and promoting seagrass growth, weather and natural variability also likely played an important role. Several recent years have had long, dry periods during spring and much of the summer (annual seagrass growth season), resulting in less runoff, clearer water, and more light for seagrass growth. Should the weather pattern revert to the more traditional start of the wet season in the spring, some of these gains in seagrass coverage may be reversed.

Issues and causes

A seagrass monitoring program has been established to evaluate the status and coverage trends of seagrass beds throughout the lagoon. The program, together with water quality monitoring, helps determine the causes of localized seagrass losses, establishes priorities for preserving and restoring seagrass beds, and evaluates the successes of restoration and water quality improvement programs.

Preliminary analysis of data developed by this monitoring program indicates that inadequate light reaching bottom-growing sea grass is the primary factor for limiting seagrass growth in the lagoon. Other factors, such as salinity, hydrology and physical disturbance, can also affect seagrass growth and health, but the lack of adequate light was found to be the overriding factor determining the health and extent of sea grasses in the lagoon. This same analysis found that turbidity, chlorophyll *a*, and color are the principal factors affecting water clarity in the lagoon.

Impacts to water quality and, subsequently, the seagrass community have all been aggravated by changes in the lagoon watershed. Over the years, extensive drainage systems have more than doubled the watershed. In addition, smaller drainage systems have also been constructed to provide stormwater drainage for residential, commercial and agricultural development projects. These systems discharge large volumes of freshwater and pollutants to the lagoon.

Actions and solutions

As outlined in the Comprehensive Conservation and Management Plan (CCMP) for the Indian River Lagoon and the Surface Water Improvement and Management (SWIM) plan, a key element in the protection and restoration of sea grasses and other resources in the lagoon is the improved management of freshwater discharges and their associated pollutant loadings. The Indian River Lagoon Program, federal and state agencies, and local governments individually and collectively are developing and constructing projects designed to reduce the amounts of freshwater and pollutants entering the lagoon. The scale of these projects is broad, ranging from relatively small, localized projects to larger regional projects.

Isolation and loss of wetlands

The wetlands are a key element of the lagoon's ecosystem. While a wetland's primary function is to provide habitat for a wide variety of species, it also contributes toward water quality protection, and supports the detrital food chain. Wetlands act as buffers between the lagoon and activities on adjacent uplands, protecting the uplands from erosion by absorbing wave energy, providing flood storage and protecting the lagoon from stormwater runoff.

Issues and causes

Since the 1950s, more than 75 percent of the salt marsh and mangrove wetlands bordering the lagoon have been destroyed, altered or functionally isolated.

Salt marsh mosquitoes, which breed in wetlands, need alternating wet and dry soils to reproduce. Building an impoundment and flooding the wetlands during mosquito breeding season interrupts this reproductive cycle.

More than 40,000 acres of wetlands were converted into mosquito impoundments during the 1950s and 1960s in an effort to control the mosquito population. Impoundments were created by digging a ditch around the edge of a wetland and using the dredged material to create a dike along the ditch. The impoundments were then flooded by using artesian wells or pumps, drawing water from the lagoon, to maintain water levels in the impoundment. These wells or pumps were also used to replace water lost to seepage or evaporation.

Though effective for mosquito control, flooding wetlands has resulted in the loss of much of the original wetland vegetation and has changed the vegetative community. This, in turn, has changed the habitat so that many species once dependent on pre-impoundment conditions are no longer found in these areas. Some species such as waterfowl have benefited from marsh impoundment and flooding, enjoying the creation of sheltered, shallow water habitat. But the impoundments have also cut off the flow of water in and out of the wetland, stopping the export of food materials from the wetlands and restricting the movements of fish, crabs and a variety of other animals in the lagoon and adjacent wetlands.

Actions and solutions

Several agencies are implementing management strategies to restore hydrologic connection to the lagoon. Approximately 70 percent of existing impoundments have at least some kind of open connection to the lagoon. Reconnection projects have ranged from breaching or removing dikes to placing culverts with water level control structures. Cooperative efforts among the lagoon program, county mosquito control districts, the Merritt Island National Wildlife Refuge and other agencies are resulting in implementation of these improved impoundment management strategies.

Orange and red hues paint a colorful sunset along the lagoon.

Additional work is planned, but the restoration of the many remaining impoundments has been stymied by landownership issues. Most of these impoundments are on private land in Brevard, Indian River and St. Lucie counties, where public agencies are limited in their abilities to implement improved management practices. Several agencies and local governments are collaborating on the Indian River Lagoon Blueway Project, a program developed to acquire privately owned impoundments and to implement restoration and improved management.

Fisheries decline

Fish populations in the lagoon region are some of the richest and most diverse in the United States, with more than 600 species found there. Recreational fishing opportunities in the lagoon draw anglers from throughout the nation for a chance to catch a world-class redfish, snook or sea trout.

Issues and causes

Scientists, together with recreational and commercial anglers, have noticed reduced fish and shellfish populations in the waters of the lagoon and adjacent Atlantic Ocean. Although they may disagree on the causes, data indicate

- Declines in commercial catches of spotted sea trout by about 50 percent since the 1950s
- Declines or large fluctuations in the annual catch of many other important species
- Declines in recreational catch-per-unit-effort for many species
- Losses of oysters in the St. Lucie Estuary
- Declines in commercial blue crab and shellfish landings
- Closings of shellfish beds, due to bacteriological pollution

Many causes have been cited for these changes, including

- Loss of habitat from
  - — Dredging and filling
  - — Alteration of shoreline habitats by bulkheads and seawalls
  - — Reduced water quality/excessive freshwater discharges
- Isolation of salt marsh and mangrove habitat, for mosquito control purposes
- Declines of habitat due to sedimentation, excessive nutrients and a variety of contaminants
- Bacterial contamination of shellfish areas, from septic systems and stormwater runoff
- Salinity changes
- Overfishing

Actions and solutions

Several projects and programs are planned or underway to improve water quality, to protect and restore seagrass habitat and to reconnect isolated wetland habitats throughout the region. Many of these projects are collaborative projects involving a number of agencies and, in some cases, private organizations. These efforts to protect and restore the seagrass community and wetlands associated with the lagoon will benefit fisheries by improving habitat and water quality.

The Florida Fish and Wildlife Research Institute also is undertaking programs to monitor juvenile fish populations, to determine population trends for key species and to better understand the dynamics of lagoon fisheries.

Threats to biodiversity

From its broad variety of natural community types, to its various drainage features and connections to the Atlantic Ocean, these complex hydrodynamics have combined to create a unique ecosystem. The overlapping boundaries of two biotic provinces, the temperate Carolinian and subtropical Caribbean, occur within the region. Biological diversity is high because a variety of species associated with both of these biological provinces, as well as species unique to the area, are found in the region. The wealth of species found there makes the lagoon the most diverse estuary in North America.

More than 50 of the species found within the region are listed as either endangered, threatened or species of special concern by state or federal agencies. These species include a wide variety of creatures and plants, which range from the small, seldom seen and poorly understood fish known as the mangrove rivulus (*Rivulus marmoratus*), to the large, well-publicized Florida manatee (*Trichecus manatus latirostris*). The lagoon region contains some of the largest populations in the state for many of these species.

Issues and causes

Loss of habitat, directly or indirectly as the result of development and population growth in the lagoon region, is the primary threat to the biological diversity, integrity and productivity of the lagoon and its watershed. Other threats include reduced water quality, fragmentation of habitats or ecosystems, overuse or overharvesting of the lagoon's resources and the introduction of exotic species.

Muck — fine grained sediment and decaying organic material — clouds lagoon waterways, releasing pollutants when resuspended by wind, waves or boat traffic.

Actions and solutions

In addition to restoration and protection efforts, residents within each county of the lagoon region have voted to establish programs to acquire environmentally sensitive lands and important habitats within the lagoon's watershed. These projects, in conjunction with state, federal and private environmental land acquisition programs, have secured thousands of acres for the protection and restoration of critical lagoon habitat, along with vital upland habitats, to help buffer the lagoon from the impacts of development.

Water and sediment quality

While much of the lagoon meets the minimum for water quality standards, water quality in other areas is not sufficient to support healthy seagrass beds or the unrestricted harvest of shellfish. Assessment of water quality in certain segments of the lagoon and its tributaries has resulted in such a designation as "impaired" for certain water quality parameters. This impaired designation set into motion the development of plans by state and federal agencies to address pollutant sources.

Issue and causes: Excessive freshwater discharges and salinity fluctuations

The decline in water quality within the lagoon may be attributed to changes in the lagoon's watershed. Historically, the lagoon watershed had a long, narrow drainage basin. Since the early 1900s, however, extensive drainage systems were constructed, and these have more than doubled the size of the lagoon's drainage basin. Smaller drainage systems were also constructed to provide drainage for residential, commercial and agricultural development.

As the result of these changes, substantial quantities of freshwater are discharged to the lagoon during the wet season and following storms. These discharges cause rapid reductions in salinity over broad areas of the lagoon.

During drier times of the year, freshwater flows are reduced as the result of water retention for agricultural or urban irrigation and other uses. This lack of freshwater inflow may result in increased salinities in the lagoon.

The resulting wide and often rapid fluctuations in salinity can affect many important life-forms, especially sedentary organisms, such as shellfish and sea grasses.

Issue and causes: Increased nutrient levels

Freshwater discharges often contain increased amounts of suspended solids, including elevated levels of nutrients and other pollutants. Elevated levels of nutrients can cause algal blooms, fish kills, odors and a host of other problems.

Issue and causes: Muck deposits

Muck deposits create another negative impact for the lagoon. Muck is a fine-grained sediment, consisting of silts, clays and organic matter. Deposits are primarily found in the deeper parts of the lagoon, such as the Intracoastal Waterway, marina basins and connecting channels, dredge holes and lagoon tributaries. The primary sources of muck are poor erosion control practices and decayed plant materials.

Muck is an effective trap, or reservoir, for bacteria, nutrients, metals and other pollutants. However, muck is easily disturbed and resuspended by wind, waves or boat wakes, creating vast areas of turbid water that can release trapped pollutants into the water column.

Actions and solutions

Salinity, nutrient levels and muck deposits share a common element: They are the result of an extensive drainage system that delivers large quantities of freshwater and associated pollutants to the lagoon. The actions to address these issues have the common denominator of reducing the volume of freshwater that may be discharged to the lagoon. By reducing freshwater discharges, the amount of associated pollutants will also be reduced.

Several state, federal and local programs are underway to improve the management of freshwater discharges and pollutant-loadings. At the local level, nearly all governments within the lagoon region have established stormwater utilities. Stormwater utilities develop and implement plans to deal with flooding, operation and maintenance of stormwater systems and projects designed to protect and improve water quality in water bodies, such as the lagoon. The operation of a stormwater utility is similar to other utilities in that a fee is charged for services provided. The revenue generated by these fees is used for operation, maintenance and improvement of stormwater systems.

In addition, all local governments within the lagoon region are now subject to National Pollutant Discharge Elimination System (NPDES) stormwater permitting. NPDES stormwater permitting is a program authorized by the federal Clean Water Act to regulate the discharge of storm water to surface waters. In Florida, authority for the NPDES stormwater program has been delegated from the U.S. Environmental Protection Agency to the Florida Department of Environmental Protection (FDEP). Local governments are developing and implementing projects and programs, often using their stormwater utility, to meet the requirements of the NPDES program. Pollutant load reduction goals (PLRGs) are under development for the lagoon by the St. Johns River and South Florida water management districts. Similarly, total maximum daily load (TMDL) requirements for pollutants are under development for the lagoon by the FDEP. The water quality standards established for PLRGs and TMDLs will be based on the ecological needs for a healthy seagrass community in the lagoon. As the PLRG and TMDL programs develop water quality standards and limitations for pollutants entering the lagoon, projects and programs will be developed and implemented to meet these new standards.

Beyond these programs, the U.S. Army Corps of Engineers, in partnership with the St. Johns River and South Florida water management districts, has initiated feasibility studies to design and evaluate restoration projects for the lagoon, as part of the Comprehensive Everglades Restoration Program (CERP). The design of the Indian River Lagoon—South Restoration Project includes extensive water storage and treatment areas, acquisition and restoration of natural storage and treatment areas, muck removal and habitat creation. In 2006, the project was under congressional consideration for authorization and funding. The Indian River Lagoon—North Restoration Project is anticipated to include similar project elements and is scheduled to be submitted to Congress for consideration for authorization and funding in 2008.

For the individual property or business owner, numerous best management practices (BMPs) can be used to reduce pollutant runoff, such as the correct use of fertilizers and pesticides; improved septic tank design, installation and maintenance; and simple car-washing methods. Several programs are in place to promote the use of BMPs to protect or improve water quality. Some programs are regulatory, such as the requirements that land development projects implement BMPs to prevent sediments from washing into drainage systems or local waterways. Others, such as the Green Business and Florida Yards and Neighborhoods programs, are voluntary and seek to educate residents and business owners on what they can do to protect the lagoon.

In recent years, the implementation of sediment management BMPs for new construction and similar activities has reduced the rate of deposition of muck into the lagoon and its tributaries. Implementation of PLRGs, TMDLs and the construction of storage reservoirs and treatment areas will further reduce the deposition of muck. Removal of existing muck deposits will reduce the potential for future release of pollutants. Many deposits will be removed during routine maintenance dredging of the Intracoastal Waterway and channels. Dredging projects have been undertaken in several tributaries, and additional projects are pending or under development.

NEWEST THREATS

Exotic species pose newest threats to the lagoon

Australian spotted jellyfish

The Australian spotted jellyfish (*Phyllorhiza punctata*), a native of the Indo-Pacific, was first found in the south Banana River area in the summer of 2001. A survey undertaken at that time estimated that approximately 500 of these "jellies" were present in the lagoon. Spotted jellyfish were also seen in summer of 2002; however, the numbers were much less than the previous year. No Australian spotted jellyfish have been found in the lagoon since 2002.

This jellyfish first appeared in the Gulf of Mexico in 2000 where large numbers clogged shrimp nets. The jellyfish devour huge numbers of fish eggs, larvae and other microzooplankton, which could affect fisheries and other components of the ecosystem. Similar impacts would be likely in the lagoon should this species become established locally. It is believed that this species was transported to the Gulf of Mexico, and ultimately the lagoon, as polyps attached to the hulls of ships passing through the Panama Canal.

Through a grant from the U.S. Environmental Protection Agency (EPA), the Indian River Lagoon National Estuary Program (NEP) and the Mobile Bay NEP, the Barataria-Terrebonne NEP and Dauphin Island Sea Lab Dock Watch Program have begun a joint effort to educate the public about this invasive species and to develop a monitoring plan to help track occurrence of these jellyfish.

Caulerpa brachypus

The marine algae *Caulerpa brachypus* is a nonnative species originating in the Pacific Ocean. It may have arrived in the lagoon region either in ship bilges or by being discarded by aquarium hobbyists. This algae has no known natural controls in Florida waters and can spread rapidly, overgrowing valuable, natural submersed aquatic communities, such as sea grass or coral reefs. In recent years, scientists have observed this species encroaching on large areas of coral reef in the ocean offshore of Palm Beach County.

In the spring of 2003, several small patches of *Caulerpa brachypus* were observed in the lagoon near St. Lucie Inlet and Fort Pierce Inlet. By summer, these patches had disappeared. However, the potential still exists that given the right conditions, this species may become established in the lagoon and displace native submersed aquatic vegetation.

Several agencies, including the Florida Department of Environmental Protection, the Florida Fish and Wildlife Research Institute, the South Florida Water Management District, Florida Sea Grant, Harbor Branch Oceanographic Institution and others, have joined together in an effort to educate the public about this potentially invasive species and have coordinated monitoring programs to detect the presence and possible spread of this species.

Toxic puffer fish

Between January and June 2002, 19 cases of puffer fish poisoning (PFP) were reported to state and federal health officials. In all of these incidents, the affected individuals reported consuming puffer fish caught in the lagoon. Nearly all of the puffers involved in these incidents were caught in the Titusville area, with two individual cases occurring in the Cocoa and Pineda Causeway areas.

Puffer fish poisoning is usually caused by the ingestion of tetrodotoxin, which is usually found in the internal organs of some species of puffer fish. Occasionally, tetrodotoxin is found in the muscle of puffers. PFP is fairly common in Japan, where people eat the delicacy "fugu," a dish made with puffer. Between 1941 and 1974, three people in Florida died from eating puffer fish. A small number of additional, nonfatal, PFP cases were reported during that era. Until recently, there had been no known cases of PFP in Florida since 1974.

The recent cases of PFP in the lagoon are unusual. Analysis of the fish tissue found that the toxin involved was saxitoxin, not tetrodotoxin. While saxitoxin has been found in puffer fish in the Far East and the Philippines, this is the first report of saxitoxin in puffer fish in the United States.

Saxitoxin is usually found in shellfish and can cause paralytic shellfish poisoning (PSP) in humans if affected shellfish are consumed. Shellfish usually become toxic from feeding on microalgae that produce saxitoxin.

Typically, none of the numerous algal species found in the lagoon are known to produce saxitoxin. However, after extensive investigation by the Florida Fish and Wildlife Research Institute (FWRI) it was determined that a common algal species (*Pyrodinium bahamense var. bahamense*) in the lagoon was producing saxitoxin. This alga is a planktonic dinoflagellate that produces bioluminescent displays in seawater at night. Although a related species found in the Pacific Ocean (*Pyrodinium bahamense var. compressum*) is known to produce saxitoxin, this is the first time that the native species has been confirmed to produce this toxin in the United States or the Atlantic Ocean region.

Finding that an algal species native to the lagoon is now known to produce saxitoxin is a public health concern, an environmental concern and an economic concern. Public health may be threatened should significant concentrations of saxitoxin be found in clams, oysters or other lagoon species that are commonly caught and eaten. The presence of saxitoxin in the food chain may have contributed to several unusual events (fish kills, horseshoe crab mortalities, dolphin mortalities and similar events) that have occurred in recent years in the lagoon. While landings have been low, shellfish harvesting has been an important fishery in the lagoon. Should saxitoxin be detected in shellfish in concentrations greater than allowed by the Food and Drug Administration, this fishery may be closed and its economic benefits to the region lost.

The Florida Fish and Wildlife Conservation Commission has prohibited the harvest of puffer fish from the entire lagoon. FWRI and the Florida Department of Agriculture and Consumer Services — Division of Aquaculture continue to monitor shellfish and several other species for saxitoxin.

LAGOON HISTORY

Diverse history shaped lagoon region

The Indian River Lagoon, as it exists today, is a product of long-term natural landscape development and short-term impacts caused by human activity.

The area has evolved from a totally submersed environment to an upland system to today's lagoon environment — all in response to sea level fluctuations and the resulting changes in plant life and rock formations in the land above and below the water. The entire barrier island and lagoon system took about 240,000 years to form, but most human development activities have occurred within the last 8,000 years.

Human history in the lagoon region began about 15,000 years ago, with tribal hunters and gatherers that moved throughout the region. Native American settlements have been recorded from about 12,000 years ago. Many of these ancient coastal settlements are now under water due to rises in sea level. These early residents caused little environmental impact on the area because their numbers remained relatively small. The lagoon remained largely unchanged and in its natural state until after the arrival of the Spanish in the mid-1500s. The harsh environment — disease, mosquitoes and swamplands — initially discouraged colonization and settlement.

Early settlements

The first settlements were established by the Spanish and include St. Lucia, which was settled in 1656. This settlement later became a major trading post during the English period, and today we know it as Fort Pierce. In 1645, one of the first Englishmen to journey to the area was Jonathan Dickinson, a survivor of a shipwreck near present-day Jupiter. Dickinson was captured by Indians and transported through the lagoon region to St. Augustine, where he was traded to the Spaniards.

In 1763, Spain ceded Florida to the English, who undertook a vigorous program to repopulate the area. Englishmen were given favorable land grants to settle permanently, but many balked at settling in the lagoon area because of its swampy conditions and lack of overland access.

Andrew Turnbull's English colony, New Smyrna, began with 1,255 English settlers in 1768. It lasted only a decade, but its residents started to build drainage canals that would characterize the area over the next 200 years. By 1770, approximately 3,000 acres had been drained for agricultural use.

An aerial view illustrates the fragile nature of barrier islands.

Left
Steamboats, sailboats and trains brought needed supplies to settlers in the Indian River Lagoon region in the 1800s.

Above
Anglers have enjoyed the lagoon's waters for decades.

Spain regained control of the area via the Anglo/Spanish Treaty of 1783. Despite a relatively large population influx in subsequent years, environmental impacts to the lagoon remained minimal.

Stability in the 1800s

In the 19th century things began to change, largely due to more consistent colonization efforts, development of transportation routes, agricultural growth and a booming population. Spain ceded Florida to the United States in 1821, and a census taken at the time counted only 317 settlers in all of south Florida.

However, migration soon began to snowball, and a scant five years later, Mosquito County, which included nearly all of the lagoon area, had a population of 733 settlers. Although plantations a century earlier had included orange groves, the first commercial citrus production appears to have been Douglas Dummett's grove on Merritt Island. It began production in about 1828 and, reportedly, was the only citrus grove to survive the great freeze of 1835. By 1856, Indian wars, mosquitoes and disease reduced the number of homesteading families in the lagoon region to just eight. The Armed Occupation Act of 1843 encouraged settlers to inhabit the area, but transportation for commerce was limited.

The increase in steamboat traffic by 1865 and the Homestead Act of 1866 helped rebuild the local settlements and expand trade and commerce. By 1870, the local population was estimated at 1,216. The lagoon had become a primary route for transportation, trading and supplies. Improved access to other markets provided the base for expanding trade in crops, timber and commercial goods.

Most water transportation until 1885 was by sailboat, but the steamboat "Indian River" started servicing the route from Titusville to Melbourne. The Indian River Steamboat Company was organized in 1886 and competed with rail companies in Jacksonville and Tampa for freight and passenger service. Increasing freight and passenger service caused Henry Flagler to extend his Florida Coast and Gulf Railroad south through the lagoon region, reaching Palm Beach by 1894.

The railroads built some of the first bridges across the lagoon's tributaries, and development, fostered by access to transportation, began to alter natural drainage patterns. Expanding agricultural activities began to divert runoff destined for the St. Johns River or Lake Okeechobee to the lagoon. These former freshwater floodplains were fertile, producing crops, such as citrus, pineapples and vegetables, for markets in the North.

Growing pains in the 1900s

Special taxing districts, to promote agriculture by providing flood and drainage control, were authorized by the Florida Legislature in 1916. As a result, nearly all natural streams and rivers were ditched or rerouted, permanently lowering groundwater where standing water had once covered the land for six or more months each year. This drainage encouraged urban development and nurtured the creation of sprawling citrus groves, grazing land for cattle, and early residential development projects.

Other special taxing districts promoted mosquito control along the lagoon. The mosquito control districts south of Cape Canaveral sought to eradicate the pests through ditching and

Red mangroves frame a launch of a space shuttle over the Indian River Lagoon.

impoundment of marshes and through the use of pesticides. More than 140 miles of drainage ditches were dug for mosquito control in Volusia County alone.

During World War II, military uses — bombing practice, dredging for PT-boat training and widening inlets — took their toll on the lagoon and its barrier islands. Prior to 1940, access to the barrier island was largely by boat or ferry. Following the war, however, expanding development, as well as causeway and bridge construction continued to impact the lagoon. From 1950 onward, a tourism boom accompanied urban and agricultural growth. The location of the Joint Long-Range Proving Ground and the missile-testing program at Cape Canaveral in 1950 provided the main growth impetus for the upper lagoon region, and by 1960, more than 200,000 people inhabited the region.

The safety and security needs of Kennedy Space Center required the acquisition of more than 140,000 acres of beaches, dunes and wetlands. To manage these lands, the Merritt Island National Wildlife Refuge and Canaveral National Seashore areas were created in the 1960s and 1970s. These large tracts of land remain largely undeveloped and provide valuable habitat for threatened and endangered species, as well as for migratory birds, and serve as a local counterbalance for the negative impacts associated with rapid, sustained and predominantly unplanned regionwide growth.

From 1950 to the 1970s, the fight against mosquitoes switched from a campaign of ditching and spraying of breeding grounds to one in which wetlands were surrounded by dikes and flooded to prevent mosquito breeding. However, this tactic resulted in the loss or isolation of more than 70 percent of the mangroves in the lagoon.

In 1955, the Florida Legislature established the Florida Resources Study Commission to evaluate the state's resource challenges. The findings of the committee resulted in a more comprehensive structure of water law in the state. One result of these findings was the expansion of the authority of the Department of Water Resources, a division of the State Board of Conservation, to include issuing permits for withdrawal and use of excess surface water.

The 1970 census counted 303,900 people in the lagoon region. The urban and suburban areas of Titusville, Cocoa Beach, Melbourne, Vero Beach, Fort Pierce, Port St. Lucie and Stuart were flourishing, but not without cost. Discharges of domestic waste and the effects of stormwater runoff had damaged habitat and strained the lagoon's environmental equilibrium. The federal Clean Water Act of 1972 was passed with the intent of regulating the impacts of increased development. As a result of this legislation, new rules were enacted that established water quality standards and limited the discharge of pollutants to water bodies such as the lagoon. The Florida Legislature also passed the Water Resources Act of 1972, creating the regional water management districts.

The passage of the 1972 Clean Water Act produced the modern beginnings of environmental protection regulations, both at the federal and state levels. The Florida Legislature responded to the federal mandates contained within the Clean Water Act by empowering the Florida Air and Water Pollution Control Board (now the Florida Department of Environmental Protection) to create water classifications in accordance with present and future most beneficial uses.

The 1970s also brought the federal Coastal Zone Management Act of 1972, to manage coastal development, and the state Development of Regional Impact (DRI) program, to address state and regional interests in any development that had a substantial impact in more than one county. In 1975 state legislation established the Aquatic Preserves Act, which set aside forever state-owned submersed lands and associated waters to be maintained essentially in their natural condition.

Beginning in the early 1970s and extending into the 1990s, Florida established several land acquisition programs (Conservation and Recreational Lands Program, Save Our Rivers, Preservation 2000, Florida Forever) to protect water resources. More than 50,000 acres of land in the lagoon region have been purchased under these programs with an additional 69,000 acres identified for future acquisition.

Urban stormwater management programs for new development, targeted at controlling the discharge of nutrients, sediments and metals into the lagoon, were also initiated by state and local governmental agencies. The St. Johns River and the South Florida water management districts have established watershed management programs, to regulate the construction of stormwater treatment facilities and freshwater discharges and to develop surface water improvement and management plans. Additionally, the federal Endangered Species Act, passed in 1972, provided the protection for species determined to be threatened or endangered.

In 1987 the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act. The SWIM Act required the state's five water management districts to develop plans to protect and restore certain priority water bodies within the state. The Indian River Lagoon was one of the priority water bodies identified.

At the federal level, Congress passed the Water Quality Act of 1987, amending the Clean Water Act of 1972. This amendment included the creation of the National Estuary Program with the purpose of protecting and restoring estuaries of national significance. To complement state restoration efforts, the Indian River Lagoon was nominated for inclusion in the National Estuary Program in 1990 and, following review by the U.S. Environmental Protection Agency, the Indian River Lagoon National Estuary Program was initiated in 1991.

Close coordination of both the SWIM plan and the National Estuary Program has resulted in common goals and objectives for the protection and restoration of the lagoon. Ultimately, these programs were merged to create the Indian River Lagoon Program.

The roots of a red mangrove reach into the water like outstretched fingers.

The U.S. Census Bureau estimated the current population of the lagoon region at 1.54 million, with growth anticipated to continue. The challenges of dealing with the environmental impacts of a growing population and resulting changes in the landscape of the region will require diligent and effective management to protect, preserve and restore the resources of the lagoon for future generations. Through the management initiatives and environmental enhancement objectives implemented by the Indian River Lagoon Program in collaboration with local, regional, state, federal and private efforts, these challenges can be met, ensuring the continued health and productivity of the Indian River Lagoon.

HELPING OUT

Who to call to volunteer

If you would like to join the efforts to help protect the Indian River Lagoon, you can call:

Volusia County

- Environmental Management (386) 423-3303
- Keep Volusia Beautiful (386) 943-4905
- Marine Discovery Center (386) 257-4828
- Marine Science Center (386) 304-5545
- Volusia County Watershed Action Volunteers (386) 822-7329

Brevard County

- Brevard County Watershed Action Volunteers (321) 633-2016, Ext. 6073
- Environmentally Endangered Lands Program (321) 633-2016 • (321) 255-4466
- Keep Brevard Beautiful (321) 631-0501
- Marine Resources Council (321) 725-7775
- Merritt Island National Wildlife Refuge (321) 861-0667
- Natural Resources Management Office (321) 633-2016
- The Nature Conservancy (321) 956-7711
- Turkey Creek Sanctuary (321) 952-3433

Indian River County

- Environmental Learning Center (772) 589-5050
- Indian River County Watershed Action Volunteers (772) 567-8000, Ext. 1511
- Keep Indian River Beautiful (772) 978-0722

St. Lucie County

- Harbor Branch Oceanographic Institute (772) 465-2400
- Manatee Observation and Education Center (772) 466-1600, Ext. 3333
- Spoil Island Project, FDEP Southeast Aquatic Preserve Field Office (772) 429-2995
- St. Lucie County Environmental Learning Center (772) 785-5833

Martin County

- Florida Oceanographic Society (772) 225-0505
- Hobe Sound National Wildlife Refuge (772) 546-6141
- Keep Martin Beautiful (772) 781-1222
- The Nature Conservancy (561) 744-6668

About this document

This document was produced through a cooperative effort of the Indian River Lagoon National Estuary Program and its sponsors the St. Johns River Water Management District and the South Florida Water Management District. Photography and graphics were provided by Robert Day, Tom Ellis, Florida State Archives, Ed Garland, Patrick Lynch, NASA, Mat O'Malley and Janet Sloane.

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