

Northwest
Florida WMD

Suwannee
River
WMD

St. Johns River
WMD

Southwest
Florida WMD

South Florida
WMD

The Delicate
Relationship
Between
Southeast
Florida's
Inland,
Intracoastal,
and Atlantic
Ocean Littoral
Zone, Native
Waters.



South Florida's Geographic & Geologic History

(65.5 Million Years Ago – 10,000 Years Ago)

Florida as we know it began to take shape deep under sea during the Cenozoic Era near 65.5 million years ago. (D.E.P. Web) As dead creatures settled beneath the water over millions of years, their skeletons formed a limestone base. (D.E.P. Web) Limestone is a sedimentary rock, primarily composed of calcium carbonate, in Florida's case organic sedimentary limestone formed as calcium carbonate shells and skeletons of deceased animals lithified into limestone. (Geo. Web) Limestone which underlies all of Florida can be dissolved by slightly acidic rain water, over millions of years, pore spaces opened and sink holes and other karst features such as springs and air caves formed. (D.E.P. Web) During the Late Oligocene Epoch around 25 million years ago, Florida's reefs began to form; at the end of this period, around 23 million years ago, sea levels dropped and the land mass of Florida rose above sea level, Florida will never be completely submerged under water again. (D.E.P. Web) At the start of the Miocene Epoch around 23 million years ago, water level fluctuated depositing sands and clays across Florida, the Appalachians were also uplifted during this time moving, and grand deposits of phosphorite accumulated on Florida land, many fossils including those of the megalodon were deposited at this time. (D.E.P. Web) In the Pliocene Epoch around 5 million years ago, North America and South America were connected and the Gulf of Mexico was formed, limestone and shell beds formed in south Florida, and the largest variety of molluscan faunas on earth accumulated in southwest Florida. (D.E.P. Web) The Pleistocene Epoch, also known as the Ice Age, which lasted from 2.6 million years ago to 10,000 years ago, changed the dynamics of the sea, and the world's climate. (D.E.P. Web) Sea level fluctuated to 300 feet lower to 100 feet higher than it is today. (D.E.P. Web) As water heights rose more limestone accumulated, and as they fell limestone was eroded. (D.E.P. Web) At the end of this period man arrived to Florida. (D.E.P. Web)

South Florida's Geographic & Geologic History

(10,000 Years Ago – Present)

As the Holocene Epoch began 10,000 years ago, sea level reached its current height.

(D.E.P. Web) Throughout this time period, the Everglades took shape in south Florida, and thick layers of peat were deposited. (D.E.P. Web) Peat is an organic spongy material, composed of dead plant material, often found in swamps and marshes; which is also used as a fuel source. (E.B. Web)

The Keys became islands and new coral reefs sprouted around Florida; our modern climate began to take shape and Florida became the long peninsula of what we are familiar with today.

(D.E.P. Web) In 1565 our nation's oldest remaining city, St. Augustine was founded by the Spanish in Florida, which by now has been inhabited by natives the French and the Spanish. In 1819

Florida officially becomes part of the United States. (F.M. Web) In 1822 Florida's government was founded, and in 1830 Florida had its first census, having a population of 34,730. (F.M. Web)

Florida becomes a state in 1845. In the 1920's the Florida land boom began, people of diverse economic and social standards flooded Florida. (F.H. Web) The Florida Forestry Service is

created in 1927. (F.M. Web) In 1930 Florida's population is measured to be 1,468,211. (F.M. Web)

In 1933 the State Board of Conservation is created, and in 1935, the Florida Park Service is

created, as well as the Florida Citrus Commission. (F.M. Web) In 1946, Everglades National Park

is established. (F.M. Web) In 1970 Florida's population hits 6,789,443. (F.M. Web) In 1971 Disney

World open's in Orlando boosting Florida's, already large tourist economy. In 1992 Hurricane

Andrew strikes southern Florida causing severe damage, costing the United States around

\$45,561,000,000 in damages. (W.U. Web) In 1993 the Dept. of Environmental Protection was

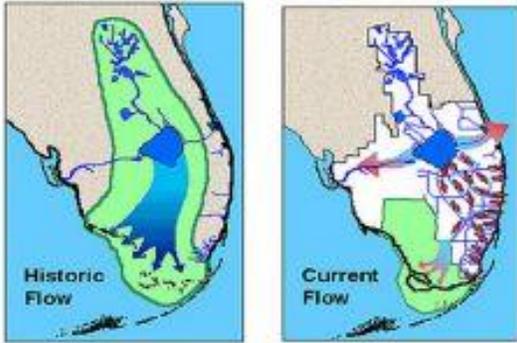
created. (F.M. Web) In 2010 Florida's population reached 18,801,310 persons. (C.V. Web)

National and State Environmental Legislation / Public Awareness Timeline

It is important to understand how Florida's ecosystem has been shaped by culture and legislation. The Federal Water Pollution Control Act was passed in 1948; which provided limited authority to the federal government to regulate pollution. (E. Web) Media has been used as a tool to sway public opinion, one of the first and most influential media relations tactic was The Silent World, by Jacques Cousteau; the film documented underwater life, and introduced the public to a new world, with new interest and issues. In 1955 the first piece of legislation addressing air pollution passes, Air Pollution Control Act; the act provided technical and research assistance to handle the crisis of air pollution, however it largely designated enforcement to individual states. (PBS Webpg.1)(E.E. Web) In 1960 worldwide carbon hits 300 parts per million. (PBS Webpg.1) Rachel Carson's, Silent Spring, is published in 1962 challenging chemical industries' use of DDT (dichlorodiphenyltrichloroethane), which will be banned in the United States in 1972. In 1963, Congress passes the Clear Air Act, which allocated \$95 million for air and water research and management. (PBS Webpg.1) The Water Quality Act passes in 1965 and sets federal standards which apply to states. (PBS Webpg.1) In 1967 the United States releases its first list of Endangered Species, and \$15 million annually to protect these species. (PBS Webpg.1) The U.S. government in 1968 enacts both the Wild and Scenic Rivers Act and the National Trails System Act. (PBS Webpg.1) The National Environmental Policy Act is enacted in 1970 and federal agencies must prepare an Environmental Impact Statement for any legislation. (PBS Webpg.1) The first Earth Day was held, and the EPA (Environmental Protection Agency) and NOAA (National Oceanic Atmospheric Association) were formed in 1970. (PBS Webpg.1) In 1972 the United States government implemented many acts to protect America's marine environments; such as the Clean Water Act, which is meant to rid toxins from surface water; the Marine Mammal Protection Act, which protects marine mammals from importation, exportation,

hunting, capture, or any form of harassment; and the Coastal Zone Management Act, which was meant to offset negative human impact on coastal areas. (PBS Webpg.1) The mid 1970's lacked no essence of environmental legislation; in 1974 the Forest and Rangeland Renewable Resources Planning Act was enacted; in 1975 the Eastern Wilderness Areas Act was enacted; in 1976 the Toxic Substances Control Act, Resource Conservation and Recovery Act, and the National Forest Management Act were all enacted. (PBS Webpg.1) In 1977 the Department of Energy is formed. (PBS Webpg2) In the early 1980's the world population reaches 4.5 billion, and carbon hits 335 parts per million. (PBS Webpg2) In 1986 the Emergency Planning and Community Right-to-Know Act was enacted, and in 1988, the Ocean Dumping Ban Act of 1988 was put in place. (PBS Webpg2) In 1991 Florida passed the Marjory Stoneman Douglas Everglades Protection Act, to help restore the Everglades, and led to 32,000 acres of storm water treatment areas and phosphorous monitoring stations. (D.F.L. Web) In 1997 Florida passed the Everglades Restoration Investment Act, which split the cost of the Comprehensive Everglades Restoration Plan, half paid for by the state and half paid for by the federal government. (D.F.L. Web) In 2000 the Lake Okeechobee Protection Act was passed, which is a multiphase plan to restore the health of the lake. (D.F.L. Web) In 2005, now former Florida governor Jeb Bush presented the Lake Okeechobee and Estuary Recovery (LOER) Plan. Throughout the rest of the 2000's the state and federal government would continue to acquire vast amounts of land to improve the well-being of many south Florida water systems, the land that was purchased spanned a large distance, stretching from the north of Lake Okeechobee, to the Indian River Lagoon, and down to the Florida Everglades. In 2009 Florida enacts the Coral Reef Protection Act. Most recently the Florida Water and Land Conservation Initiative was passed in 2014; this initiative allocates funds to promote clean drinking water, and ecosystem restoration.

Lake Okeechobee & Its Possibilities



This graphic shows the original drainage pattern of Lake Okeechobee (Left), and a more modern version of drainage (Right).

Lake Okeechobee is essentially shallow bowl, measuring 730 square miles, before a dike was created, to help flood control. (SFWMD). Lake Okeechobee is still at 730 square miles with a maximum depth of only around fifteen feet. (I.E.O. Web) Lake Okeechobee provides surrounding communities with drinking water, farmers with a source of water for agricultural purposes and, has huge economic benefits thanks to tourism, an example being in

2000, \$117 million of revenue was made for the lakes' five surrounding counties due to retail freshwater fishing sales alone. (F.F.W. Web) The lake is also home to fisheries which supply a steadier food supply and are hubs of scientific research. As of 2011 approximately 176,000 metric tons of phosphorus were stored in and around Lake Okeechobee; on top of that approximately another 500 metric tons of phosphorous is loaded into the lake each year, at this rate it would take between 23 and 57 years to flush the existing phosphorous out of lake, being if phosphorous imports and exports immediately leveled out. (S.F.W.M.D.R.) Another issue in Lake Okeechobee is the intake of excessive nitrogen, which enters the lake at around 5,000 metric tons each year. (U.S.G.S) Phosphorous is generally harmful to plant aquatic plant growth while, nitrogen promotes it, nitrogen and phosphorous however promote, harmful blue-green algae growth. (F.D.E.P.B. Web)



Toxic blue-green algae bloom in Lake Okeechobee. (Right)

The Possibilities of Lake Okeechobee:

The first step to my Lake Okeechobee restoration would be the construction of stone piers entering the lake at where the mouth of the Kissimmee River enters the lake, and near the source of the St. Lucie River, and near the source of the Caloosahatchee River. The piers will be home to a native Florida mussel, the main species being the Dark false mussel (*Mytilopsis leucophaeata*), the Dark false mussel will be incorporated on these piers because it needs minimal flow of water to filter out nutrients from the water, and the piers being near the transition zone between lake and river will have a higher flow rate. (F.W.S.D.F.) The piers could also serve as a haven for fish reproduction; an extra artificial rock reef may be developed near the center of the lake purely for the purpose of fish reproduction, which will increase the money spent on fishing each year. The plan will also incorporate the use of freshwater Fingernail Clams and Pea Clams (*Eupera*, *Musculium*, *Sphaerium* and *Pisidium* sp.), which burrow into the ground or attach to plant life, these fauna will thrive in Lake Okeechobee's floral ecosystem, while at the same time removing a harmful excess phosphorus and other nutrients. (F.W.S.D.F.) Another step to the process would be the implementation of oxygenation systems in strategic locations across the lake, to increase fauna viability, and help reduce harmful plant life and muck. One system that I look to incorporate into the oxygenation plan is the inversion oxygenation system manufactured by Lake Savers. (L.S.O.I.) South of Lake Okeechobee the soil is generally sandy with a high water table (D.E.R.A.P.); these conditions are favorable for many native south Florida grasses, however it would be economically beneficial if we plant almost solely Purple Lovegrass and Muhly Grass, for a generously sized patch; this could be a huge tourist destination, while also helping the environment. (F.Y.P.)



Purple Lovegrass (Top Right), Muhly Grass (Bottom Right), Dark False mussel (Left)



St. Lucie Estuary History & Possibilities

The St. Lucie Estuary is a 35 mile long waterway, which stretches from Lake Okeechobee to the Indian River Lagoon. St Lucie River was transformed into an estuary when in 1892 local residents dug an inlet to connect the river to the Atlantic Ocean. (S.L.R.D. Pg.2) An estuary is where a body of fresh water meets a body of salt water; this combination forms brackish water; estuaries generally have high diversity in both flora and fauna. The St. Lucie estuary enters the Indian River Lagoon near Stuart Florida. The estuary was forked to help with flood prevention. In 1998 fisherman reported many fish with sores and lesions, researchers believed the sickness was caused by aquatic fungus. (S.L.R.D. Pg.5)

Florida Power & Light and its connection to the St. Lucie Estuary

Florida Power & Light operates the Martin County Power Plant, which is 3,750 MW plant, which burns oil and gas. The plant is the single largest fossil fuel burning plant in the United States, the plant uses a 17 square mile cooling pond which connects to the St. Lucie estuary. (W.I.K. Web) Air emissions are regulated by the government however water waste is not. (F.P.L.E. Pg.5) Some chemicals that may be released from power plant process are chlorine, chlorine dioxide, hydrazine, sulfur, nitrogen, and metals, such as nickel and vanadium. (F.P.L.E. Pg. 4-5) Some controversy surrounding the Martin County Power Plant, is when they purchased the Barley Barber Swamp, environmentalists harped on the company claiming that the cooling pond was diverting water away from the swamp. (WikiBB) Also, Florida Power & Light was one of 25 US companies that paid the least US taxes in 2009, coming in at 1.3 percent annual tax rate, much less than the standard 35 percent corporate rate. (WikiBB)

St. Lucie Estuary Possibilities:

Either publically funded, or assistance funding by the Martin County Power Plant, to improve public relations, the St. Lucie Estuary can be restored. One step would be the planting of the native Florida aquatic grass Sago Pondweed (*Potamogeton pectinatus*), which is a plant that grows in shallow river water, in south Florida. (F.L.F. Web) In these patches of aquatic grass we can also implement the Paper Pondshell (*Utterbackia imbecillis*), which will help filter harmful pollutants from the water. (EOLUI) Near the mouth of the St. Lucie Estuary we can also implement a current practice that has been used in the Everglades; a Periphyton-Based Stormwater Treatment Area, which is an artificial geological design to remove pollutants. (CorpsEP Pg.1)

Indian River Lagoon History & Possibilities



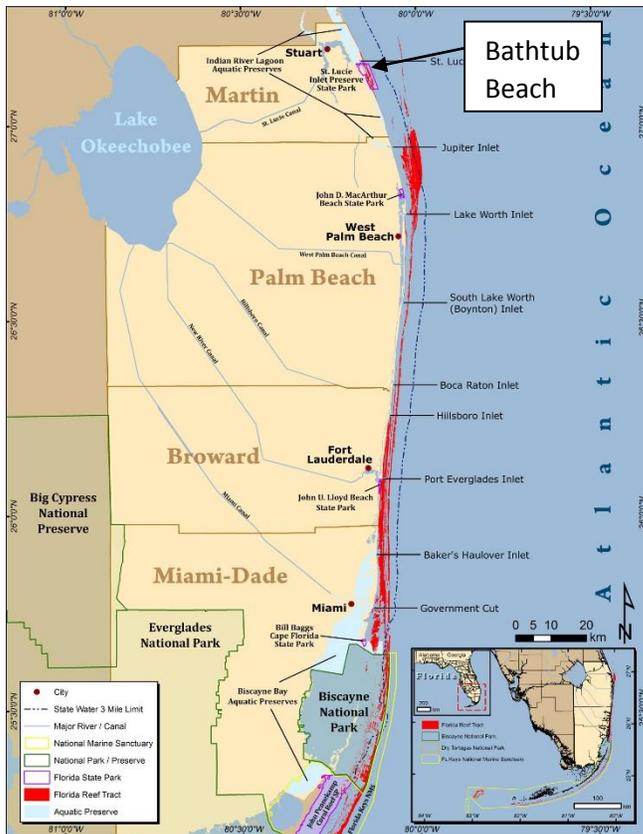
The Indian River Lagoon is the longest barrier island complex in the United States; it occupies more than 30% of Florida’s eastern coast. (S.M.F.I.) It is the most biologically diverse estuary in the United States. The Indian River Lagoon has been center stage to deal with the effects of southeastern Florida’s population explosion. By the 1970’s, 75% of the lagoon’s salt water marshes’ when dikes were built to curb the mosquito problem, nitrogen and phosphorous deposits from Lake Okeechobee run-off caused an explosion of algae in the lagoon. The lagoon however has not

provided all negatives for the south Florida region, it is a huge economic resource, thanks to tourism, fishing, boating, real-estate, and a plethora of other options.

Indian River Lagoon

One step to restoring the lagoon would be the implementing a greater amount of mangrove forests, which will also help prevent erosion, and provide a barrier against tropical storms and hurricanes. Implementation of these mangroves would prove much wiser than the constant beach nourishment, which costs millions of dollars a year for the state of Florida. Patches of Ribbed Mussels (*Geukensia demissa*) should be planted to cut down on nutrients, these mussels are also able to survive in high salinity. (S.M.S.T.) Academic research centers and public awareness centers should be funded along the lagoon to showcase its value.

Florida's Atlantic Coastline History & Possibilities



Florida's Atlantic coast is the home of many reefs, and fauna species. Florida is the only state in the continental United States to have such an extensive coral reef structure. Coral reefs are colonies of coral polyps, these animals host photosynthesizing algae, commonly referred to as zooxanthellae. (Tobin Pg.226) The Atlantic coast however is also one of the most populated areas in Florida, due to both housing and tourism. Many of these social wants lead to the neglect of our valuable reef system. Coupled with on shore effects, heavy fishing also damages the delicate coral reefs.

The Bathtub Beach Catastrophe

Bathtub Beach is located in Stuart, Florida; near the mouth of the St. Lucie Estuary. Bathtub Beach was home to an extensive worm rock reef and brain coral collections. Immediately next to the beach private housing was constructed. To build these houses reef was covered by sand. As hurricanes and rough water battered the coastline; the beach naturally eroded, so the government implemented soft stabilization of the beach, soft stabilization is when sand added to the beach to mitigate erosion; during hurricane season natural hard stabilization factors were included, tree stumps were added and left in the water to trap sand. These methods became detrimental to the natural ecosystem covering and damaging reefs, the tree stumps (roots included) held debris in the intertidal zone. Whole levels of reef were covered in debris and sand in a futile effort to halt erosion. Lifeguards neglect their responsibilities as citizens walk on the reef, destroying it. Despite all the efforts to keep tourism a thriving economy at Bathtub Beach, the efforts were for naught, developing into a covered dying reef, with a parking lot almost completely covered in sand dunes. It is not purely physical debris harming reefs at Bathtub Beach, but also chemical, phosphorous and nitrogen plumes exiting the St. Lucie Inlet; which is harming reef health, and even bleaching some reefs. Bleaching is when algae leaves the coral, which kills the polyps, due to the expulsion of zooxanthellae, ending the polyp / algae symbiotic relationship. Both an excess of nitrogen and phosphorous deter coral colonization. (McClanahan abstract)

The Possibilities

Implement the use of sea grass instead of sand, and limit how close private property can be built next to a state park. The excess of sand at the beach is covering nearly half the parking lot. Increase the penalty and enforcement for disturbing reefs. These steps will eventually bring

in revenue due to increased tourism. Investing into an artificial coral reef program could also be a possibility.

Conclusion

In today's interconnected world, we must see that we are interconnected with nature. If we keep moving away from nature we'll eventually need an environmental suit to live on our planet. We must accentuate the value of the environmental movement for the economy, social life, and even for its aesthetic value. Humanities focus should be on preserving natural landscapes, and also implementing the use of hybrid landscapes. It's a delicate world out there, and one person can surely make a difference.

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