



MARTIN COUNTY

**LAKE OKEECHOBEE SYSTEM
OPERATION MANUAL
(LOSOM)**

SCOPING

APRIL 22, 2019

TABLE OF CONTENTS

- I. Martin County's Scoping Letter
 - Background
 - Environmental Impacts (past and under a no-action alternative)
 - Martin County's Conservation of Land and Investments in Water Quality Projects
 - Economic Impacts (past and under a no-action alternative)
 - Summary of Requested Considerations in LOSOM
- II. Exhibit A Martin County's Technical Scoping Comments
- III. Exhibit A-1 Statement from Mark Perry, Director, Florida Oceanographic Society
- IV. Exhibit A-2 References
- V. Exhibit A-3 Acronyms
- VI. Exhibit A-4 Table of Currently Listed Threatened and Endangered Species – IRL and Connected Waterbodies
- VII. Exhibit A-5 The Stuart News, Announcement, 1961

VIII. Exhibit A-6 Photos

IX. Exhibit A-7 S-80 Discharges Video

X. Exhibit A-8 Discharges out the St. Lucie Inlet Video



MARTIN COUNTY

BOARD OF COUNTY COMMISSIONERS

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April 22, 2019

Via electronic mail to: LakeOComments@usace.army.mil; and overnight mail

Dr. Ann Hodgson
U.S. Army Corps of Engineers - Jacksonville District
701 San Marco Boulevard
P.O. Box 4970
Jacksonville, Florida 32232-0019

Re: Scoping Comments for the Proposed Lake Okeechobee System Operating Manual

Dear Dr. Hodgson:

The Martin County Board of County Commissioners (Martin County or the County), on behalf of its 147,000 residents and over 6,300 businesses, many of which are water front and water dependent businesses, appreciates the opportunity to submit scoping comments to the U.S. Army Corps of Engineers (ACOE) for its preparation of a National Environmental Policy Act (NEPA) assessment for the Lake Okeechobee System Operating Manual (LOSOM). This letter summarizes the unique environmental characteristics of the coastal estuary region of Southeast Florida. It provides the historical and legal background of managed water in South Florida, as it relates to the current water quality issues experienced in Martin County. The background is relevant in the current LOSOM review to explain why water management changes are necessary to restore water quality in the eastern coastal estuary. The letter also describes the environmental and economic impacts from Lake Okeechobee (Lake) discharges under current and past Lake management and would likely continue under a “no-action alternative” or other alternatives with similar discharge protocols. Exhibit A to this letter contains detailed scoping comments. Subsequent exhibits contain additional information and documentation including photographs and videos.

BACKGROUND

Martin County – Environmental Characteristics

Indian River Lagoon

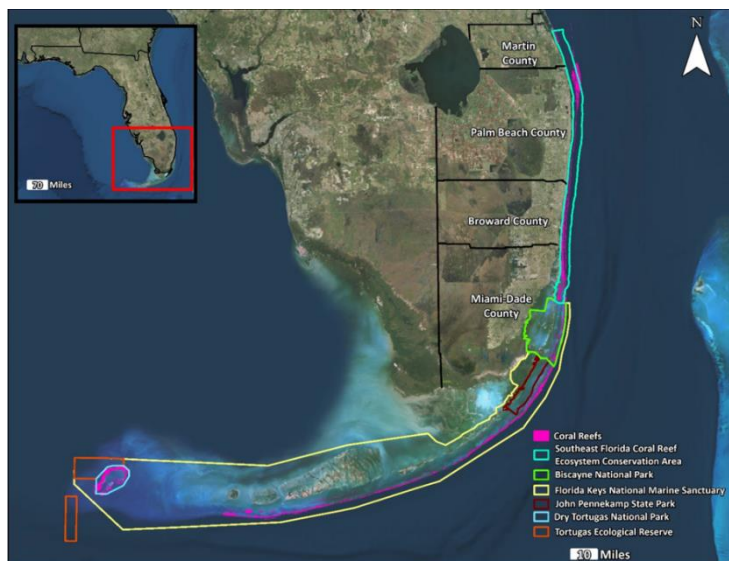
Martin County is a coastal Southeast Florida county located between the Lake and the Atlantic Ocean. A section of the Indian River Lagoon (the Lagoon or IRL) flows north and south through the eastern part of the County. The IRL in its entirety extends from Jupiter Inlet at the southern end to Ponce Inlet on the northern end. It is designated an “Estuary of National Significance” under Section 320 of the Clean Water Act (CWA). The Lagoon “is a biogeographic transition zone, rich in habitats and species.”⁶¹ It is commonly recognized that the Lagoon has been home to 3,000 - 4,000 plant and animal species. Many of the plant and animal species that have been found in the Lagoon are listed as “species of special status,” including threatened and endangered species such as Johnson’s seagrass, the smalltooth sawfish, green sea turtle, Florida manatee, and the Everglade snail kite to name just a few.⁶⁵ The sheer numbers of species of special status has resulted in the recognition that the Lagoon is the most species diverse estuarine environment in North America.⁶¹ The State of Florida has designated the IRL as an aquatic preserve and an Outstanding Florida Waterway. The IRL is also a component of the U. S. Environmental Protection Agency sponsored National Estuary Program (NEP).⁸³ NEPs promote comprehensive planning for long-term protection of 28 nationally significant estuaries in the United States that are deemed to be threatened by pollution, development, or overuse.

St. Lucie River and Estuary

The St. Lucie River (the River) and the St. Lucie Estuary (the Estuary) comprise the watershed which encompasses approximately 832,500 acres in Martin and St. Lucie Counties. The River includes the South Fork and the North Fork. The two forks converge to form a single waterbody that extends eastward, where it joins the IRL. The Estuary and IRL provide habitat for a variety of estuarine fish communities. The Estuary is a brackish sub-tropical water body. It has been known to be among the most productive ecosystems in Florida providing vital nurseries and refuge habitat for thousands of aquatic species including over 30 threatened and endangered species.

Southeast Florida Coral Reef Tract

Extending from the St. Lucie Inlet, a nearshore reef is formed by bands of unique marine habitat. Southeast Florida Reef Tract Conservation Area (RTCA or Reef Tract) was designated by the legislature in 2018 as an area of special significance in need of active



conservation action. Florida's coral reefs and coral reefs in general developed a highly sophisticated ecological system that was resilient to extreme challenges from nature – episodic events like hurricanes that brought both crashing waves that threatened their physical existence and elevated turbidity that temporarily clogged their respiratory systems and shut out the light they need to survive, temperature fluctuations and some variations in salinity. They also protect our coasts by acting like a breakwater, reducing wave energy from storms and hurricanes. They provide critical habitat for numerous species, including those with special commercial and recreational importance to Florida's economy. Most of Florida's sport fish species and many other marine animals spend significant parts of their lives on or around coral reef ecosystems, as juveniles, in spawning aggregations or full-time residents.

Central and Southern Florida Flood Control Project on the Eastern Side of Lake Okeechobee

In 1913, the State of Florida constructed a canal between the Lake and the Estuary. Prior to that time, there was no natural connection between the two water bodies. As more people moved to Florida, more canals were dug to drain the land for agriculture and community development. The first reported discharges from the Lake to the Estuary occurred in June of 1923. In 1930, the Martin County Board of County Commissioners made the first of many requests to terminate the discharges. In 1948, Congress authorized the Central and Southern Florida (C&SF) Project as a federally operated system of levees, canals, pumps and water control structures much broader in scope than the piecemeal canals and levees. At that time, the C&SF was designed to further drain the Everglades, provide flood protection and other water management needs from the Orlando region to Florida Bay. When the C&SF Project was initially authorized in 1948 the population in Florida state-wide was just under 3 million. Relevant to Martin County, local C&SF components include the Lake, the C-44 canal (also known as the St. Lucie Canal, hereinafter referred to as the C-44) and also the C-23 and C-24 canals. The C-44 serves as the conveyance for forcibly discharged Lake water to lower the Lake's water elevation when necessary to achieve the C&SF operational purposes.

Upon a discharge event, high volumes of water are flushed from the Lake (the Lake Okeechobee Basin) into the C-44 then into the South Fork of the River (the C-44 Basin), on to the Estuary, Lagoon (the St. Lucie Estuary and Lagoon Basin) and ultimately out of the St. Lucie Inlet reaching the Reef Tract. The construction of canals C-23 and C-24 provided connections between their respective sub-basins and discharge to the North Fork of the River, which flow to the Estuary, Lagoon and ultimately out of the St. Lucie Inlet. Lake water is discharged through the Estuary for no other purpose than other than disposal.

The County recognizes that the Lake is a critical part of the C&SF Project and that the C&SF Project components are critical for the continued operations of agriculture and existence of human population in South Florida. However, as acknowledged in the Lake Okeechobee Regulation Schedule (LORS) Environmental Impact Statement (EIS), the C&SF Project,

although achieving its originally intended purpose, “has contributed to the decline of the South Florida ecosystem.”⁸²

The Water

The St. Lucie River and Estuary Basin is designated as a Class III surface water body. In Florida, designated Class III water bodies must be suitable for “recreation and must support the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.”⁶⁷ The discharged Lake water is “fresh” water simplistically due to its lack of salt concentrations, also characterized as low specific conductivity. The River and the Estuary on the other hand, are brackish and grow higher in salt concentrations and specific conductivity as the water in its natural state reaches the St. Lucie Inlet and the Atlantic Ocean. Thus, healthy and well-balanced populations of fish and wildlife have developed specific regional ecosystems and can vary greatly between the Lake and the Estuary and Lagoon.

In addition to low specific conductivity, Lake water contains high concentrations of nitrogen and phosphorous and is tainted with an abundance of silt and chemicals from stormwater, agricultural runoff, and domestic and industrial wastewater effluent (2001 FDEP TMDL Total Phosphorus technical document: 69 industrial, 121 domestic permitted point sources). The Lake water compounds and exacerbates local basin runoff as it is forcibly discharged through federally operated C&SF Project components, e.g., the S-308, the C-44, and the S-80, into the River and Estuary.

The C-44 discharges carry significant nutrient loads which have a known impact on the Estuary watershed. In 2001, the State adopted a Total Maximum Daily Load (TMDL) for the Lake. A TMDL is the maximum amount of a specific pollutant that a waterbody can assimilate while maintaining its designated uses, in this case Class III uses. The Lake calls for an annual maximum load of 140 metric tons of phosphorus to achieve an in-lake target phosphorus concentration of 40 parts per billion (ppb) in the limnetic zone of the Lake. Currently, any TMDL targets already in place automatically become inputs into models for any connecting waterbodies. Thus, the St. Lucie TMDL is predicated on the modeled assumption that the Lake is meeting its target total phosphorous (TP) concentration of 40 ppb. TP loads to the lake exceeded 1,080 metric tons (t) in WY2018, raising the most recent five-year average TP load to almost 500 t above the TMDL target of 140 t.

In addition to the nutrients, the low specific conductance or “fresh” Lake water then flushes through the brackish River and Estuary, through the Lagoon, the St. Lucie Inlet and finally out to the Atlantic Ocean, as mentioned above. Depending on the tide and current, the Lake’s discharges ultimately send a lens of fresh and nutrient (nitrogen) rich water on to the Reef Tract. The forced discharges can persist days, weeks or months, depending on the water management needs of other basins outside of Martin County and the maintenance needs of the Herbert Hoover Dike (HHD). The stability concern of the HHD has been a major cause of increased forced

discharges through the Estuary, coinciding with time of LORS 2008. The River, Estuary, and the nearby Reef Tract have been and still are, therefore, ground zero for ecological decline from the C&SF Project due to authorized forced discharges of chemically distinct Lake water under LORS.

Downstream estuarine and Coastal waters are physically, chemically and biologically distinct from freshwater ecosystems and, as a result, their responses to nutrient inputs and over enrichment can contrast those observed with freshwater ecosystems...Historically, phosphorous (P) has been the priority nutrient controlling upstream freshwater productivity, whereas nitrogen (N) limitation has characterized coastal waters.⁶⁷

South Florida's Ecological Decline and Restoration Goals

The litigation and settlement of the *United States of America v. South Florida Water Management District and the State of Florida*, case no.: 88-1886 (the USA lawsuit) brought about sweeping changes to water management in Florida. The USA Lawsuit and the resulting "Consent Decree" were arguably the most significant impetus for implementation of the major restoration objectives resulting in the "re-study" of the C&SF Project.

The USA lawsuit and the laws furthering the agreements reached in the settlement of the USA lawsuit specifically concerned phosphorous levels from water flowing through water management structures into the Everglades Protection Area (EPA) and Everglades National Park (ENP or the Park). In the Section 3 of the 1995 settlement agreement of the USA lawsuit, the parties agreed among other things that:

The nutrient – lean (oligotrophic) condition of the aquatic ecosystems is one hallmark characteristic of the unspoiled Everglades...These ecosystems are changed by even slight increases in nutrient concentration of phosphorous.... Indeed, the high levels of phosphorous in EAA discharges constitute the most immediate water quality concern facing the Everglades system...The presence of these excessive nutrients [entering the Park through water management structures] is potentially harmful or injurious to animal and plant life in the Park. Accordingly, such nutrient-polluted water is, or is reasonably expected to be, a source of pollution in the Park.

The recognition of these facts, as agreed to by the federal and state governments, resulted in a fundamental shift in the water management and allocations of billions of state and federal dollars for projects to sharply reduce nutrient (phosphorus) loading while maintaining water supply for legal users and the Park itself. In Section 601(b)(1)(A) of the 2000 Water Resource Development Act (WRDA), Congress authorized the following:

[The Comprehensive Everglades Restoration Plan] is approved as a framework for modifications and operational changes to the [C&SF] Project that are needed to restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Plan shall be implemented to ensure the protection of water quality in the reduction of the loss of fresh water from, and the improvement of the environment of South Florida ecosystem and to achieve and maintain the benefits to the natural system and human environment. . . .as long as the [C&SF] project is authorized.

Goals and Objectives of CERP include:

Operational changes: Fine-tuning water management operations so that the right amount of clean fresh water is provided to the right places at the right time.

Water quality standards: Addressing regional water quality issues by establishing maximum pollutant levels in specific water bodies or regions (Objective 1B2).

Source controls: Reducing the introduction of pollutants into natural areas through a variety of structural and operational management efforts on private lands.

Protecting coral reefs: Restoring offshore habitat through improved freshwater flows to coastal estuaries and protection of coral habitat and reef fisheries (Objective 2A2).

Improving habitat quality: Improving the quality of habitats through restoration and conservation efforts (Objective 2A3).

CERP and its Connection to LOSOM and to the Coastal Estuaries

The ACOE's 2019 public information on LOSOM identifies project purposes of Lake management, citing WRDA 2018, which cites as its authority, Section 601 of the WRDA 2000, i.e. the CERP goal of: "modifications and operational changes to the [C&SF] Project that are needed to restore, preserve, and protect the South Florida ecosystem" and to "ensure the protection of water quality."

The Lake and its associated water control structures and pumping that force Lake water into the River and Estuary are part of the C&SF Project and therefore fall under the WRDA 2000 obligation that the C&SF Project and its operations be modified to "ensure the protection of water quality." The state has set nutrient water quality standards through TMDLs.

Furthermore, in CERP's authorizing document the Governor's Commission recognized the need to protect the ecology of nearshore coastal marine ecosystems, to recognize the impacts of hydrology on coral reef ecosystems and to value their socioeconomic importance. It also

discussed the importance of safeguarding marine ecosystems, not only for their intrinsic value, but for protecting the fisheries, the fishing and tourist industries, and the characteristic South Florida lifestyles that depend on nature's bounty. It recognized that "The Florida Keys, including Florida Bay and the offshore coral reefs and sea grasses, are a threatened resource of international significance." Finally, the original charge under WRDA 2000 was to "restore and protect the greater Everglades ecosystem" with the term "South Florida ecosystem" meaning "the area consisting of the lands and waters within the boundary of the South Florida Water Management District, including the Everglades, the Florida Keys, and the contiguous near-shore coastal waters of South Florida."

The LORS Environmental Impact Statement (EIS) made mention of the environmental impacts of the releases to the two coastal estuaries and Reef Tract. However, the regulation of the Lake under LORS principally focused on flood control, water supply, and controlling high water conditions to prevent threats to the structural integrity of the HHD.⁸² The ACOE, as operator of the C&SF Project components, including the C-44, the S-308 and the S-80, must take CERP priorities and the Lake's related congressionally authorized purpose of "enhancement of fish and wildlife", i.e., water quality, into consideration under LOSOM.

Phosphorous, as the Limiting Factor, has been the Priority in Freshwater Restoration

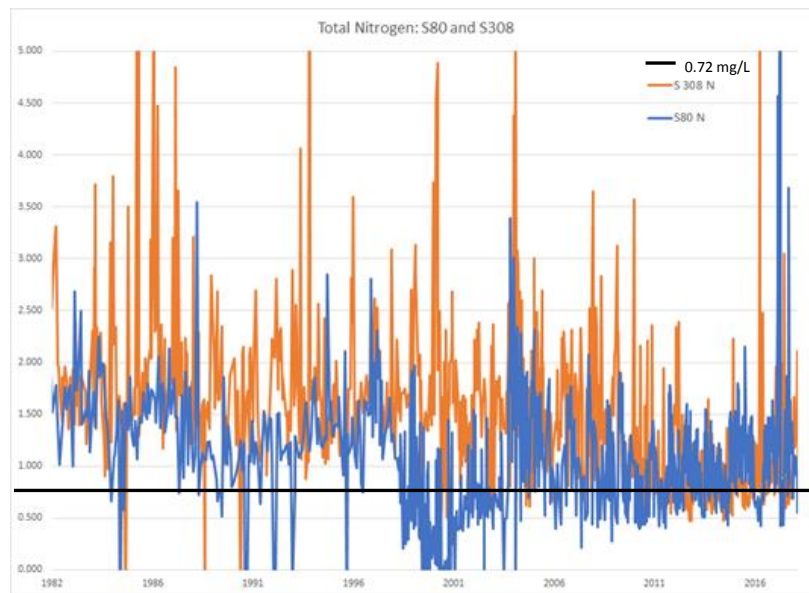
Nitrogen Loads May Need Priority Reductions in Lake Discharges to the Brackish Estuary

Underscoring the state's commitment to greater Everglades ecosystem restoration, the Florida Legislature in 2007 expanded the Lake Okeechobee Protection Act to strengthen protection for the Northern Everglades as the Northern Everglades and Estuaries Protection Program, Section 373.4595, Florida Statutes (NEEPP). NEEPP recognized that the coastal estuaries are "critical water resources of the state."⁶⁰ The state recognized the same problems that plagued ENP, phosphorous, also plagued the critical water resources of the Northern Everglades and estuaries. NEEPP restricted the South Florida Water Management District (SFWMD), the ACOE's local sponsor for the C&SF project, from diverting water to the St. Lucie River "in such a way that the state water quality standards are violated, that the nutrients in such diverted waters adversely affect indigenous vegetation communities or wildlife, or that fresh waters...adversely affect the estuarine vegetation or wildlife" unless an emergency is declared.⁶⁰

The only nutrient the legislature expressly sought to reduce through NEEPP was phosphorous.⁶⁰ The reduction in phosphorous loading was to be achieved through TMDLs, implementation of Basin Management Action Plans (BMAP) and Best Management Practices (BMP) in "coordination with [CERP] project components and other federal programs..."⁶⁰ The State has set the phosphorous TMDL for the Lake pursuant to NEEP, but not for nitrogen, regardless of the discharges to the brackish estuaries.

The following graph depicts the nitrogen levels in mg/L at the S-308 (the intersection of the Lake and the C-44) and the S-80 (the intersection of the C-44 and the River). The horizontal black line

depicts the nitrogen TMDL imposed upon Martin County in its BMAP for the receiving water bodies east of the S-80.



“[W]hen one looks beyond the single system interpretation of nutrient limitation and related eutrophication dynamics to the entire freshwater to marine continuum, it turns that P limitation is only part of the story.”⁵²

“Research during the past decade confirms that N is the chief culprit in eutrophication and other impacts of nutrient over-enrichment in temperate coastal waters, while P is the most problematic in eutrophication of freshwater lakes.”³¹

ENVIRONMENTAL IMPACTS OF LAKE DISCHARGES

Additions of Total Suspended Solids, Nutrients, and Salinity Imbalances

Indian River Lagoon, St. Lucie River and Estuary

Even though the IRL has been designated an “Estuary of National Significance,” and an Outstanding Florida Water, it is also designated as an “impaired water” due to the pollutants, mostly nitrogen and phosphorous, and altered unstable salinity in the Lagoon.⁸²

Freshwater flow into the estuaries and their tributaries increased both in volume and frequency (often to prevent flooding) relative to the pre-drainage era. This caused rapid, often within a few hours, changes in salinity resulting in degradation of the biological integrity of the estuaries. Furthermore, inflow is often too great in the wet season and too little in the dry season to support a healthy estuary. Additionally, flood releases and inland runoff contain numerous contaminants from urban and agricultural

development including excess suspended solids, nutrients, pesticides, and other Emerging Pollutants of Concern such as hormones and pharmaceuticals. This results in poor quality water entering the estuaries.⁸⁴

According to Mark Perry, Director of the Florida Oceanographic Society, the seagrasses in the southern IRL inside the St. Lucie Inlet and outer Estuary have been known to be among the most productive ecosystems in Florida providing vital nurseries and refuge habitat for thousands of aquatic species. In a healthy and balanced ecosystem, these seagrasses stabilize sediments, anchor ecosystems, cycle nutrients and support a significant economy in fisheries and tourism. See Exhibit A-1. Perry has further concluded that the seagrasses in this area have undergone dramatic decline, including the endangered Johnson's seagrass. The most significant factor influencing the seagrass decline is "the releases of large volumes of freshwater from Lake Okeechobee over long durations of time through the St. Lucie Canal into the St. Lucie River Estuary and southern IRL" (Exhibit A-1).

In the 2008 LORS DEIS Study, the ACOE found that "[I] large volumes of freshwater basin and Lake Okeechobee releases have caused SAV to virtually disappear from the St. Lucie Estuary as well as some areas of the IRL South closest to the St. Lucie Estuary."⁸² Below are two photographs that depict the evisceration of seagrasses in the Estuary over a 7 year period of time, exactly the scenario the ACOE and Perry described.



JANUARY 2017



Sailfish Flats, Stuart, FL.

Florida Oceanographic Society

The St. Lucie Estuary and the IRL ecosystems should provide habitat and nursery grounds for a variety of estuarine fish communities. However, species richness in many of the fish communities of the Estuary and Lagoon has decreased since the 1970s. The ACOE noted in the LORS EIS, “[i]chthyoplankton recruitment into the St. Lucie Estuary and Lagoon is diminished due to freshwater regulatory discharges during key times of the year.”⁸²

Southeast Florida Coral Reef Tract

Because coral reefs require unique conditions, coral reefs are not ubiquitous. Their development occurs only in areas with specific environmental characteristics: a solid structure for attachment, water temperatures within a specific range, clear waters low in phosphate and nitrogen nutrients, and moderate wave action to disperse waste and bring oxygen and plankton to the reef.

The biggest and most pervasive threat to the continued existence of coral reefs worldwide is the degradation to the water that surrounds them. Land based sources of pollution find their way through the estuaries, out the inlets, into the marine environment and onto the reefs. To coral, water is air. High volume and/or sustained releases from the Lake have a direct impact on these coral reefs. The photos on pages 13-14 show the flow of water from the Lake to the nearshore Reef Tract.

While there may be some photosynthetic impacts from the darker possibly turbid fresh water lens that floats on the denser salty ocean water, it is, under normal conditions, transitory. However, during elevated, long term Lake releases, the volume and persistence of freshwater moving into

the St. Lucie Inlet State Park Preserve area allows it to mix with ocean water, penetrating deeper into the water column as the duration extends, ultimately making direct contact with the corals. The particulate matter carried in the release water can smother the corals. The increased turbidity reduces photosynthetic activity. The warmer estuarine water also raises water temperatures above the healthy range for corals. The corals expend valuable energy each time they are faced with stress.

Even under the best scenario, the mere influx of fresh water directly threatens the coral animals causing them to use their remaining strength to excrete a mucous layer to (ostensibly) protect it from the freshwater. If higher salinity water does not return, osmotic pressure will cause the coral cells to explode. Even if appropriate salinity returns, the coral may too weak to survive and they are far more susceptible to other stressors that would be non-threatening to a healthy coral. Episodic events throughout the year can likewise cause the corals to expend so much energy mounting a defense, with little time to recover, that mortality results. Decreased salinity also inhibits coral reproduction with broadcast spawning concentrated in the late summer/early fall and brooding occurring year-round.

Water chemistry changes also change the behavior of fish species that use the reef. Spawning aggregations of critically endangered goliath grouper change their behavior during high freshwater discharges moving away from their established spawning grounds increasing stress at a critical life stage. Other expected impacts to fish would include local movements of larger bodied reef fish (snappers, groupers and hogfish) out of their established habitat region to avoid dark, fresher water. Behavior of small bodied reef fish is likely to be changed, as well. With lower light levels and reduced visibility, reef fish are expected to move closer to the bottom/reef. Local reductions of prey due to avoidance of fresher water may also adversely affect reef fish. All of these changes upset the highly developed ecological balance that provides a resilient and productive environment.

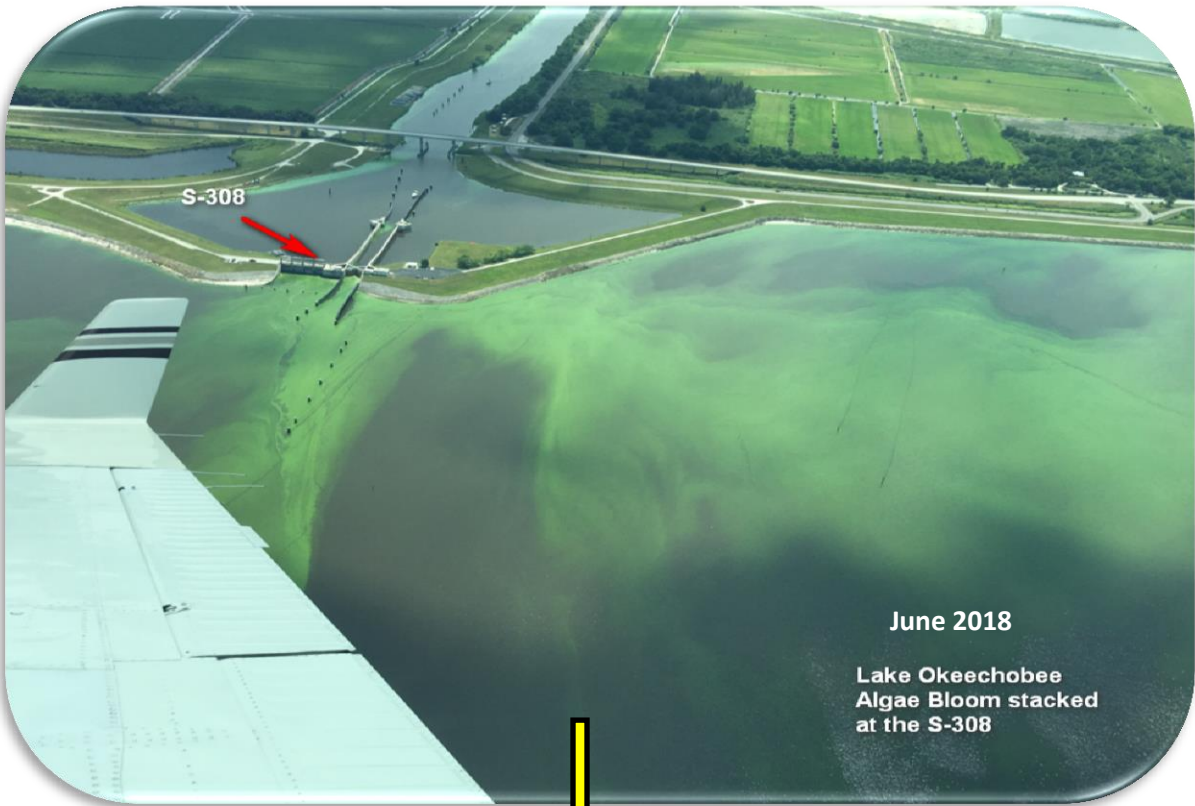
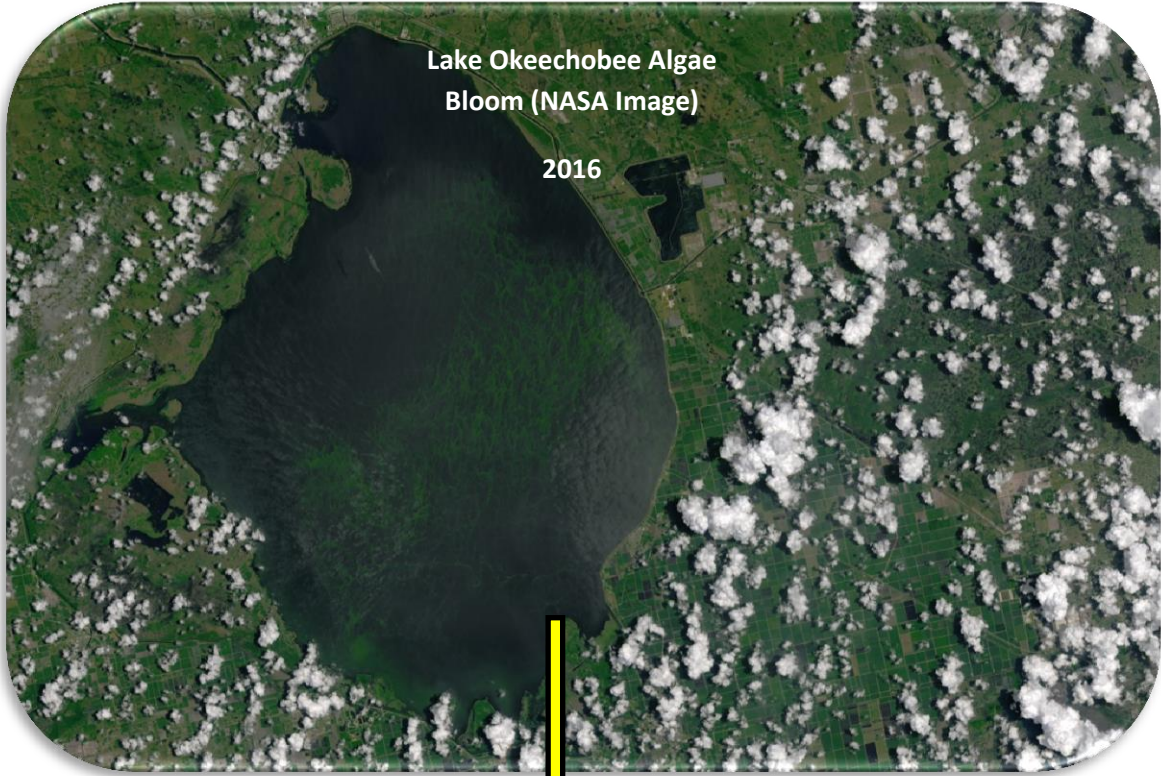
Increases in dissolved inorganic nutrients have been shown to reduce coral calcification rates, reduce fertilization success, and possibly promote the growth of macroalgae that compete for space with corals.²¹

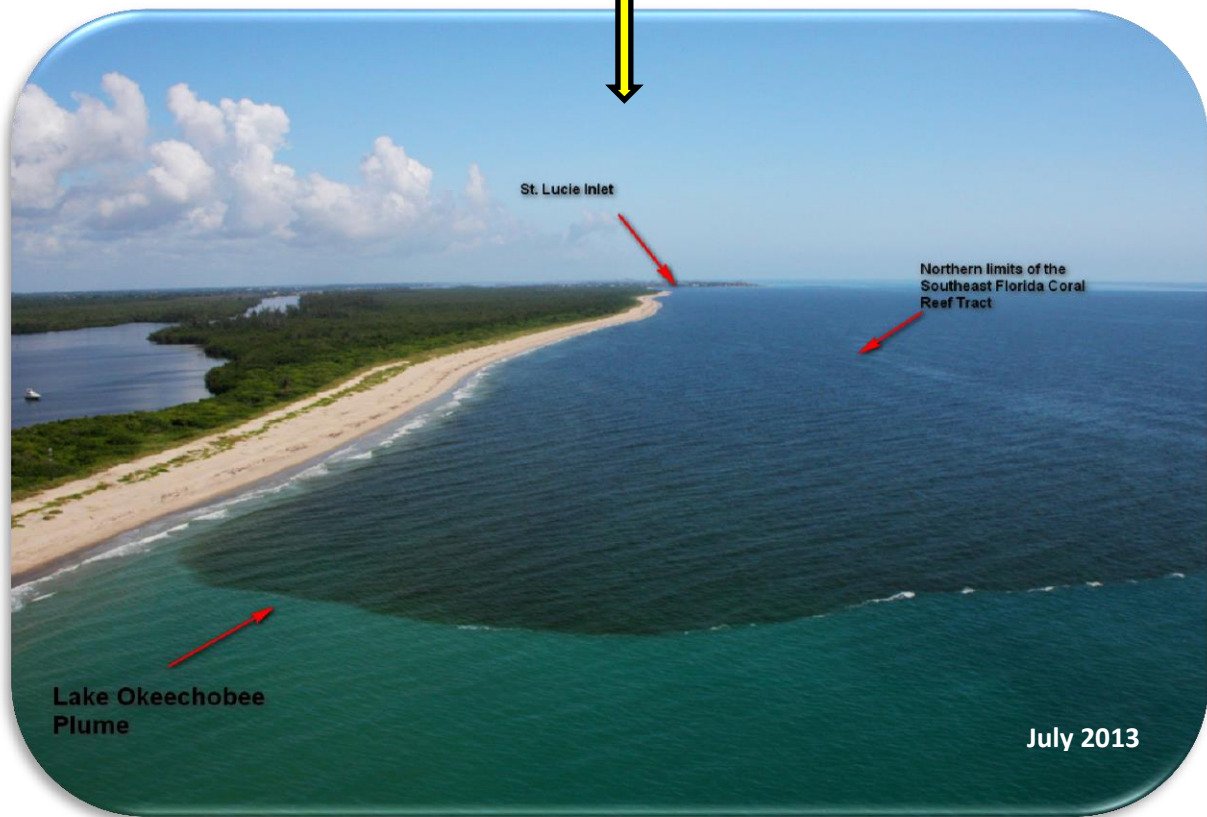
This table shows Lake discharges to the Estuary in acre-feet and duration of days of Lake discharges to the Estuary since 2000 (note: 1 acre foot = 325,850.943 gallons):

Event	Duration (days with flow)	Start	Volume (AF)
1	36	4/20/2000	113,443
2	76	7/16/2002	65,781
3	84	12/12/2002	130,650
4	14	3/31/2003	2,039
5	174	5/3/2003	380,280
6	120	12/15/2003	116,369
7	104	9/9/2004	463,167
8	31	1/26/2005	32,290
9	189	3/14/2005	554,515
10	77	10/29/2005	289,740
11	50	2/16/2006	60,665
12	109	9/5/2008	104,190
13	13	7/28/2009	10,369
14	137	3/27/2010	244,673
15	26	9/3/2010	9,890
16	62	9/20/2012	69,624
17	3	4/15/2013	821
18	150	5/9/2013	418,483
19	66	1/17/2015	73,045
20	25	5/4/2015	30,144
21	261	1/30/2016	673,242
22	111	9/6/2017	585,322
23	103	6/1/2018	265,615
24	30	2/23/2019	24,806

Source: Gary Goforth, P.E., Ph.D, Gary Goforth, LLC, 2019

Below is a composite of aerial photographs depicting the flow from the Lake with algal blooms and turbid water through the C-44, to the Estuary and the near shore Reef Tract. The photograph of the near shore Reef Tract was during the 150 day discharge event in 2013.





Harmful Algal Blooms

Harmful algal blooms (HABs) can occur anytime water quality is impaired due to excessive accumulation of nutrients. The occurrence of HABs is affected by a complex set of physical, chemical, biological, hydrological and meteorological conditions, making it difficult to isolate specific causative environmental factors. However, conditions within the Lake and the River and Estuary have created an environment allowing for HABs to occur on a regular basis, often garnering national attention.

In 2005 both east and west coasts experienced the toxic green algal blooms. In 2013, the Florida Department of Health in Martin County issued advisories to avoid contact with visible algae in the St. Lucie River from the Okeechobee Canal to the St. Lucie Inlet after initial test results detected bloom concentrations of *Microcystis aeruginosa*, a type of blue-green algae also known as Cyanobacteria, that can produce toxins. The summer of 2013 was dubbed the “The Lost Summer” as no one was able to use or be near the water safely.

In 2016, freshwater discharges from the Lake to the Estuary began on January 29 and had virtually turned the Estuary into a freshwater environment by early summer. A 33-square mile algal bloom of *Microcystis aeruginosa* was discovered in the lake on May 9. The bloom could be seen traveling from the Lake to the Estuary along the C-44 canal during the discharges. The presence of algae in the Estuary and the hot summer conditions allowed the algae to form thick mats in certain areas of the Estuary causing concern. On June 29, Governor Rick Scott issued an emergency order to Martin and St. Lucie counties. Martin County posted advisory signs along the river and Estuary advising people to “Avoid Contact with Water in the St. Lucie River.” The summer of 2016 was dubbed “The Toxic Summer.”

In an abundance of caution during the 2016 bloom and to understand the risk to residents and visitors, the County took actions to sample the water and air in the areas of the watershed where the algae was accumulating in thick mats. The air was tested for hydrogen sulfide, species of algae, toxin levels present, and respirable particles (whether algae could be inhaled). Water quality samples were also collected at two sites to detect algae species and toxin levels. The report contained the following conclusions:

- Hydrogen Sulfide - Levels were discernable at levels which may be intolerable for individuals with respiratory conditions and asthmatics.
- Water Toxins – Microcystin levels in the algal water samples present a significant health threat upon direct exposure or ingestion. The water results indicate extremely high levels of Microcystin toxins in the accumulated algae areas, reported at 100-1000 times higher than the World Health Organization of recreational guidance levels of 10 micrograms/liter.
- Airborne Toxins - Microcystin levels in the air were identified, indicating that toxins can become aerosolized when agitated. It should be noted that there are no set standards for

inhalation risk by any federal, state or local regulatory agency. We defer to our public health authorities for inhalation avoidance or inhalation risk concerns.

- Particulates - Measured respirable particle concentrations are within an expected range for an outdoor environment, however, increased particle concentrations measured by water pump discharge associated with algae removal technologies suggest that further study should be performed to determine what impact this may have on human, animal exposure and/or the environment.
- Volatile Organic Compounds- The total volatile organic compounds were not detectable.¹⁹

HABs and Adverse Health Impacts to Humans and Animals.

Studies

Many academic studies are finding that exposure to microtoxins and cyanobacterial toxins lead to various health related problems as noted in the following abstracts:

With the increasing incidence of asthma, there is increasing concern over environmental exposures that may trigger asthma exacerbations. Blooms of the marine microalgae, *Karenia brevis*, cause red tides (or harmful algal blooms) annually throughout the Gulf of Mexico. *K. brevis* produces highly potent natural polyether toxins, called brevetoxins, which are sodium channel blockers, and possibly histamine activators.

The cyanobacterial toxins, nodularin and microcystin, are highly efficient inhibitors of cellular protein phosphatases. Toxicity primarily evolves following ingestion of cyanobacterial material or toxins and results in liver and renal pathology. Ingestion is the main route of exposure in the World Health Organizations current risk assessment of nodularin and microcystins. Nasally applied microcystin appears to have a 10-fold higher availability and toxicity than orally ingested toxins, suggesting that aerosolized toxins could represent a major risk for human populations close to lakes with cyanobacterial blooms.⁸⁶

A more recent study using dolphins, a sentinel species, has indicated HABs composed of cyanobacteria and containing cyanotoxins, such as microcystins, can bioaccumulate when acutely or chronically exposed, leading to neuropathological changes.¹⁵

Specific to Martin County and subsequent to the HAB outbreak of 2018, Ocean Research and Conservation Association, Inc. (ORCA) recently completed a study to determine if microcystin is bioaccumulating in local fish populations. The chart below shows ORCA’s findings analyzing the potential for microcystin bioaccumulation in fish caught in Martin County.

Microcystin in Fish in Martin County

	Fillet	Liver
No Microcystin Detected (n)	21	3
Microcystin Below Detection Limits (n)	15	10
Microcystin Detected	15	37
Microcystin (ng/g)		
Average	7.4	17.2
Range	0.8-39	0.6-149

Average serving size for fish is 240 grams = 1,776 ng

ORCA caught and analyzed the fillet and liver of 51 fish for the toxin microcystin. Microcystin was detected in 15 fillets with an average of 7.4 ng/g (range 0.8 – 39 ng/g) and in 37 livers with an average of 17.2 ng/g (range 0.6 – 149 ng/g). The World Health Organization (WHO) has developed a Tolerable Daily Intake (TDI) exposure level for microcystin that is 40 ng/kg of body weight. Based on an average individual weight of 70 kg the WHO TDI for that individual would be 2800 ng.

Therefore, a local individual consuming a fish fillet (240 grams or 8 ounces) with the average of 7.4 ng/g microcystin would be exposed to 1776 ng which is lower than the WHO recommendation. However, if the individual were to consume a fillet with microcystin at the top end of the range at 39 ng/g they would be exposed to 9400 ng microcystin which is three times the limit of the WHO TDI guidelines.

Nitrogen and Microcystin

Another published study indicates that Nitrogen may contribute to the cyanobacteria blooms as these blooms, including Microcystis, require combined nitrogen for growth and toxin production.⁵³ “The recent dominance and persistence of non-N₂ fixing taxa, some producing N-rich toxins enhanced by N loading, sends a strong signal that management should focus on reducing N as well as P inputs in this system and others with Microcystis or other non-N-fixing taxa (e.g. Lake Okeechobee in Florida, and Lake Taihu in China).”⁵³ Further, symptoms of

eutrophication “can be attributed to N loading.” Such symptoms include “toxin-productin blooms of non-N2 fixing cyanobacteria, most notably...Microcystis.”⁵²

2018 Human Health Impacts in Martin County

Medical Providers within the County also observed patients with similar complaints of respiratory and skin ailments during the same general time frame as the blue green algae (Microcystis) and red tide (brevatoxin) were observed in the waterways and along the County’s coastline. Summaries of three patients’ medical notes are as follows:

Patient 1 is a 50-55 year male with no past medical history. He was seen initially on 6/24/16 after exposure to Blue Green Algae that occurred when swimming at Bathtub Beach. He complained of eyes burning and a cough. By the following week his symptoms had resolved. He was re exposed to blue green algae on 8/22/18 and again presented with a dry cough. He was treated with inhalers and steroids and his condition improved. On 9/29/18 while stationed at Hobe Sound Beach he was exposed to red tide. He developed coughing, wheezing and shortness of breath. He was treated at the Emergency Room at MMHS. He was seen in the office in follow up on 10/4/18 and he was still wheezing. He was treated with nebulized medication and steroids. His condition did not improve until 10/10/18.

Patient 2 is a 26-30 year old male. He was exposed to red tide on 09/29/18 at Hobe sound beach. He developed cough, shortness of breath and chest tightness. He was taken to the ER for treatment. He was seen in the office on 10/4/2018 and was still symptomatic. He was given an inhaler and steroids.

Patient 3 is a 30-35 year old male who was seen on July 27th 2018 after exposure to Blue Green Algae. He presented with a rash on his lower extremity after being at Stuart Beach. He was treated with antibiotic and steroid ointment.³⁷

2018 Domestic Animal Impacts in Martin County

During August and September 2018, 7 canines were reported to have visited veterinary hospitals for similar symptoms of vomiting followed by severe lethargy. All 7 canines had either recently been exposed to the River or other local shoreline and ingested either a dead fish or the water. One of the canines died from the exposure to the water. The other 6 recovered after being treated with plasma infusions, IV fluids and antibiotics, and liver support medications. All of the

canines' laboratory work was identical, but the severity reached different degrees. The canines were noted to have thrombocytopenia, absence of all clotting factors, and severe elevations in the ALT liver enzyme. The autopsy of the dead canine noted the following:

The underlying cause to the acute vomiting and subsequent mortality was not observed through gross examination, but microscopic changes in the liver provide evidence of toxin exposure (blue-green algae toxin, ricin, amanita, sago palm, xylitol, etc.). . . .Although the amount of toxin that [the canine] ingested is unknown, 530ng/ml (ug/kg) were present in the liver and 41,200 ng/ml(ug/kg) were present in the urine. Reports of acute microcystin toxicity in canine patients with similar gross, histopathological, and clinicopathological findings have been documented. **The measured tissue/fluid toxin values and concurrent lesions are supportive of an acute toxicity due to ingestion of blue-green algae (cyanobacteria) toxins.**

(emphasis added).

Fish and Wildlife

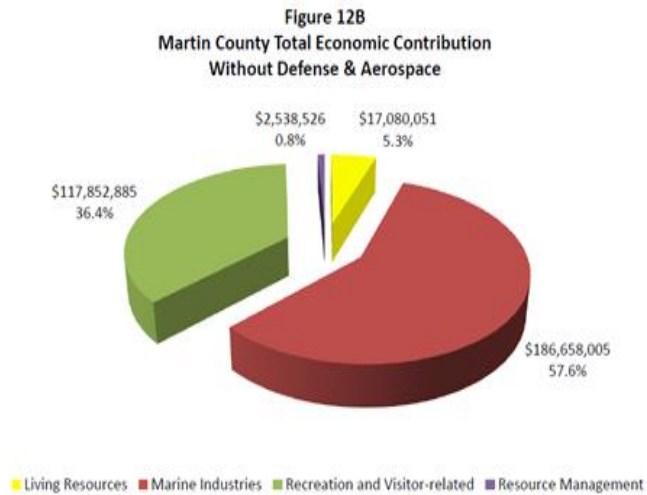
At the time of submission of this scoping document, Martin County does not have data on fish and wildlife impacts or mortality from Lake discharges. However, as the data becomes available, the County will submit supplemental information.

Microcystin Accumulation in Agricultural Crops Irrigated with Contaminated Water

Increased agricultural production to feed a growing population combined with poor water management strategies have led to eutrophication and the presence of harmful algal blooms across the globe. Microcystin-producing algal blooms remain a cause for concern for Florida residents due to toxicity and potential for bioaccumulation. Recent studies have noted microcystin bioaccumulation in crops grown for human consumption, including white mustard seedlings^{32, 43}, salad lettuce¹³, and potatoes⁴³ when irrigated with microcystin-contaminated water.

ECONOMIC IMPACTS FROM LAKE DISCHARGES

As a coastal community with the Lagoon and the St. Lucie Inlet as its centerpieces, many crucial economic drivers for Martin County are water-based businesses including the marine and fishing industries, and tourism. The economic impact of the Lagoon is estimated at \$7.64 billion per year.¹⁷ A figure that is over one-seventh of the region's economy. The Reef Tract attracts over 16 million visitors each year generating over \$6 billion in sales and income and supporting more than 70,000 jobs in the region annually. Coral reefs provide critical habitat for numerous species, including those with special commercial and recreational importance to Florida's economy. Most of Florida's sport fish species and many other marine animals spend significant parts of their lives on or around coral reef ecosystems, as juveniles, in spawning aggregations or full-time residents. Coral reefs also serve as a vital socio-economic engine for South Florida. Millions of tourists and residents enjoy scuba diving, snorkeling and fishing on Florida's coral reefs. These activities constitute a prime income generator for Florida not only from tourism but also from the steady migration of businesses and individuals into the state. As discussed below, thousands of jobs are associated with or dependent upon the coral reefs and the waterways in Martin County and the Treasure Coast.



Boat Builders and Boat Sales

Ten boat builders have chosen Martin County as their manufacturing headquarters because of the accessible waterways. To show the significance of the marine industry to Martin County, of 41 Florida counties having a sizeable economy for boat-related sales, a 2015 study indicates that Martin County had the 6th highest boat sales in terms of aggregated dollar amounts. The following table shows the approximate amount for the top 6 counties for boat sales in 2015 corresponding with each counties' respective population.

2015 Boat Sales by the Top 6 Florida Counties by Aggregated Sales Totals			
County	Sales amount	Population	Per Capita
Broward	\$1,516,358,221.00	1,700,000	\$891.98
Palm Beach	\$530,893,144.00	1,300,000	\$408.38
Miami-Dade	\$365,612,686.00	2,500,000	\$146.25

Pinellas	\$308,153,167.00	920,000	\$334.95
Manatee	\$265,403,350.00	330,000	\$804.25
Martin	\$253,804,214.00	147,000	\$1,726.56
Citrus	\$23,033,301.00	140,000	\$164.52
Santa Rosa	\$14,645,923.00	155,000	\$94.49
Indian River	\$9,398,892.00	139,000	\$67.62
St. Lucie	\$97,387,024.00	280,000	\$347.81

73

The study shows that Palm Beach County’s population is nine times higher than Martin County, but only has just under 3 times the boat sales totals. Manatee County has more than double the population of Martin County, but roughly similar sales totals to Martin.

The bottom portion of the 2015 Boat Sales table shows sales in three population comparable counties. St. Lucie County is included based on its proximity to Martin County. Indian River County is close to Martin geographically and in population, but along with Citrus and Santa Rosa counties, has only a fraction of boat sales totals.

In terms of jobs, according to the 2015 Boat Sales study there are 7,329 people employed in the

Treasure Coast in the boat-sales field. To put that in perspective, the Treasure Coast (Indian River, St. Lucie, and Martin) has a combined population of approximately 566,000; Miami-Dade County’s population is approximately 2.5 million. However, Miami-Dade’s boat-sales related jobs only total 7,900.

The economic contribution specific to the marine industry in Martin County generates \$227 million dollars annually that is supported by 5,000 jobs. The true impact of water degradation on the county’s economic wellbeing may be better represented in Governor Rick Scott’s 2016 “State of Emergency from Lake Okeechobee Discharges and Algal Blooms” which quoted the Indian River Lagoon Economic Valuation update of 2016, stating Martin County had a total output in marine related activities of \$324M which represented 3,290 jobs and \$230 million in income.¹⁷ This analysis did not take into account impacts to real estate values in the region.

Table 12 Martin County Contribution to the Indian River Lagoon Economy Total Output Amount Based on IMPLAN Analysis		
<i>With Defense & Aerospace</i>		
Industry Group	Amount	Percent
Living Resources	\$17,080,051	2.8%
Marine Industries	\$186,658,005	30.6%
Recreation and Visitor-related	\$117,852,885	19.3%
Resource Management	\$2,538,526	0.4%
Defense & Aerospace	\$284,999,281	46.8%
Total	\$609,128,748	100.0%
<i>Without Defense & Aerospace</i>		
Industry Group	Amount	Percent
Living Resources	\$17,080,051	5.3%
Marine Industries	\$186,658,005	57.6%
Recreation and Visitor-related	\$117,852,885	36.4%
Resource Management	\$2,538,526	0.8%
Total	\$324,129,467	100.0%
<i>Adjusted to include estimated total jobs in Accommodations and Food Services within Recreation & Visitor-related industry group</i>		
<i>Total output amount equals all sales associated with that economic activity or jobs classification</i>		

Recreational Fishing

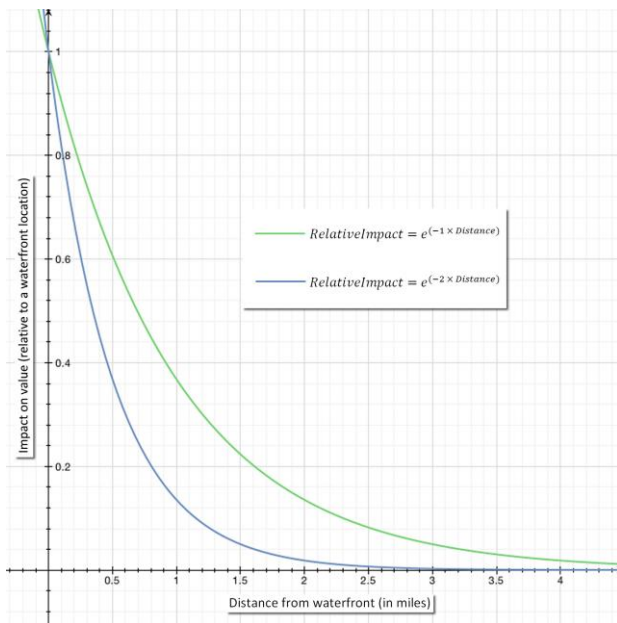
Florida has the highest number of anglers and recreational fishing related jobs in the entire country, with 4,143,120 anglers and 54,784 jobs. Only Texas comes in a close second with 4,092,996 anglers and 46,593 recreational fishing related jobs.⁶⁶

Recreational fishing is also a significant economic driver in Martin County and the surrounding area. A January 2019 study calculated the economic contributions of recreational fishing per congressional districts. The table below depicts recreational fishing economic contributions within Martin County and nearby congressional districts.

District	Anglers	Fishing Related Jobs	Federal Tax Revenue	State and Local Tax Revenue
18 -Mast	106,884	1,641	\$15,970,327	\$10,333,097
21- Frankel	93,066	1,429	\$13,905,564	\$8,997,157
23-Wasserman-Shultz	100,615	1,545	\$15,033,622	\$9,727,032
20-Hastings	76,386	1,173	\$11,413,403	\$7,384,683
8- Posey	117,147	1,799	\$17,503,783	\$11,325,271

66

Real Estate



When the viability of our waterways is threatened, the County's economic engine is weakened and disproportionately results in the failure of small, locally owned businesses. Successive events threaten the county's long term economic resilience causing a domino effect on the financial stability of business owners, employees, vendors, other business that provide services to those business and employees, the area's real estate market and to the state, local and federal tax bases. Waterfront property values alone fell \$488M after the "Lost Summer of 2013". This number ignores the unrealized gains waterfront property values would have otherwise had. It

also excludes non-waterfront property value impacts and potential impacts to the tax base if these properties are devalued. The largest concern in the Florida Realtors assessment was the impact of recurrent events. While a single event might be overlooked by home buyers as an outlier, multiple events in the past lead to an expectation that they will continue into the future and result in reduced desirability properties near the water. Because changes in property value influenced

by declining water quality indicate the perceived value of the water as an amenity, the decline in waterfront value points to a much larger impact to county property values in general, reduced attraction to new businesses and job opportunities, decline of non-water related investments and overall expectation that conditions will remain bad or get worse.²⁶

Tourism

In 2016 the Martin County Tourist Development Council commissioned a study to determine the economic impact of fresh water discharges on the tourism economy in Martin County.

Research shows environmental crises have a longer impact on the tourism sector than political turmoil, terrorism, man-made oil spills or health crisis such as Zika. Even after a destination rebounds to its pre-crisis level, the crisis may hamper the industry for years. Even after the destination has reached its pre-crisis level, visitation and spending may be below where it would be had the crisis not occurred.

In 2016, there was a loss of an estimated \$4.8 million in potential visitor spending. The analysis of data from Martin County and the state of Florida indicates that the

algal blooms resulted in 14,400 lost hotel rooms and a total of \$4.8 million in lost hotel guest spending.

The analysis indicates that over five years, continued bad media coverage could decrease room nights by 84,300 and guest spending by \$29.6 million in comparison to the counterfactual scenario. In the continued bad media scenario losses suffered beyond the counterfactual scenario include:

\$29.6 million in total hotel guest spending

\$38.7 million in total business sales;

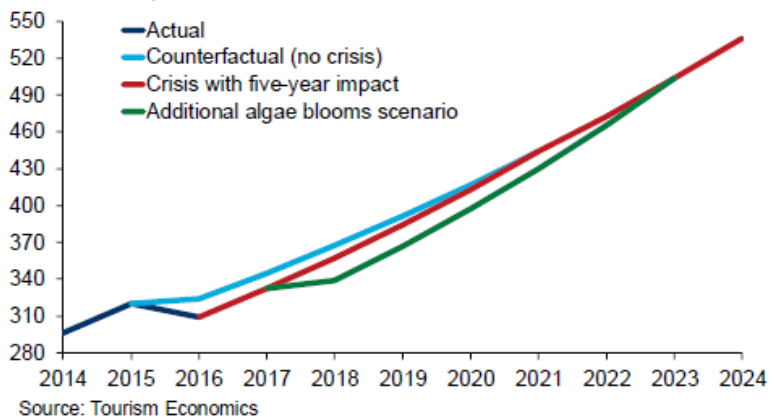
\$10.1 million in lost income; and

2.3 million in state and local taxes.

An economic hit at any time of the year is significant for businesses. Environmental disasters, such as the algal blooms of 2013, 2016 and 2018, would be one such economic hit due to the far-reaching impacts of tourists' avoidance of actual and perceived health and safety impacts.

Potential future impacts of algae blooms

Room demand, 000's



Environmental disasters can result in the most far reaching of any type of crisis because of the protracted recovery time beyond mere cleanup.⁷⁴

This means that tourism impacts from events such as toxic algal blooms or fish kills associated with Lake releases will persist into future years even though water quality may be fully rehabilitated. Cascading water crises in the subsequent years can be expected to have amplified and persistent impacts, further extending the recovery time. It is conceivable that events perceived as occurring on a near regular occurrence, as these blooms seem to be, could have an extremely long-term effect. For example, considering a graduated 5 year recovery rate, the 2016 algae bloom resulted in a \$16.4 million dollar loss in guest spending with the additional impacts seen in 2018 that impact increased to \$26 million dollars in losses. It should be noted that travelers are not precise in their perceptions. News of an environmental disaster translates to an entire region, not to the pinpointed location where the event occurred – visitors believed that Orlando was the #1 area impacted by the 2018 red tide events. This means that calculations of economic impacts from harmful algal blooms have almost assuredly underestimated the total magnitude.

Florida Department of Economic Opportunity Small Business Loans

After the 2018 HAB outbreak that coincided with Lake discharges, the Florida Department of Economic Opportunity launched a small business loan program for those businesses impacted by the water quality problems. 16 Martin County businesses applied for loans due to the indirect consequences of the HABs. The estimated costs of damages ranged from a low of \$10,000.00 to a high damage estimate of \$120,000.00. Of the 16 businesses that applied for loans, 3 had job layoffs as a result of the HABs. The affected businesses included outfitters, real estate, travel and transportation/tourism related, a fish hatchery, and business supplies.⁴⁴

MARTIN COUNTY'S LAND CONSERVATION AND INVESTMENTS IN WATER QUALITY PROJECTS

Martin County has been a partner with, but has not relied on the state or the federal government for complete restoration of water quality. The County has actively addressed water quality for our local basin runoff. Since 2001, the County has constructed over 30 water quality retrofit projects to treat runoff from neighborhoods that predate current water quality regulations. The water quality program that implemented these projects predates both the BMAP and TMDL programs.

The projects provide over 290 acre/feet of treatment which represents 10,300 treated acres for a basin area in excess of 17,900 acres. The annual nutrient load removed by these projects is 1,025 kg/year of TN, 396 kg/year of TP, and 67,121 kg/year of total suspended solids (TSS).

Martin County performed the land acquisition, design, permitting, and construction of these stormwater treatment area (STA) facilities at a cost in excess of \$70 million dollars. The county has a continued commitment to maintain and retrofit these STAs to maximize the benefits of these treatment areas, and invests over \$500,000 of local dollars annually to achieve that goal.

The County also aggressively pursues a natural land conservation program to purchase and preserve natural areas within our community. In 2006, Martin County residents voted to implement a half-cent tax for five years to dedicate revenue for acquisition of land for river restoration, conservation land purchase, and to fund capital projects for water quality improvement and recreation. The tax generated over \$60 million dollars in local funds, which were leveraged with state and federal funds to preserve as much property as possible. Many of the sites that were purchased through this program have been hydrologically restored to allow for natural attenuation of runoff and decrease our footprint on the Estuary. There are nearly 114,000 acres of conservation land within Martin County, which represents over 25% of the total land area. These figures do not include all of the areas preserved for conservation on private lands pursuant to Martin County's Comprehensive Growth Management Plan and land development regulations. These conserved areas also contribute to aquifer recharge, storage and natural area treatment.

REQUESTED CONSIDERATIONS IN LOSOM

Coastal Estuary Water Quality

Coastal estuaries have co-extensively shared in the absorption of adversities from Lake regulation prior to and continuing under LORS, including recent HAB outbreaks. Consistent with Congressional direction under WRDA and the Goals and Objectives in CERP, the County respectfully urges the ACOE to consider, as a priority, the protection of the coastal estuaries in LOSOM. Any discharge above 0 cubic feet per second is unnatural and harmful. The standard can no longer be how much adversity an estuary can absorb before there is an ecological collapse.

Water Quality must be a priority at all times for C&SF Project operations that forcibly discharge chemically distinct water from one basin to another. Specifically, water quality standards for TSS, nitrogen, phosphorus, chlorophyll a, chemical components of pesticides, fungicides and herbicides, must be met as well as assurances that there will be no lowering of the salinity envelopes within the Estuary before Lake discharges can occur.

A challenge for the ACOE in the LOSOM process, as operator of the C&SF Project that discharges water from the freshwater Lake basin into the chemically distinct St. Lucie Estuary basin and marine environment for disposal, is how to achieve acceptable water quality to ensure discharges will not cause or contribute to the perpetual decline of the coastal ecosystem under a no-action alternative or alternative with similar discharge protocols.

The Congressional intent of the Clean Water Act was “to restore and maintain the chemical, physical and biological integrity of the Nation’s waters.” High volumes over sustained time periods of nutrient rich water coupled with low specific conductivity has damaged estuarine habitats within an Outstanding Florida Water in contravention of the State’s anti-degradation policy to which the “highest protection” should be afforded. R. 62-302.700, Fla. Admin. Code.

The Coastal Zone Management Act would require that, LOSOM, a federal action, be reviewed for federal consistency by the State because any future Lake discharges may likely affect water or natural resources of the State. The State would then have to determine whether the Clean Water Act (and surface water criteria and TMDLs) and the anti-degradation policies and implementing rules apply. The County strongly urges the ACOE to closely review these factual and legal issues with its local sponsor for the C&SF Project and the State of Florida.

LOSOM Operational Flexibility

The new management of the C&SF Project under LOSOM must also incorporate the flexibility necessary for a changing climate and the consequences of changing precipitation patterns that cause high volume discharges to the Lake and result in the relatively recent historical need for high volume discharges to the coastal estuaries. Lake management flexibility should also be maintained for CERP projects as they become operational, including but not limited to projects in the Southern end of the system.

The Kissimmee River Inflows and Southern Capacities

The Kissimmee River was modeled as part of LORS. The ACOE has stated in LOSOM information guides and in public scoping meetings that neither water quality improvements, the regulation schedule of the Kissimmee River Chain of Lakes (Kissimmee River), nor the operation of the Water Conservation Area’s (WCA) to the South will be considered in this NEPA process. Instead these parts of the larger C&SF system will only serve as constraints to LOSOM. The County urges the ACOE to re-evaluate these positions. As a hydrologically factual matter, the Kissimmee River has to be part of the equation in LOSOM as it adds approximately 50% inflow, into the Lake on an average annual basis during the previous five years. These annual averages are not as consistent as they were during the design of the C&SF Project.⁶⁴ If the Kissimmee River is excluded from the LOSOM assessment; LOSOM (and the coastal estuaries) will be devoid of a critical component of water management to sufficiently meet the needs of the requirements of Section 601 of WRDA 2000 and WRDA 2018.

As CERP projects become operational in the Southern end of the system, water storage could be increased relieving a need for discharges through the Estuary.

Air Quality

LORS expressly excluded air quality as a parameter. Due to the aerosolization of toxins released from HABs flowing within the Lake discharges, the County similarly urges the ACOE to include air quality as a parameter in the LOSOM assessment.

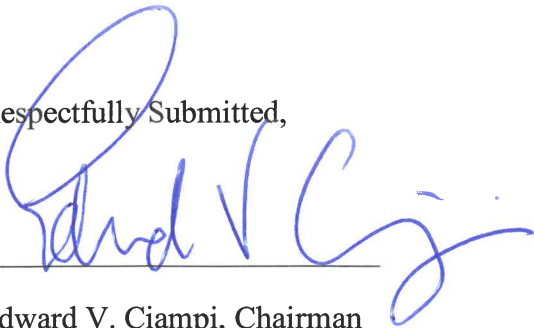
Florida is blessed with some of the nation's finest resources. We are the fishing and boating capital of the United States. Our beaches bring millions of tourists to our state each and every year. The state's unique natural environment is central to our economy, our quality of life, and our identity as Floridians.

Given the persistent water problems we have seen over the past several years, now is the time to be bold.

Governor Ron DeSantis, March 5, 2019, State of the State.

With the foregoing as the framework for Martin County's scoping issues, the following exhibits comprise detailed scoping comments, questions, and cited background information the County believes should be considered and/or studied from a no-action alternative (continuation with LORS), potential alternatives under a new Manual and proposed performance/success measures for a new Manual. On behalf of Martin County, we look forward to working with the ACOE on these very significant LOSOM issues throughout the NEPA process.

Respectfully Submitted,



Edward V. Ciampi, Chairman
Martin County Board of County Commissioners

cc: U.S. Senator Marco Rubio (*hand-delivered with exhibit A only*)
U.S. Senator Rick Scott (*hand-delivered with exhibit A only*)
Congressman Brian Mast (*hand-delivered with exhibit A only*)

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

WATER QUALITY

Water quality is the most formative aspect of what Martin County is focused on during this LOSOM review and the development of alternatives and performance measures. Based on several decades of forced discharges through the S-308 and S-80, the water quality parameters of concern are the salinity envelope, total suspended solids, nutrients and other pollutants of concern. To this end, Martin County strongly urges the Corps to consider the following:

- Quantify measured nutrient and sediment loads from Lake Okeechobee to the St. Lucie Estuary and nearshore Atlantic Ocean during the LOSOM EIS modeling and alternatives process.
- The Northern Estuaries Salinity Envelope Performance Measure calls to reestablish a salinity range most favorable to juvenile marine fish, shellfish, oysters and submerged aquatic vegetation. This range is estimated at 12 to 20 parts per thousand (ppt) as measured at the Roosevelt Bridge over the estuary, and has been chosen as a Valued Ecosystem Component. Discharges from the lake this past winter of 500 cfs after just three weeks caused our salinities to start dipping below 10 ppt. In the LOSOM review the Corps should consider that its operations have failed to achieve this critical salinity envelope by sending discharges to the estuary and tide. The Corps should identify alternatives that prevent this failure as well as alternatives that will allow the estuaries to recover and flourish.
- Consider the impact to water quality if back-pumping is going to be allowed under LOSOM, as that back-pumped water would contribute to nutrient loading as it is forcibly discharged into the St. Lucie canal, river, estuary and nearshore reef.

Water Transfers

To the extent that the Water Transfers Rule may allow forced discharge of water from Lake Okeechobee through the canal, river, estuary and nearshore reef, the Corps should consider the following critical questions and include them in any analysis of lake operations:

- Is it the federal government's contention that Lake Okeechobee and the St. Lucie Estuary are located in the same basin or different basins?
- Is it the federal government's position that when the water is discharged eastward from Lake Okeechobee, the lake water flows through the S-308, then through the C-44 canal, then through the St. Lucie River, then through the St. Lucie Estuary, then out to the Atlantic Ocean through the St. Lucie Inlet?
- If so, is the water discharged eastward from Lake Okeechobee chemically distinct or indistinct from the water in the C-44 canal, St. Lucie River, St. Lucie Estuary, St. Lucie Inlet and the Atlantic Ocean?

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- If the federal government contends that the water discharged from Lake Okeechobee through these bodies of water identified above is chemically indistinct from each of the water bodies identified above, what water quality parameter/chemical/ or ion is the federal government using as a basis for that contention?
- If the federal government contends that the discharged Lake Okeechobee water is chemically indistinct from the water in the St. Lucie Estuary, does that contention rely on the salt concentrations / specific conductivity in the lake as compared to the estuary? If the contention does not rely on salt concentrations or specific conductivity, why not? If salt concentrations and specific conductivity were compared in the lake and the estuary, what would the differences be, if any?
- Are salt concentrations / specific conductance in Lake Okeechobee different than in the St. Lucie Estuary under natural conditions, e.g., no forced discharges from the lake?
- Are there any other ions/chemicals or water quality parameters that are different?
- Will the Corps take Lake Okeechobee TMDL compliance into consideration in its, future management and “discharge oversight” of Lake Okeechobee under LOSOM? If so, will the Corps prohibit discharges of Lake Okeechobee water through the S-308 if the lake water is not meeting the TMDL requirements? If the Corps cannot commit to that prohibition, why not?
- Will the Corps work with the State of Florida to establish a TMDL for TN?
- Under LOSOM, will the Corps or its local sponsor ensure that neither the S308 nor the S80 convey pollutants into receiving waters?

CERP

It is Martin County’s position that LOSOM should be consistent with the goals and objectives of CERP, since CERP was predicated on the restudy of the C&SF system and Lake Okeechobee is the primary component of that system.

- LOSOM must achieve the water quality restoration, protection and habitat protection for the coastal estuaries and the coral reef tract as mandated in CERP’s Goals and Objectives.
- Specifically, LOSOM should ensure that lake discharges into the coastal estuaries, the Indian River Lagoon and the nearshore Atlantic Ocean meet Florida’s goals for Outstanding Florida Waters, Impaired Waters; will not violate Florida’s Anti-Degradation Policies found in Rules 62-4.242, 62-302.300 and 700; and will not cause or contribute to a violation of state water quality standards for “primary pollutants of concern,” all as set forth under CERP.

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

Harmful Algal Blooms (HABs)

Forced lake discharges, under current conditions, are thought to cause or contribute to harmful algal blooms in the river, estuary and nearshore environment. HABs such as *Microcystis* sp. and *Karenia brevis* are becoming a recurring threat to human and animal health, wildlife and aquatic ecosystems and appear to correlate with Lake Okeechobee discharges. Answers to the following are critical in the development of LOSOM:

- Are *Microcystis* sp. producing viable benthic resting cells? Are *Microcystis* sp. cells now present in the sediments of the SLE/IRL and what are the ecological repercussions of this? Could these resting cells inoculate future local blooms without Lake Okeechobee discharges and/or do they represent a persistent benthic source of microcystin toxin?
- How do the growth dynamics of the *Microcystis* sp. populations change when they enter into the SLE/IRL from the Lake Okeechobee discharge canal? Are the *Microcystis* sp. populations merely persisting or actively growing in the SLE/IRL? How long will the populations persist in the SLE? To what extent do the lake discharges contribute to the populations?
- How tolerant is *Microcystis* sp. to salt gradients? What is the effect of salinity on growth rate, cell death/cell lysis and the release of intra-cellular toxin into the water? If cells do lyse upon contact with high salinity water and release toxin, does the toxin have an impact on human and aquatic life in the water column and after becoming aerosolized.
- How does the toxin production/profile of *Microcystis* sp. vary over environmental gradients?
- What are the effects of salinity and nutrient gradients on toxicity of *Microcystis* sp.? Does toxin content per cell increase and/or do the *Microcystis* sp. populations produce microcystin and/or other toxins?
- How are toxins distributed throughout the SLE during and subsequent to forced releases from Lake Okeechobee? What is the spatial variation of toxin concentration within the SLE/IRL? How much toxin from *Microcystis aeruginosa* blooms is free in the water versus bound in cells? What is the time scale for natural degradation of microcystin in SLE waters?
- How are the toxins from *Microcystis aeruginosa* blooms bio-accumulating or propagating into the food chain and humans? Are microcystins detectable in SLE/IRL shellfish and finfish species that are consumed by humans and marine wildlife? If so, how do these toxin concentrations compare to human health action levels or levels expected to cause disease in wildlife? Does the toxin accumulation depend on the exposed organism's trophic level or feeding habits? How are the toxins accumulated by these putative vectors distributed spatially in the SLE/IRL system? If microcystin toxins are in freshwater sources used for irrigation of food crops, can these toxins be taken up into plants and pose a human health threat? What is the concentration of microcystin in human populations that are exposed either recreationally or occupationally to the blooms?

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- What is the genetic diversity of the *Microcystis sp.* populations in SLE/IRL? What is the variability in the 16s ribosomal RNA gene, as a measure of species complex diversity in this environment? Can genomic information provide further information on the predominance of the *Microcystis sp.* species complex and differences in strains compared between Lake Okeechobee source waters and the SLE? The Corps should use sentinel species and human epidemiology studies (and hospitalization data) to define mechanisms and further refine the extent of trophic uptake of HAB toxins in both wildlife and humans exposed to the IRL.
- Determine the life cycle and persistence of cyanobacteria (*Microcystis sp.*) and its toxins in the SLE/IRL as they relate to past and future discharges.

Air Quality

During the HAB outbreak of 2016, which coincided with excessive volumes of forced lake discharges over the course of multiple consecutive months, Martin County confirmed that toxins from the HABs within the water column could become aerosolized. Anecdotally, in 2016 and again in 2018, it has been established that the HABs carrying the toxins or the intense hydrogen sulfide odor occurring with the existence of the HABs created a respiratory health impact, which also resulted in economic damages.

- Under LOSOM the Corps should consider whether the lake is discharging water from one basin into a separate, chemically distinct water basin, whereas the discharged water has the potential to emit aerosolized toxins in the receiving basin.

HEALTH IMPACTS

The Corps should confirm whether lake discharges are causing or contributing to the liver and/or respiratory sicknesses, disorders and/or conditions that have occurred in humans and domestic animals at the same time the blue green algae events occurred in Martin County in 2016 and 2018.

If such causation or contribution (between lake discharges and liver / respiratory maladies) is confirmed or is found to be more likely than no causation or contribution, will the Corps prohibit discharges until the source of the causation or contribution is eliminated to prevent future harm to human and animal health in and around the coastal estuaries?

CLIMATE/EXTENDED METEOROLOGIC FORECASTS

Significant improvement has been made in climate sciences since WSE and LORS2008 were developed. Improved climate/meteorological forecasts have the potential to continually improve the proficiency in satisfying the competing objectives of water management both from a quantitative and qualitative perspective.^{7,9,10,14,18,30,33,41,45,48,75-79,81} LORS2008 is still applying 1990s climate/extended meteorological forecasting science in models. Improved climate based

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

Lake Okeechobee inflows forecasts should be employed in the LOSOM development. The Corps should consider updating the method for making seasonal and multi-seasonal climate-based Lake Okeechobee/inflow forecasts.

The Corps should consider the following:

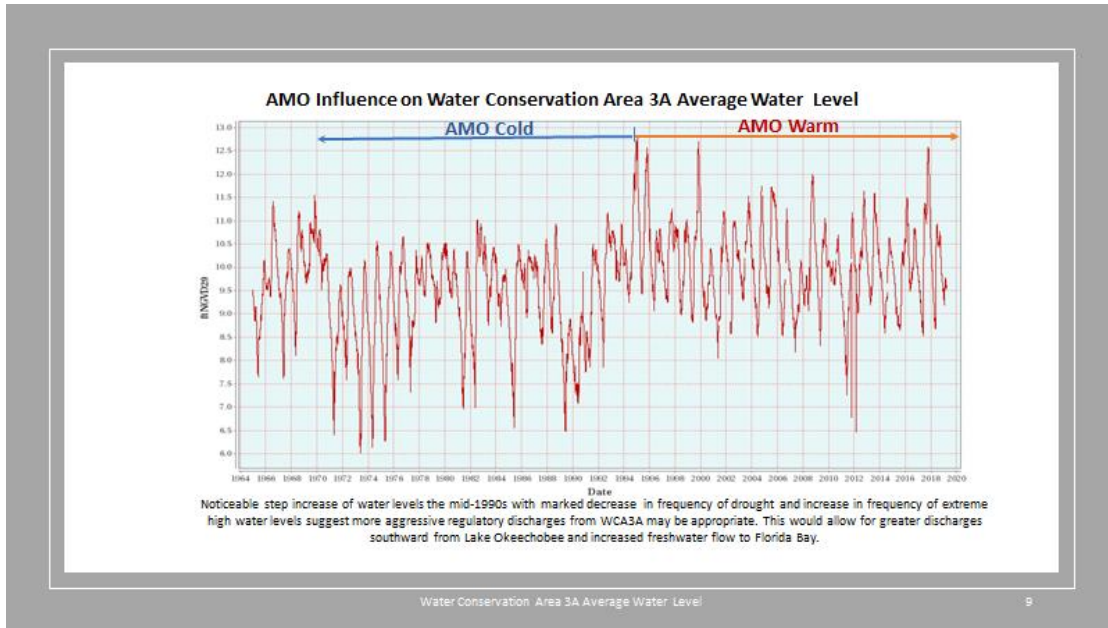
- How climate change is incorporated into projections.
- Ensure that sea level rise is incorporated into models using the latest, most sophisticated projections.
- Current, state-of-the-art weather and climate predictions for rainfall extremes (drought and flood) should be employed in the LOSOM study, and the analysis should adopt and employ improved prediction models as they are developed.
- Extended meteorology/climate-based operations should be applied to improve deliveries to the ENP while also minimizing harmful discharges to the estuaries. This is especially true with the new infrastructure improvements being made and the repair of the HHD.
- While flood protection and human safety are of paramount importance, great effort should be taken to identify operating procedures that also allow for protection of the entire system of affected environments that are tied to lake operation.
- Given that WSE was replaced by LORS2008 on an interim basis until the HHD project is completed, how will this be considered in the future without project alternative definition for LOSOM? While it is understood LOSOM is being fast-tracked in order to realize the benefits of it concurrent with the completion of the HHD, what will happen when the HHD is completed if LOSOM is not finished or is inconclusive? Does the WSE get reinstated automatically?
- It is recommended that climate based rainfall deliveries be made to more proficiently meet the objectives of achieving water management goals. Seasonal climate outlook methodology should be updated and applied to all other regions of water management in South Florida.^{3,6,16,20,29,38-40,42,46,47,51,70,80,85,87}
- The WSE Lake Okeechobee Operational Schedule that was developed in the late 1990s and implemented in July 2000, was originally developed with the application of artificial neural networks and a few climate and solar indices. In this development, the SFWMD reached out to NOAA, NASA and university scientists for peer review on this approach. Mark Craven of the Carnegie Mellon Computer Science Department developed an Artificial Neural Network Rule Extraction Program.¹⁴ Based on this extraction tool and NOAAs AOML recommendations; it was decided to implement median values of analog years based on the phase of ENSO and the Atlantic Thermohaline Ocean Current (now known as the AMO). Development of new LOSOM rules should include the allowance to update inflow forecasts technologies as they advance.
- Advancement of dynamic climate/extended meteorological forecast models since the late 20th Century has been significant. Weekly dynamic forecasts up to a month in advance and monthly and seasonal forecasts up to year in advance are now available from several

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

sources. The weekly and short-term seasonal climate outlooks can be applied to minimize impacts and optimize operations for the benefit of Lake Okeechobee and downstream ecosystems and the health of the STA. Application of extended meteorology forecasts can help water managers better understand short term rainfall variability in terms of shorter term oscillation and variability (e.g. MJO, PNA NAO).^{40,46,47,70,85} The Corps should consider weekly dynamic meteorological forecasts up to a month in advance and monthly and seasonal climate outlooks up to year in advance. The weekly and short-term seasonal climate outlooks can be applied to minimize impacts to Lake Okeechobee and downstream ecosystems and optimize the performance of the STAs and water supply and delivery to the ENP.

- The two phases of the AMO (warm/cold phase) have very different meteorological and hydrologic characteristics. Below normal wet season rainfall is a common occurrence during the AMO cold phase. This leads to an increased frequency of hydrologic drought. On the other hand, during the AMO warm phase, extreme wet events are more likely. Rainfall formulas must adequately capture the differences between the warm and cold phases of the AMO.⁴⁰
- ENSO is more predictable during AMO cold phase. Understanding this is critical to best meeting the competing Goals of Water Management.³⁹
- The change in phase of the AMO on Florida's climate can occur quite abruptly as shown in the graph below. The switch in 1970 brought South Florida into an extended period of shortened hydroperiod and increased frequency of drought and water shortages. In very late 1994, the AMO transitioned back to the warm phase with a signature, very active hurricane season in 1995. It seems possible the AMO may be about to go back to the cold phase. The AMO indices should be monitored very carefully. Like ENSO, there are several ways to compute AMO index. The official index is posted by NOAA at the following site: <https://www.esrl.noaa.gov/psd/data/timeseries/AMO/>. NCAR has another index that is de-trended with global sea surface temperature trends rather than the trend in just the North Atlantic Ocean. This index best represented a break in the Florida wet season average rainfall that occurred in 1970 and 1995.³⁰ Recommend that consideration be given to other ENSO indices. Strength and type of El Nino events should be considered when selecting as analog years for estimating seasonal inflow. Likewise, for PDO and AMO.

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS



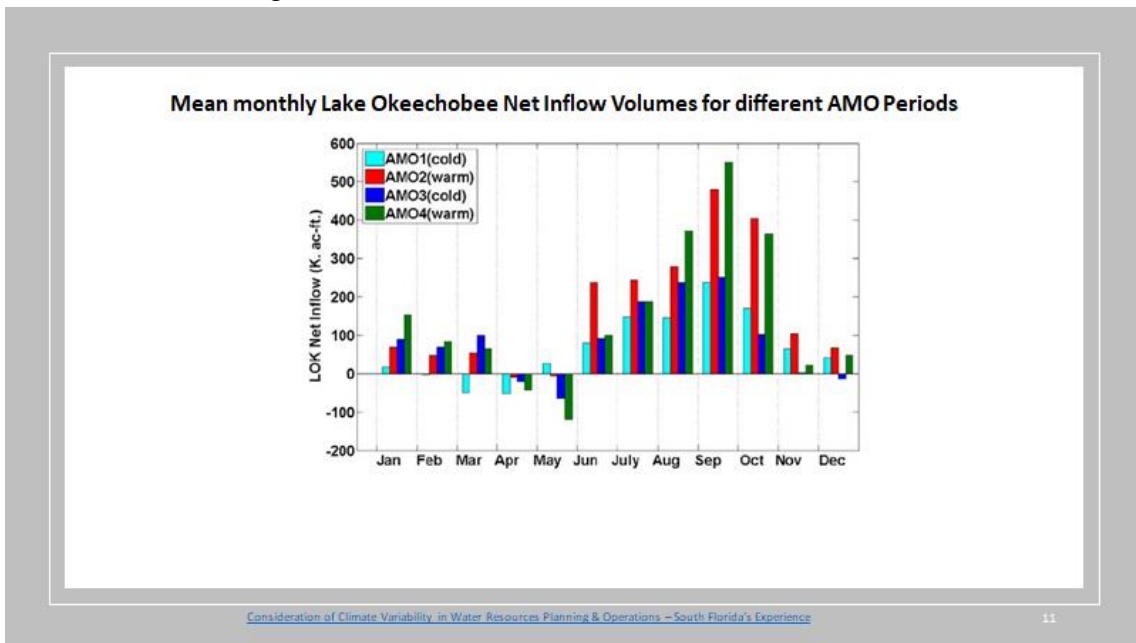
- Various meteorological and climate agencies may emphasize certain indexes because they reflect the aspects of ENSO that impact their country most strongly. South-central Florida climate correlates best with NINO3. Each El Nino/La Nina event has unique properties. NINO3 has the best correlation with the South Florida climate. Moderate to strong El Nino events produce more certain influence on Florida rainfall. Central Pacific El Nino tends to influence Florida rainfall later in the dry season. Strength and type of El Nino events should be considered when selecting as analog years for estimating seasonal inflow. Likewise for PDO and AMO.^{3,51,87}
- Better incorporation of the effects of decadal to multidecadal climate variability must be considered for the entire regional hydrologic system. Climate and pattern recognition sciences have made tremendous advances since the 1990s. It is recommended that this new knowledge be applied to improve operational proficiency for predicting climate variability in South Florida.^{20,29,42,78,79}
- It is recommended that the method for making seasonal and multi-seasonal climate-based Lake Okeechobee/inflow forecasts be updated.
- The major infrastructure improvements that have been made (or will be completed in the near future) to the regional hydrologic system should be analyzed using extended meteorological forecasts and seasonal climate forecasts, increasing the probability that water management objectives are achieved. The regional hydrologic system is an integrated system and should be operated as such. Applying similar extended meteorological/seasonal climate outlooks rules for the entire system would move management towards reaching this goal. The Corps should consider applying extended

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

meteorological forecasts/ seasonal climate outlooks system wide when evaluating the next Schedule.

Climate Forecasting Impacts on Southern Capacity

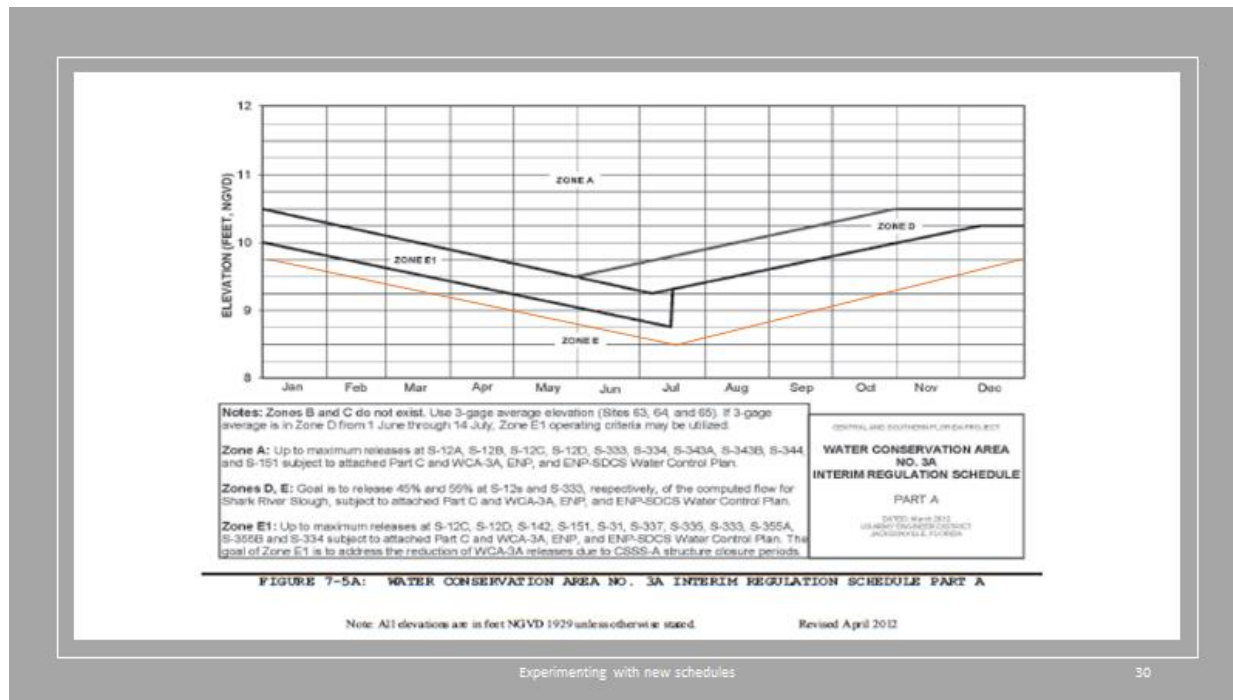
- One of the concerns for sending water south has been the high water levels in WCA3A since 1995. These high water levels have restricted the ability to make regulatory releases south from Lake Okeechobee. These high water levels are associated with the positive phase of the Atlantic Multi-decadal Oscillation (AMO). The figure below illustrates the difference in expected net inflows to Lake Okeechobee and Water Conservation Area 3A during the warm and cold phases of the AMO. [NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami](#) recommended that the AMO, PDO and ENSO should be considered in regional water management operational decisions. However, this recommendation was only applied to Lake Okeechobee, not the entire region. Consideration should be given to the recommendation for these models to be used for the entire region.



- Below is a proposed WCA3A regulation schedule change that would make it possible to send more water south as a matter of regular operations, prior to emergency situations. This operational change would lessen the required discharges through the estuary, especially in response to extreme episodic weather events. Releases in the new zone would only be made based on selected tools such as position analysis, the National Multi-model Ensemble forecast, Lake Okeechobee net inflow outlook and others. This new zone would also allow for regulatory discharges to be made prior to strong El Nino events. This would be important to effectively minimize large spring discharges during these events. This additional zone could be implemented to benefit the multi-objective

EXHIBIT A MARTIN COUNTY SCOPING COMMENTS

purpose of water management. If the ENP cannot take additional water because of the strict phosphorus and nitrogen loading restrictions, sparrow nesting or other ecological concerns, the additional water could be sent to tidewater from the three WCAs. This should be seriously considered in the development of LOSOM.



ESTUARINE AND MARINE ECOSYSTEMS

To effectively address the entire lake-to-ocean continuum and prevent harm to estuarine and marine ecosystems the Corps should consider the following:

- High turbidity and suspended sediment should be kept within ranges that support healthy oysters (interferes with filtration), fish (correlated with disease/lesions) and seagrass.⁸
- The impact of increased nutrient loading as a contributing factor to low dissolved oxygen, algal blooms and impacts to coral reefs should be evaluated as a factor in LOSOM development.
- The Coastal Zone Management Act (1972) (CZMA) encouraged states to implement coastal management programs to give “full consideration to ecological, economic...values. The state is also given the authority by Congress to review certain federal activities that have reasonably foreseeable effects on any land use, water use, or natural resource in its coastal zone”²⁴ to ensure those activities comply with the federally approved Coastal Management Plan. The Florida legislature adopted the State of Florida codified the Florida Coastal Management Plan in 1981 and assumed consistency review responsibilities. Forced discharges from Lake Okeechobee sends water that carries

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

elevated levels of nutrients, suspended solids and freshwater into the marine environment, potentially impacting the coral reef ecosystem and marine fisheries. The LOSOM process must ensure all selected alternatives comply with the Florida Coastal Management Plan.

- Artificially depressed salinity in the estuary causes biochemical reactions in organisms that upset their osmoregulatory capacity, inhibits oyster reproduction and feeding and seagrass growth, and, in worst cases, causes total mortality. These conditions also allow blue green algae to persist in the estuary and inhibit (changes the ecology of) recreational fishing in the estuary.
- Chemical changes to estuarine water caused by forced discharges impact the stability and persistence of oyster populations (middle estuary) and seagrass meadows (southern Indian River Lagoon), and therefore cause impacts to the fishery (nursery) of Atlantic game fish.
- The LOSOM must accelerate progress toward restoration goals: e.g. acres of persistent, live oysters in the middle estuary.
- Lake stage effects on the ecology of the SLE and related variables influence the development and persistence of algae blooms.
- How might the frequency, magnitude and duration of pulsed lake releases affect the ecological character of downstream receiving waters? How might antecedent ecosystem conditions in the estuaries be factored into lake regulation schedule decision making? The potential for lake discharges to impact the occurrence and life span of harmful algal blooms along the South Florida coastline should be quantified and factored into the analysis.
- The most recent and appropriate projections of climate change and sea level rise must be incorporated to identify the tradeoffs between the health of the lake, estuaries, marine environment and Everglades, as well as the provision of flood control and water supply.
- High volume, sustained or repetitive freshwater discharges have been observed to have an impact on (spawning) aggregations, such as goliath grouper, that are documented to occur near inlets in southeast Florida.²³
- High volume, sustained or repetitive freshwater discharges change local movements of larger bodied reef fish such as snappers, groupers and hogfish as they attempt to avoid dark, fresher water that is present in the marine environment a result of releases from Lake Okeechobee. The impact of movements into non-traditional habitat areas is unknown at this time.
- Estuarine salinity, at key locations (e.g. U.S. 1 Bridge), should be model inputs and outputs?
- Climate change is expected to increase the difficulty of controlling HABs in the future, especially if nutrient loads are not reduced.⁵³

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

CORAL REEFS

Coral reefs have not been adequately factored into water management to date. Understanding the fate of estuarine efflux in coastal seas is paramount to correcting this omission. Therefore, the Corps should consider the following:

- The stress to offshore coral reefs (reefs adjacent immediately south of the St. Lucie Inlet) from high turbidity/low light/low salinity/increased temperature related to Lake Okeechobee discharges have not been adequately determined. What are the net flux rates of the major inlets and how will they change in response to altered management strategies? How will these changes impact coral reefs?
- Increases in volumes of estuarine efflux water, including nitrogen, phosphorus, DOC or particulates, transported to coral reefs and the durations that these excessive nutrient rich conditions persist on the reef tract after a lake discharge event and appear to be correlated with changes in coral condition.
- The effect of lake discharges on coral spawning and resilience, seasonality of estuarine effluxes, is compounded by additional coastal coral reef stressors such as thermal stress, disease, upwelling, etc. How do estuarine effluxes driven by lake discharges, including episodic events and chronic discharges, impact coral reef health and ecology? How does the duration of episodic events impact coral reef organisms' health and survivorship? Are there causative or synergistic relationships between estuarine efflux driven by lake discharges and coral or fish disease events.
- “A strict P standard for (Lake) Okeechobee and a P-TMDL was set by the US EPA, but no such limit or standard has been established for N.⁵² Research during the past decade confirms that nitrogen (N) is an important factor in the eutrophication of temperate coastal waters, while phosphorus (P) has been viewed and managed as the driver for eutrophication in freshwater lakes.³¹ LOSOM development should view these waterbodies as a system where both N and P must be managed to minimize impacts of estuarine efflux events, driven by lake discharges, to coral reproduction, recruitment, and survival.
- Secondary impacts on coral reef ecosystems are manifested through responses of mobile reef organisms to estuarine efflux driven by lake discharges. For example, certain fish species appear to demonstrate avoidance behaviors during episodic events. If true, what For a No Action Alternative:
- What is the extent of coral loss in Southeast Florida and what part of these losses can be attributed to factors including sedimentation caused by large volume, repetitive or sustained Lake Okeechobee discharges?
- How are coral reef communities changing as a result of estuarine efflux driven by lake discharges? How long do these changes persist once the putative causative factor is abated? Can we accurately predict and/or promote coral reef resilience or recovery time?

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- How are the resulting losses of coral reefs impacting ecosystem function and ecosystem services in Southeast Florida, including recreational and commercial fisheries?

THREATENED AND ENDANGERED SPECIES

According to Mark Perry, Director of the Florida Oceanographic Society, the seagrasses in the southern IRL within the St. Lucie Inlet and outer estuary have been known to be among the most productive ecosystems in Florida, providing vital nurseries and refuge habitat for thousands of aquatic species. In a healthy and balanced ecosystem, these seagrasses stabilize sediments, cycle nutrients and support a significant economy in fisheries and tourism. See Exhibit A-1. Perry further concluded that the seagrasses in this area have undergone dramatic decline, including the endangered Johnson Seagrass. The most significant factor influencing the seagrass decline is “the releases of large volumes of freshwater from Lake Okeechobee over long durations of time through the St. Lucie Canal into the St. Lucie River Estuary and southern IRL.” Id. See Exhibit A-2 for a full list of currently listed Threatened and Endangered Species in the IRL and connected water bodies.

- Under LOSOM, the Corps should ensure that Lake Okeechobee discharges do not convey additions of pollutants into receiving waters of a separate basin that then impact threatened or endangered species.
- LOSOM should consider impacts to habitats of listed threatened and endangered species within the Indian River Lagoon and St. Lucie Estuary.
- If Corps intends that LOSOM will have operational flexibility, LOSOM should also have the flexibility to consider future listed threatened and endangered species that would likely be impacted by Lake Okeechobee discharges to the coastal estuaries and nearshore coral reefs.

ECONOMICS

Recurring Lake Okeechobee discharges over the course of several decades have caused substantial economic impacts to Martin County. (See copy of Stuart News announcement, 1961, attached Exhibit A-3). However, the more recent outbreaks of HABs in Martin County, corresponding to lake discharges, have intensified the impacts by an order of magnitude and wreaked undeniable damage to the economy. The true economic impacts of lake discharges to a smaller, water-dependent community must be ascertained and factored into the development of LOSOM. The Corps should also consider the following:

- The Florida Realtors documented some impacts to waterfront properties as a result of discharges in 2016 and again in 2018. Understanding that this was not a definitive study, a methodology needs to be developed and an analysis conducted regarding the true impacts to waterfront property values from releases (decrease + unrealized appreciation).

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

Additionally, comprehensive impacts to all property values in a community that has become less desirable or undesirable must be assessed and accounted for.

- Negative economic impacts that result from repetitive algal blooms, fish kills or other negative water quality impacts from lake water releases have been observed, and some studies conducted to quantify the 2016 release. This information should be updated and included in a factor for lake management.
- Impacts from repetitive lake discharges can result in job loss, recreational and commercial fishing decline and other marine related impacts. Quantification and valuation of this condition is needed.
- What data and model will be used to determine the counterfactual (economic condition that would have existed if no lake discharges had occurred) scenario?
- How do you precisely define the “affected area” in an economic sense that represents a comprehensive understanding of the overall impacts.
- A comprehensive understanding of overall impacts must include negative media coverage surrounding an environmental disaster.
- FL Realtors 2015 final report showed that a 1 ft. increase in Secchi disk depth in County waterways (Lox, SLE and IRL) increased MC aggregate property values by approximately \$428M. Appropriate metrics must be used to define both the magnitude and duration of negative impacts.
- Determine types of multi-criteria decision support systems available to help guide LOSOM decision making under conditions of high complexity and high uncertainty.

MODELING

The Corps should consider the following regarding any models, inputs and assumptions used in the modeling for LOSOM:

- The Kissimmee Chain of Lakes is a major contributor to lake levels. The Kissimmee Headwaters Revitalization Project should be incorporated in the LOSOM development and alternatives analysis.
- The Everglades Agricultural Area Reservoir and Stormwater Treatment Area Project present a future alternative for water storage when lake levels require discharges and would present options it increase operational flexibility. Holey Land and Rotenberger Wildlife Management Areas and the Water Conservation Areas should be considered as current storage areas until, at minimum, the EAA Reservoir comes online.
- How is the Combined Operational Plan being incorporated into alternatives?
- Increasing conveyance capacity to the south (North New River, Miami River, etc.) should be considered and evaluated.
- Are disposal wells or Aquifer Storage and Recovery options being considered?

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- LOSOM development should analyze the potential to modify flows south including into Everglades National Park, Biscayne Bay, Florida Bay, Taylor River Slough or Shark River Slough?
- The continued navigability of the Okeechobee Waterway, which the state of Florida has designated as a Strategic Intermodal System, should be considered in LOSOM.
- The cost effectiveness and uncertainty of implementation of storage facilities in the study area (LOWRP, the C-43 Reservoir, the C-44 Reservoir, the C-51 Reservoir, EAA Reservoir, Dispersed Water Management Projects, BMAP and others) should be compared against the economic impacts to the coastal estuaries under a no-action alternative or continued discharges under any alternative that is not required to meet state water quality standards.
- The county supports the continued practice of metering discharges at the S-80.
- The county requests that LOSOM recognize that water quality treatment projects, which withdraw water from the C-44, should not be factors that increase lake discharge volume. During periods when lake discharges are necessary, the prescribed formula for discharge volume should assume that all water withdrawn by water quality treatment facilities (Caulkins Water Farm, C-44, etc.) would eventually return to the C-44 canal. Therefore, any prescribed discharge volume at the S-80 should consider water pumped to reservoirs, stormwater treatment areas and dispersed water facilities as discharged waters.

Shared Adversity

- If the Corps intends to address the application of the shared adversity concept in the LOSOM process, the Corps should weigh the economic impacts and natural resource damages to the coastal estuaries and reef tract from four decades of Lake Okeechobee discharges.
- Non-CERP projects such as dispersed water management should not be factored into
- The selection of the proper, most current and precise screening model(s) is of paramount importance as it will have significant bearing on factors considered in the selection of management options. As a party that will be directly impacted by the final decisions, Martin County should be part of the selection process.
- Likewise, the selection of model(s) that will be used for the detailed analysis of alternatives (LO schedules) will form the basis of alternatives reviewed for the new LOSOM. Therefore Martin County should be part of the model selection process as well.
LOSOM.
- Identify all constraints including conveyance limits, stage limits and endangered species.
- Which models are being used to create outputs? Do models vary by performance measure? If existing models are being used, please describe what changes/updates are being made for LOSOM.

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- Consideration should be given to incorporating rainfall/hydrology over a larger region for estimating the flows to the ENP. Larger flows may be critical for the Everglades to adapt to sea level rise.²
- What is the calibration period of modeling efforts?
- What is the projection period of modeling efforts?
- How is data collected to populate the model (rainfall, ET, flows, water levels, etc.)?

PERFORMANCE MEASURES

It is recommended that the Corps employ multiple performance measures in the St. Lucie Estuary so that a “weight of evidence” approach can be used to evaluate scenarios or alternatives and ensure that levels established as essential for estuarine health are met. These would include a salinity envelope with a range from 12-20 ppt, nitrogen levels of 0.72 mg/L and phosphorous levels of 0.08 mg/L. Using this approach imparts a higher level of confidence to the final result. The Corps should consider the following existing performance measures, as well as the development of new performance measures for LOSOM.

Hydrologic Performance Measures

The Corps should consider not only discharges through the S-80 but also the S-48, S-49 and the Gordy Road structure when calculating inflows for the St. Lucie River and estuary.

- Distribution of total mean monthly inflows.
- Distribution of discharges from Lake Okeechobee.

Salinity Performance Measures

The Corps should consider not only discharges through the S-80 but also the S-48, S-49 and the Gordy Road structure when making salinity calculations for the St. Lucie River and estuary.

- Number of days in or out of a preferred salinity envelope at key locations (e.g. US 1 Bridge).
- Number of days below pertinent thresholds (e.g. 2 psu for oyster mortality) at appropriate location.
- Number of times salinity stays below a threshold for a given amount of time (e.g. Number of times salinity below 2 psu for two weeks or more).
- Additionally, the existing Northern Estuaries Salinity Performance Measure under section 6.2 states: “Salinity monitoring needs to continue, RMA 2 and 4 need to be run and the oysters model described in NE-5 need to be developed and used to fine-tune the salinity envelop.” The Corps should update this performance measure for LOSOM.

Water Quality Performance Measures

EXHIBIT A
MARTIN COUNTY SCOPING COMMENTS

- Estimation of total suspended solid loading from Lake Okeechobee discharges to the St. Lucie River.
- Estimation of nutrient loading from Lake Okeechobee discharges to the St. Lucie River.

Resource-Based Performance Measures

- Along with other information, output from the 2x2 or RSM can be used to drive numeric simulation models of oyster and seagrass populations.⁸
- Given the heightened attention paid to blue green algae (cyanobacterial) blooms, the Corps should develop a performance measure that estimates the likelihood that the lake will serve as a source of cyanobacteria to the St. Lucie. Request that models would output a probability of impact factor to evaluate alternative performance.
- Although CERP acknowledged the need for water management activities to consider the health of the Florida Reef Tract, this has largely been overlooked. Further research is needed to determine thresholds for coral health, and a placeholder for the ultimate performance measure required to allow coral recovery and sustained health should be maintained until this determination is made.

Economic Performance Measures

- Economic performance measures should consider the following indices: marine industries, boat building, commercial and recreational fishing, other water related industries, tourism, bed tax base, ad valorem tax base on real estate values, etc.

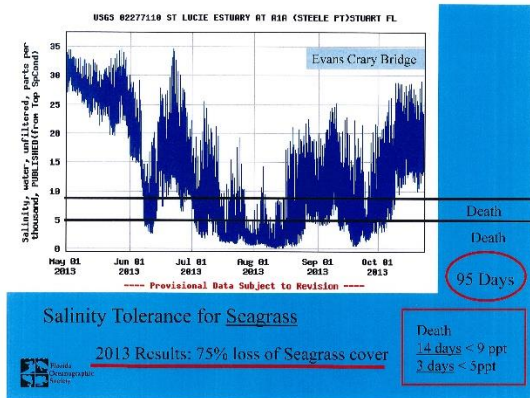
Exhibit A-1

Statement to Martin County

Observations of the loss of seagrass in the Indian River Lagoon and St. Lucie Estuary for inclusion in their Public Scoping Comments on the Lake Okeechobee System Operations Manual

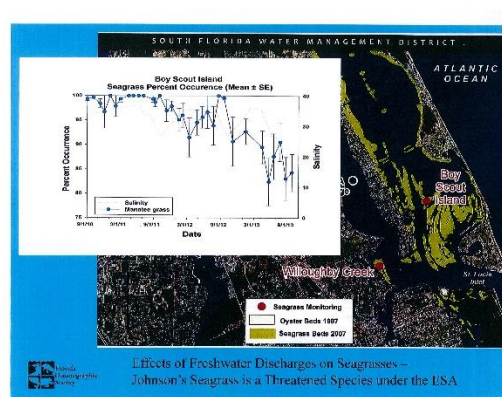
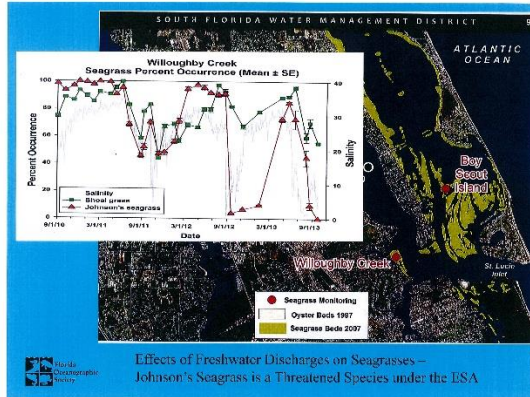
The seagrasses in the southern Indian River Lagoon inside the St. Lucie Inlet and outer St. Lucie Estuary in Martin County are among the most productive ecosystems in Florida providing vital nurseries and refuge habitat for thousands of aquatic species. These seagrasses stabilize sediments, cycle nutrients and support a significant economy in fisheries and tourism. Six species of seagrass have been commonly identified in this region; Shoal Grass (*Halodule wrightii*), Manatee Grass (*Syringodium filiforme*), Turtle Grass (*Thalassia testudinum*), Johnson’s Grass (*Halophila johnsonii*), Star Grass (*Halophila engelmannii*) and Paddle Grass (*Halophila decipiens*). Johnson’s Seagrass is listed in the U.S. Endangered Species Act (ESA) as a Threatened species.

Dramatic declines in seagrasses have occurred in this area over the years with documented loss of seagrass habitat caused mainly by anthropogenic impacts. The most significant of these influences are the releases of large volumes of freshwater from Lake Okeechobee over long durations of time through the St. Lucie Canal into the St. Lucie River Estuary and southern Indian River Lagoon. These discharges flow throughout the estuary and into the Atlantic Ocean through the St. Lucie Inlet turning the entire estuary to freshwater and lowering salinities in the outer estuary below the threshold for seagrass survival. This has happened several times in recent years with a dramatic example in 2013 of an estimated 75% loss of seagrass cover. Aerial imagery of this area shows the dramatic loss of seagrass cover comparing 2010 to 2017 and the estimated decline in seagrass cover is apparent from 1970 with 405 acres to 2016 with 218 acres;



Two sites monitored by the South Florida Water Management District (SFWMD) also show dramatic declines in seagrass percent occurrence in response to low salinities caused by freshwater discharges from Lake Okeechobee. Specifically, as an example, Johnson’s Seagrass dropped from 80% plus occurrence to 0% occurrence in 2012 and 2013;

Exhibit A-1



Areas around the St. Lucie Inlet were Designated Critical Habitat for Johnson's Seagrass by the National Oceanic and Atmospheric Administration (NOAA) on May 5, 2000. Under section 7 of the ESA, all federal agencies must ensure that any actions they authorize, fund, or carry out do not jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat.

As the U.S. Army Corps of Engineers (USACE) and the SFWMD undertake the modification of the Lake Okechobee Regulation Schedule to the new Lake Okechobee Systems Operating Manual they should discontinue all freshwater releases to the St. Lucie Estuary and southern Indian River Lagoon in Martin County as these discharges are severely impacting critical seagrass habitat.

Mark Perry
 Executive Director
 Florida Oceanographic Society
 April 12, 2019

Exhibit A-2

References

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Exhibit A- 3

LIST OF ACRONYMS

ac-ft	Acre-Feet
AMO	Atlantic Multi-decadal Oscillation
AOML	Atlantic Oceanographic and Meteorological Laboratory
BMAP	Basin Management Action Plan
C&SF	Central and Southern Florida
Canal	C-44 Canal
CERP	Comprehensive Everglades Restoration Plan
Corps	United States Corps of Engineers
CZMA	Coastal Zone Management Act
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EAA	Everglades Agricultural Area
EIS	Environmental Impact Statement
ENP	Everglades National Park
ENSO	El Nino/Southern Oscillation
EPA	Environmental Protection Agency
Estuary	St Lucie Estuary
ET	Evapotranspiration
FDEP	Florida Department of Environmental Protection
HAB	Harmful Algal Bloom
HHD	Herbert Hoover Dike
IRL	Indian River Lagoon
Lake	Lake Okeechobee
LORS or LORS 2008	Lake Okeechobee Regulation Schedule 2008
LOSOM	Lake Okeechobee Operating Manual
LOWRP	Lake Okeechobee Watershed Restoration Project
Martin County	Martin County Board of County Commissioners
Mg/L	Milligrams per Liter

Exhibit A- 3

MJO	Madden-Julian Oscillation
NAO	North Atlantic Oscillation
NASA	National Aeronautical and Science Administration
NCAR	National Center for Atmospheric Research
NEEPP	Northern Everglades and Estuaries Protection Program
NEP	National Estuary Program
NEPA	National Environmental Policy Act
ng/ml	Nanograms per Liter
NGVD or NGVD29	National Geodetic Vertical Datum
NINO3 Index	El Nino Southern Oscillation Climate Indicator
NOAA	National Oceanic Atmospheric
ppb	Parts Per Billion
PDO	Pacific Decadal Oscillation
PNA	Pacific/North American Teleconnection Pattern
SFRTCA	Southeast Florida Reef Ecosystem Conservation Area
SFWMD	South Florida Water Management District
SLE	St Lucie Estuary
STA	Stormwater Treatment Area
t	Metric Tons
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
ug/kg	Micrograms per Kilogram
USACE	U.S. Army Corps of Engineers
WCA	Water Conservation Area
WRDA	Water Resource Development Act
WSE	Water Supply and Environment
WY	Water Year

Exhibit A-3
Special Status Species of the Indian River Lagoon and St. Lucie River and Estuary

Key to Listing Status	
E	Endangered: According to the Endangered Species Act of 1973, any species which is in danger of extinction throughout all or a significant portion of its range.
T	Threatened: According to the Endangered Species Act of 1973, any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
T1	Threatened due to similarity of appearance
CE	Commercially Exploited
SSC	Florida State Species of Special Concern

Note: These species are listed by the Florida Fish & Wildlife Conservation Commission under one or more of the following criteria:

- 1: Species has a significant vulnerability to habitat modification, environmental alteration, human disturbance, or human exploitation which, in the foreseeable future, may result in its becoming a threatened species unless appropriate protective or management techniques are initiated or maintained.
- 2: Species may already meet certain criteria for designation as a threatened species, but for which conclusive data are limited or lacking.
- 3: Species may occupy such an unusually vital or essential ecological niche that, should it decline significantly in numbers or distribution, other species would be adversely affected to a significant degree.
- 4: Species has not sufficiently recovered from past population depletion.
- 5: Species occurs as a population either intentionally introduced or being experimentally managed to attain specific objectives, and the species of special concern prohibitions in Rule 68A-27.002, F.A.C., shall not apply to species so designated, provided that the intentional killing, attempting to kill, possession or sale of such species is prohibited.

Species Name	Common Name	Florida Status	Federal Status
Plants			
<i>Halophila johnsonii</i>	Johnson's Seagrass	---	T
Fishes			
<i>Pristis pectinata</i>	Smalltooth Sawfish	E	E
<i>Rivulus marmoratus</i>	Mangrove Rivulus	SSC 1	---
Reptiles			
<i>Caretta caretta</i>	Loggerhead Sea Turtle	T	T
<i>Chelonia mydas</i>	Green Sea Turtle	E	E
<i>Dermochelys coriacea</i>	Leatherback Sea Turtle	E	E
Birds			
<i>Aramus guarauna</i>	Limpkin	SSC 1	---
<i>Charadrius melodus</i>	Piping Plover	T	T
<i>Egretta caerulea</i>	Little Blue Heron	SSC 1, 4	---
<i>Egretta thula</i>	Snowy Egret	SSC 1	---
<i>Egretta tricolor</i>	Tricolored Heron	SSC 1, 4	---
<i>Eudocimus albus</i>	White Ibis	SSC 2	---
<i>Grus Canadensis pratensis</i>	Florida Sandhill Crane	T	---
<i>Haematopus palliatus</i>	American Oystercatcher	SSC 1, 2	---
<i>Mycteria americana</i>	Wood Stork	E	E
<i>Pelcanus occidentalis</i>	Brown Pelican	SSC 1	---
<i>Platalea ajaja</i>	Roseate Spoonbill	SSC 1, 4	---
<i>Rynchops niger</i>	Black Skimmer	SSC 1	---
<i>Sterna antillarum</i>	Least Tern	T	---
Mammals			
<i>Peromyscus polinotus niveiventris</i>	Southeastern Beach Mouse	T	T
<i>Trichechus manatus latirostris</i>	Florida Manatee	E	E
Corals			
<i>Orbicella faveolata</i>	Mountainous Star Coral	---	T

Data obtained from Smithsonian Marine Station Fort Pierce and Florida Fish and Wildlife Conservation Commission

The Battle for Clean Rivers Continues AND YOUR HELP IS NEEDED TO WIN IT!

★ ★ ★ ★ ★ ★ ★ ★ ★ ★
SUBSCRIBE
 TO THE →
RIVERS LEAGUE
 FOR 1961

PLEASE CLIP THIS OUT—MAIL IT IN

Mr. George W. Keith,
 Membership Chairman,
 S.L.I.R. Restoration League,
 P. O. Box 206,
 Stuart, Florida:

I subscribe to the objectives of the St. Lucie-Indian River Restoration League and want to help to protect the rivers from siltation. Enclosed find my subscription of \$_____ as membership for 1961:

Name: _____

Mailing Address: _____

Note: Your subscription can be any amount you choose, from \$1 up. Many subscribe for all members of their families. Membership cards will be mailed promptly.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★
ATTEND THE ANNUAL
ELECTION MEETING
8 P. M., FRIDAY, APRIL 14
AT MARTIN COUNTY COURTHOUSE
 ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Martin County Is Gaining Ground and Making Progress!

While the Taxpayers Suit Against the FCD has not yet been decided, our complaints are now being recognized and Funds have been Al-
 loted by Congress for a Comprehensive Survey of our Problems by
 the U. S. Corps of Engineers.

Annual Report St. Lucie-Indian Rivers Restoration League:

The League has continued its efforts during the past two years to correct practices damaging to our natural resources.

Procedures were initiated last summer to force corrective action against pollution and siltation from excessive drainage discharges into the St. Lucie River.

Suit for injunction against direct ad valorem tax levies by the Flood Control District received preliminary hearings before Judge D. C. Smith of Martin County Circuit Court in November. Counsel for the F.C.D., as defendant, argued for dismissal on grounds that F.C.D. procedures are in accordance with provisions of the special act of the 1949 Legislature which established the Flood Control District. Our attorneys, Walsh, Simmonite, Budd & Walsh, Miami, argued that the special act is unconstitutional in that it violates a provision of the State Constitution, adopted in 1940, that specifically prohibits the levy of any ad valorem taxes "for state purposes."

Although additional briefs requested by the Court from counsel for both parties were submitted in early January, the Court has not yet taken any further action or set a date for further hearings, presumably because of the present crowded calendar. (The Chillingworth murder case, for example, fully occupied Judge Smith in recent weeks.)

There are encouraging indications that the filing of the suit has already had a very salutary effect. A most significant indication is the initiation in recent months of a comprehensive survey of Martin County's problems by the Corps of Engineers, which held a public hearing at Stuart on December 13, 1960. During recent months, the F.C.D. has displayed a notably cooperative attitude toward Martin County interests and has this year included in its U. S. Con-

gressional budget requests a recommendation for a \$35,000.00 special appropriation to cover the cost of completing the survey study. Added to a prior appropriation of \$25,000.00, this will create a \$60,000.00 fund to finance a comprehensive study.

These and other "straws in the wind" encourage us to believe that the F.C.D. and the Corps of Engineers are at long last disposed to give our complaints the serious consideration that they deserve. The Court procedures which we have taken now appear largely responsible for getting preliminary steps started toward corrective action. We are determined to pursue this litigation, with appeals if necessary or in defense of appeals by the F.C.D. The continued support of all interests concerned is needed to assure eventual success.

The League was chartered as a non-profit corporation on October 20, 1960.

Through League efforts, in connection with Martin County Water Conservation Committee, the Izaak Walton League and the U. S. Fish & Wildlife Service, the third outlet from Lake Okeechobee is now receiving official acceptance as a future solution.

The Caloosahatchee River, the West Coast outlet from Lake Okeechobee into the Gulf of Mexico, is having its discharge capacity increased to about 10,000 cubic feet a second, with \$41,000,000 approved for the project, which should provide some measure of relief to the St. Lucie discharge, when that work is completed.

On the negative side, we have been unable to prevent the enlargement of C-24 and C-23 canals, which will cause increased fresh water flow from a greatly expanded North Fork discharge area. We are advised, however, that

control works on these canals are better designed to retard silt than on St. Lucie Canal.

We are continuing our efforts to establish a permanent control block in C-24 Canal to prevent additional C-25 and St. Johns River Basin flood waters from being diverted into the St. Lucie River Basin.

The League commended Mrs. Ronnie Hill for raising \$318.00 for the cause at the recent Martin County Fair.

The League is deeply indebted to the Jupiter Island Club, Martin County Taxpayers Association, Water Conservation Committee of Martin County, local service clubs, Stuart Chamber of Commerce, Jensen Beach Chamber of Commerce, the Izaak Walton League, Martin County Audubon Society, and National Wildlife Federation for support by group and individual actions.

Our Congressional delegation, particularly Senator Spessard L. Holland, is at last seeing the seriousness of our plight and has been constructively helpful in arranging the Engineer Corps survey of our situation.

A recent accomplishment sponsored by the League is a pledge by Representative W. R. Scott that he will introduce legislation to prevent the sale of publicly owned recreation waterfrontage, except if approved by public referendum.

On all fronts we will continue to fight to clear up our rivers and stop their pollution, supporting all measures for genuine conservation, including the growing problem of beach erosion.

Your continued membership and financial support are vital to the League's success.

ROBERT T. BAIR, President

We Heartily Support and Endorse the Recommendations of

MARTIN COUNTY WATER CONSERVATION COMMITTEE

in the *Study and Report which it prepared at the request of
 MARTIN COUNTY BOARD OF COMMISSIONERS ON

DAMAGES TO COASTAL COMMUNITIES

FROM

CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL OPERATIONS

Below is a Summary of this 10,000 word report, which has been mailed in its entirety at the direction of Martin County Commission to Governor Farris Bryant, the chairman of the Flood Control District, our South Florida Congressional contingent, the Corps of Engineers and others in position to help solve our water problems.

"At the request of the Public Works Committee of the U. S. Senate the U. S. Corps of Engineers is now reviewing the Central and Southern Florida Flood Control program to determine the feasibility of modifications to improve adverse conditions in Martin County which were largely omitted from original planning as outlined in the report on Central and Southern Florida published in House Document 643, (80th U. S. Congress, 2nd Session), although Martin is one of the seventeen counties taxed for support of the program.

"Involved are two principal problems: (1) effective water control within the county's inland area (fully covered in a separate report dated Dec. 7 1960, and (2) Relief from damages to coastal communities in the St. Lucie River Estuary, which is the subject of the present report.

"The Corps and FCD acknowledge the damages as consequential to the District's Flood Control operations, but their previous attitude has been that "this is an unfortunate case where some people are damaged unavoidably in order to achieve a broader public benefit."

"The St. Lucie River Estuary in Martin County with a natural tributary watershed of 750 square miles is now being forced to take the artificially diverted seaward drainage from 6,000 square miles of watershed areas in the St. Johns, Kissimmee River and Lake Okeechobee Basins which are naturally tributary to other seaward outlets. This eight-fold overload of silt laden discharges has been progressively increasing and reached an all time high in 1959 and 1960. These discharges pollute Martin County's naturally clear tide waters, deposit widespread mud flats

and shoals, restrict boating navigation, destroy marine life, and seriously injure recreational facilities which are the mainstay of the county's tourist industry," with cumulative damages of millions of dollars to coastal communities.

Martin County interests contend: (1) That a major portion of the seaward discharges is wasteful of fresh water for which there is a steadily increasing need in many inland areas to meet growing dry season usage requirements.

"(2) That protection and improvement of natural storage in headwater lakes and marshlands of the Kissimmee and St. Johns River Basins specifically recommended in House Document 643 are primary requisites to realization of the declared basic purposes of the over-all Project, especially in relation to the effective, and safe, control of Lake Okeechobee, and in relation to protection against recurrent flood and drought damages to rapidly expanding agricultural and urban activities in the Upper Kissimmee and Upper St. Johns River Basins; and

"(3) That the present practice of assigning preferential priority to expedient enlargement of local drainage facilities which increase seaward discharges, while deferring facilities for upstream storage that would decrease seaward discharges, is inconsistent with the specific priority recommendations of House Document 643, largely inconsistent with the declared basic purposes of the over-all Project as initially planned and as authorized by the U. S. Congress, and inconsistent with the long range interests of the nation, the state and the district as a whole in conservation and profitable use of fresh water, inland and marine wild life, recreational, and other natu-

ral resources of the District.

The broad scope of the combined powers of discretionary executive and taxing decisions vested in the politically appointed FCD governing board, set aside from the established normal framework of representative government, and without provision for authoritative review by any elective representative of the citizenry at interest, has no parallel in Florida State Government. It is submitted that the present set-up affords license for autocratic discretionary decisions, and opportunity for successful maneuvering by politically influential interest groups to obtain preferential allocations of public funds, that are totally inconsistent with the concept of "checks and balances" in government, which all experience has demonstrated to be essential to safe guarding the general public interest.

"Martin County interests recommend: that the policies and administrative procedures which control the scheduling of construction priorities, be reviewed in the light of present day knowledge and experience, and be revised to correct the now prevailing over-emphasis on locally expedient projects for accelerating seaward drainage, to the neglect of conservation control measures in the headwater areas of the Kissimmee and St. Johns River Basins which are recommended in House Document 643, and which are a primary essential to improving the conservation, control, efficient use and profitable exploitation of water and related natural resources of both inland and tide-water areas, and essential to the timely realization of the declared basic purposes of the region wide Project as set forth in House Document 643."

*This study and report was compiled by Martin County Water Conservation Committee, at the request of Martin County Commission, to provide a factual analysis and recommendations while the current authorized Engineer Corps survey is going on. If you desire a copy of the full report, write to Capt. Bruce C. Leighton, Box 361, Stuart.

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 Our Rivers Clean!*

St. Lucie-Indian Rivers Restoration League

NOTE: This Advertisement Is Not Paid For By The League, But Is Contributed As A Public Service By A Martin County Taxpayer And Conservationist

NASA Photo of Lake O - Pic of Day 070616



3 miles north of St Lucie inlet looking offshore_SLC_DOH



BGA on Bathtub Beach _06282016



06/28/2016

BGA on Bathtub Beach_06242016



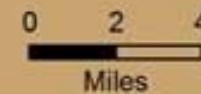
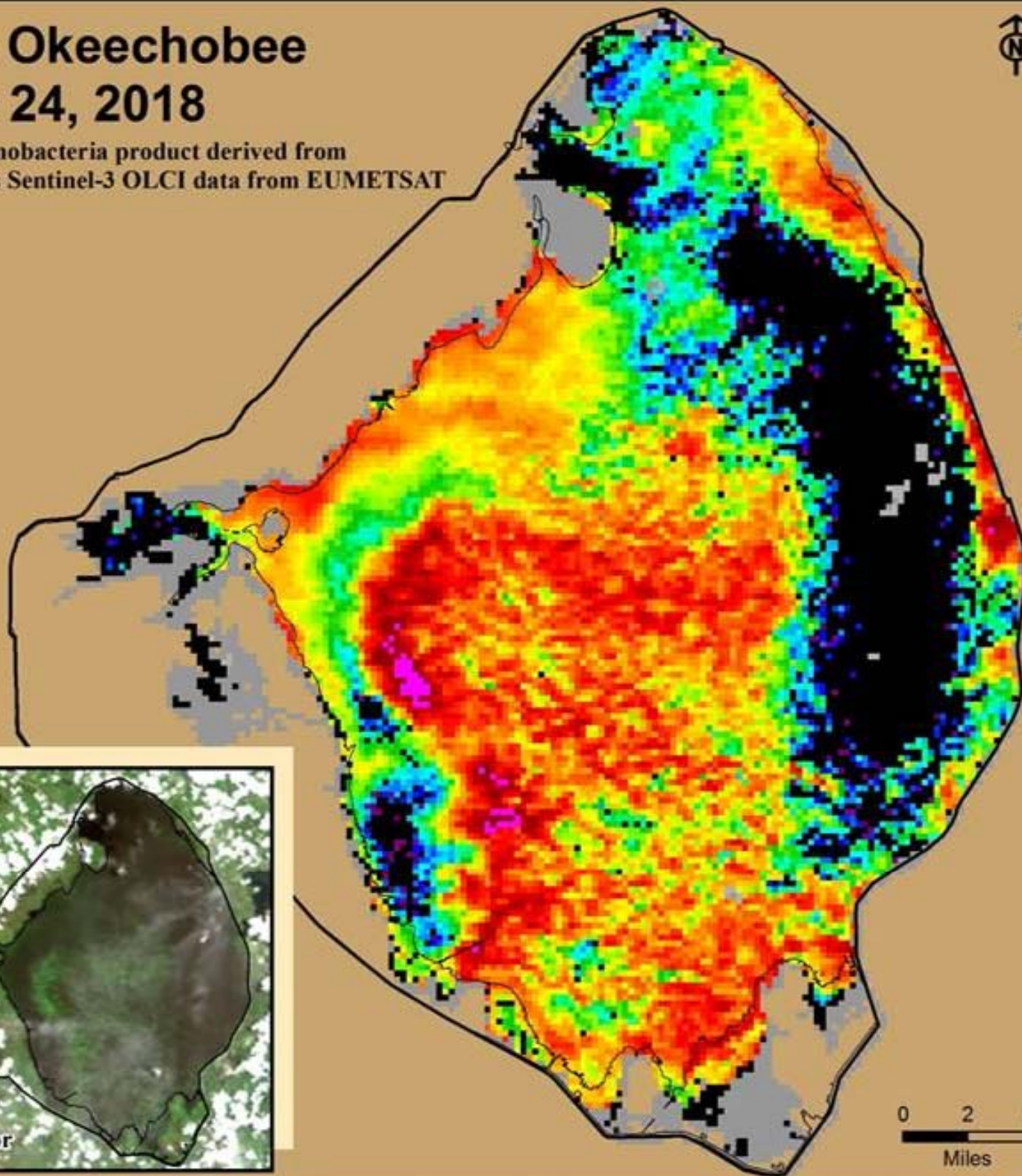
Turbidity in St Lucie River near Sailors Return 6-13-18

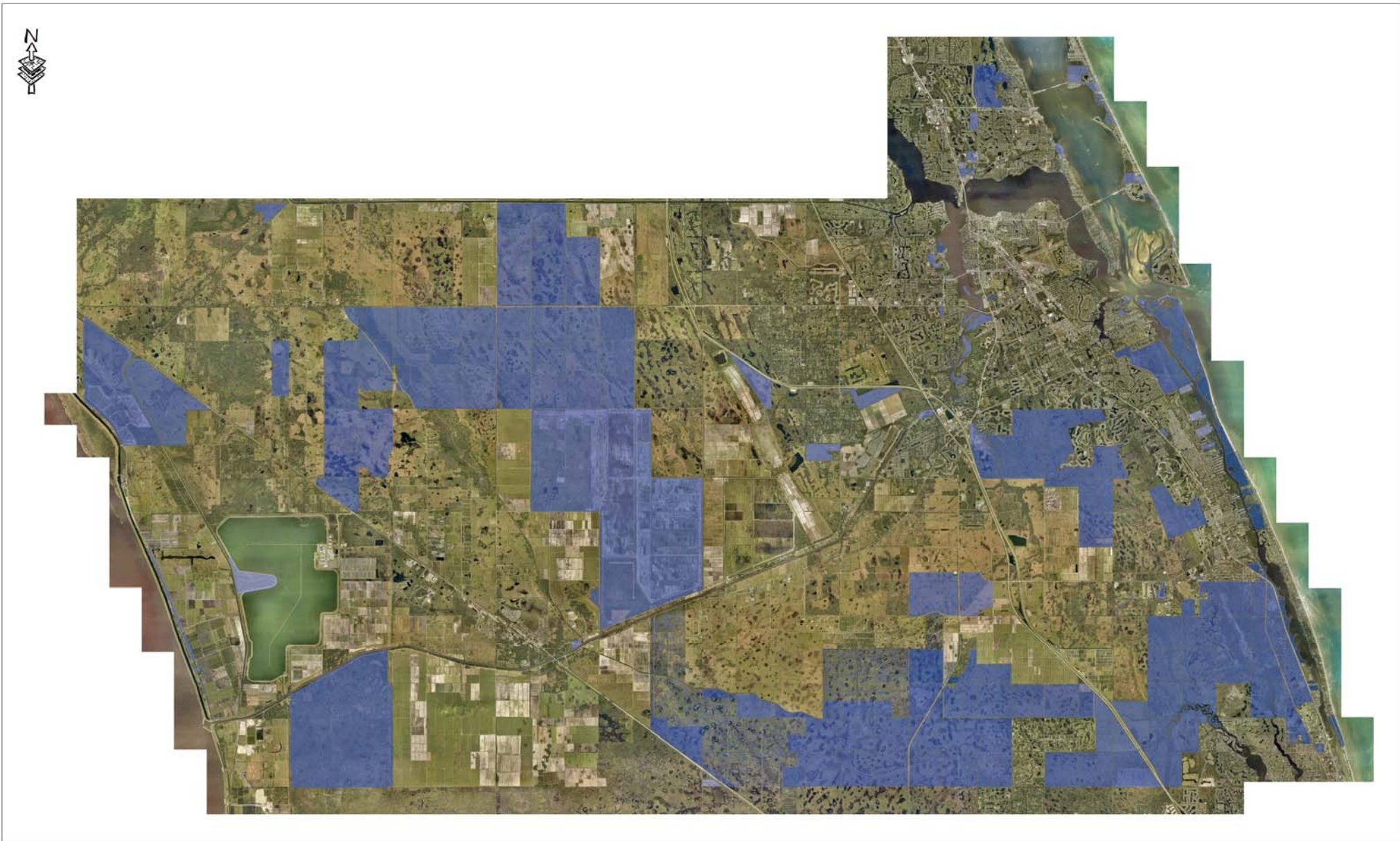


Lake Okeechobee

June 24, 2018

NOAA cyanobacteria product derived from
Copernicus Sentinel-3 OLCI data from EUMETSAT





Conservation Land in Martin County