Abstracts of Technical Presentations

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Key Note Address

Harmful Algal Blooms in the Indian River Lagoon: Past, Present and Future

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The Indian River Lagoon (IRL) and its associated watershed and waterways, e.g. the St. Lucie Estuary, constitute a complex and important ecosystem. The IRL is one of the nation's most biologically diverse estuaries, and is a major spawning and nursery ground for numerous species of fish and shellfish, and home to populations of dolphins and endangered Florida manatees. The region has large tourism, commercial and recreational fishing, boating, and aquaculture interests with an annual economic value estimated at nearly $8B. Unfortunately, recurrent large scale harmful algal bloom (HAB) events have seriously threatened both the ecological and economic stability/value of the IRL. While HABs have been recorded in the IRL for more than 50 years, increasing stress on the system from factors including nutrient inputs/eutrophication, changing land use practices, development and issues related to climate change, have many wondering if the system has hit a critical tipping point where the frequency and intensity of HABs will only increase in the future. In order to better understand and manage the significant challenges of HABs in IRL, we need to both understand past and present blooms, while also leveraging new scientific techniques and approaches to our analyses.

Contributed Papers (Oral and Poster Presentations)

(The presenting author is the first author, unless indicated by underlining.)

Laboratory Scale Modeling of Living Shorelines to Determine Design Parameters

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Brevard Zoo is partnering with the Florida Institute of Technology (FIT) and Brevard County to build a Living Shoreline Demonstration Site in Indialantic, FL. This site will educate Lagoon-front residents about existing options for installing Living Shorelines on their properties that utilize native red mangroves, salt marsh grasses, and/or oyster reefs. Living Shorelines provide a host of benefits to the properties and to the IRL including: water filtration, denitrification, erosion control, wildlife habitat, and wave attenuation. FIT is modeling three shoreline types in their wave tank: natural, rip-rap, and seawall. These existing shorelines will be modeled at two water elevations, wet and dry season. Oyster reef, oyster revetment, and/or marsh grass configurations will be tested for each shoreline type as a means of controlling erosion and reducing wave energy. Evaluation of sediment transportation and significant wave height will be used to provide guidance for wave attenuation at each shoreline type.

Elasmobranchs in Peril? Shark and Ray Assessment in the Indian River Lagoon

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Elasmobranchs (i.e., sharks and rays) are thought to fulfill integral ecological roles in subtropical and warm-temperate estuaries. Unfortunately, a substantial data gap surrounds the status of the elasmobranchs inhabiting the Indian River Lagoon (IRL), which has experienced a variety of recent anthropogenic impacts. To assess these potential threats we initiated a comprehensive fishery-independent survey (bottom longline, gillnet) to characterize elasmobranch diversity, abundance, and population health in the IRL and adjacent waters. Since July 2016, we've sampled and tagged over one-hundred individuals from Sebastian to St. Lucie Inlet, comprising 13 total species. Additionally, two critically endangered smalltooth sawfish (*Pristis pectinata*) have been collected in the St. Lucie region, spurring concerns about exposure of this species to this highly stressed estuary. Continued surveys as well as acoustic tracking of individual movements via the collaborative Florida Atlantic Coast Telemetry network will help shed light on IRL importance and impacts on these sensitive species.

Red Mangrove, *Rhizophora mangle*, Prop Root Communities Are Shaped by the Presence of Secondary Foundation Species

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Red mangrove, *Rhizophora mangle*, provides essential habitat for many other species. *R. mangle* prop roots support secondary foundation species such as barnacles throughout their overlapping range, sponges in the tropics, and *Crassostrea virginica* in subtropical/southern temperate estuaries. The focus of this study is on the biodiversity of prop roots and the influence of secondary foundation species along the latitudinal gradient on Florida's Atlantic coast. The sites range over 493 km from Key West to Vero Beach, Florida. Preliminary data reveal an overall trend that biodiversity on prop roots increases southward along the latitudinal gradient. When prop root communities were limited to ones that were not

fully submerged at all times, the latitudinal gradient no longer had the largest influence on biodiversity. Biodiversity in the communities became more dependent on the identity and number of foundation species present. This is likely due to the facilitative effects of the secondary foundation species.

Little Animals, Big Insight: Using Soft-Sediment Communities as a Proxy for Environmental Health

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Soft-sediment communities are important indicators of water quality and are useful in monitoring the overall health of a particular system. Species found within these communities (polychaetes, bivalves, amphipods, etc.) are relatively immobile, have short life spans and rapid turnover rates, making them ideal for long-term monitoring. As part of the St. Johns River Water Management District's IRL Algal Bloom Investigation project, benthic grab samples have been collected at sites spanning 100 km within the Indian River Lagoon. The project was designed as a way to develop a baseline dataset over space and time of species abundance and diversity within the IRL. This dataset will be useful for comparisons throughout the IRL during future stressful conditions including potential harmful algal blooms.

Investigation into the Health of Oysters (*Crassostrea virginica)* in Natural and Restored Reefs across a Latitudinal Gradient in the Indian River Lagoon (IRL), Florida

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This is a collaborative study between the Florida Fish and Wildlife Conservation Commission, Harbor Branch Oceanographic Institute and the Indian River Lagoon Aquatic Preserves to investigate oyster health throughout the IRL. Oyster reef ecosystem functioning and services depend upon many complex factors including the health of the individual oysters. Individual health is directly linked to growth, reproduction, and survival and therefore the organism's ability to contribute toward functional habitat. This study aims to investigate not only oyster health along a latitudinal gradient, but between natural and restored reefs and across three seasons. Health indices in this study include size and weight measurements, physiological conditions, sex determination, presence of abnormalities and prevalence of parasites (*Perkinsus marinus, Bonamia* spp.).

A GIS Approach for Determining the Potential Runoff Coefficient and Runoff Depth for the Mosquito Lagoon, FL

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Stormwater runoff transports various pollutants into waterbodies. Surrounding elevation, land use, and land cover affect the amount and types of pollutants in the surface runoff. The objective of the project is to calculate the proportion of rainfall becoming surface runoff and runoff depth for the Mosquito Lagoon watershed. Runoff coefficients were derived with the use of a Digital Elevation Model, a Land Cover/Land Use image, and soil data. The coefficients were used to calculate the percent runoff coefficient per pixel (30 meters) using the Raster Calculator Tool within the Spatial Analysis extension of ArcGIS. The output image delineates areas of high surface runoff along the shorelines of Mosquito Lagoon and within the sub-basins of the watershed. Outputs obtained from this study can be used to aid with stormwater management decisions and lead to more sustainable land use decisions.

Exploring the Unknown Microbiome of the Indian River Lagoon

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The Indian River Lagoon (IRL) is considered one of the most biologically diverse estuaries in North America. However there is little knowledge concerning the microbiome. Microbes perform many essential functions including cycling nutrients, transformation of pollutants, and serve as the bottom of the food chain. To fill this knowledge gap, we completed a survey of fifteen IRL sites to determine the microbial diversity. We will use this data to evaluate the possibility of significant correlations between the relative abundances of specific microbial population members and sediment characteristics associated with the muck. These indicators are being tested by a smaller survey at Eau Gallie River where a dredging project is occurring. The goal is to use community based indicators to supplement other monitoring techniques.

Stable Nitrogen Isotopes in Primary Producers Reveal Evidence of Sewage Pollution in the Indian River Lagoon

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The Indian River Lagoon (IRL) is an economically important ecosystem facing many challenges, including harmful algal blooms (HABs), eutrophication, and loss of essential fish habitat. There is some debate concerning the major sources of nutrient pollution within the IRL and stable N isotopes are an appropriate tool to answer this question, as they can be used to differentiate between atmospheric, fertilizer, and sewage N sources. For this purpose, 5 years of data regarding stable N isotopes from primary producers, including macroalgae, seagrasses, and phytoplankton, were compared between segments of the IRL. Lagoon-wide averages for $\delta^{15}N$ were highest in macroalgae (+6.46±1.94), followed by phytoplankton (+4.31±2.06) and seagrass (+2.23±1.61). For all sites, macroalgae and phytoplankton had relatively enriched $\delta^{15}N$ values indicative of sewage pollution (>3‰). The lower $\delta^{15}N$ signal in seagrass reflects uptake of more depleted N sources from sediments, although the central IRL and Banana River still reflected a sewage signal.

Observations of Copper Tolerant Species in the IRL: A Story of Invasion

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Copper tolerance of organisms, a biochemical and physiological adaptation that an organism develops to combat the harmful effects of copper, is becoming more widespread through Florida waterways. Several different invasive benthic fouling organisms, notably the striped acorn barnacle *Amphibalanus amphitrite* and the encrusting bryozoan *Watersipora subtoquata*, have been found inside the Indian River Lagoon (IRL) through observational data of the copper tolerant benthic community. These observations have not been published since Weiss in 1947 in Biscayne Bay, Florida. An increasing reoccurrence of these two species in the IRL points to the invasion of these organisms from human transportation on copper-coated ship hulls into a system that is susceptible to invasion because of a diving biodiversity and high human disturbance. Copper tolerance is a subject that is rarely linked to the dispersal of invasive species, but it has become increasingly apparent that this connection must be made.

Comparing Techniques Used to Determine Biodiversity on the Prop Roots

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Harbor Branch's brackish coast can be used as the archetypal estuary for the Indian River Lagoon System; visual surveys can be used to identify species and determine biodiversity, specifically on the prop roots of mangrove trees. Using a Gopro camera videos of specific prop roots on the trees are taken; from the videos, stills of the root are isolated and overlapped using Quick software to create an image of the whole prop root. The picture can then be used to determine the biodiversity and abundance of species located on the prop root. Previously, the species residing on the prop root were counted and measured capping at 30. The Gopro camera and software allows us to maintain a pre-specified distance by attaching the camera to a mount creating a cleaner more continuous shot of the prop root, giving us a more realistic look at the biodiversity on the root.

Determining the Source of Fecal Indicator Bacteria in the FDOT Canal of the Coastal Oaks Preserve

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Last year we discovered high levels of fecal indicator bacteria (FIB) in the Florida Department of Transportation (FDOT) drainage canal that runs through the center of the Coastal Oaks Preserve (COP). This year we studied two potential contributing sources for FIB: a lateral canal which drains into the FDOT Canal and groundwater seepage. We collected water samples from the canals and piezometers and tested them for FIB and water quality. We discovered there was no correlation of FIB levels between the two canals. There was a minimal amount of FIB detected in the groundwater but the greatest contribution was likely from surface water runoff. Our preliminary conclusion is that the high levels of FIB are related to wildlife in the COP. We recommend the use of microbial source tracking or anthropogenic chemical tracers such as sucralose to confirm this conclusion.

How Well Do Restored Oyster Reefs Support Key Biogeochemical Functions in the Indian River Lagoon?

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The loss of historic oyster reef habitat and increasing occurrence of algal blooms within the Indian River Lagoon (IRL) has prompted interest in the utility of oyster reefs to provide 'hot spots' of biogeochemical cycling (nutrient removal, transformation, and burial). This research seeks to determine how long it takes restored oyster reefs to provide biogeochemical functions comparable to natural reefs. Twenty reefs in Mosquito Lagoon were chosen, 4 replicates of: dead/unrestored reefs, natural reefs, and reefs restored 1, 4, and 7 years ago. Several biogeochemical indicators were quantified in the sediments beneath the reefs. Results indicate that short and long-term nutrient storage and microbial activity increase rapidly with restoration, often being equivalent to natural reefs only 1 year after restoration. High variability in biogeochemical functions between reefs of the same ages were noted and often explained by differences in the number of live oysters and reef thickness between reefs.

Developing a GIS-based Habitat Suitability Index Model for Eastern Oyster in the St. Lucie Estuary, Florida

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Oysters are considered an important valued ecosystem component (VEC) because of their ecological significance in the St. Lucie Estuary. The objective of this project was to develop a GIS-based habitat suitability index model (HSI) for the Eastern Oyster in the St. Lucie Estuary. Using three environmental variables: salinity, temperature, and depth, the monthly HSI was developed for 2010-2015. The model was then validated using spatial oyster bed distribution and the time series of live oyster densities at two stations within the St. Lucie Mid Estuary. The developed HSI model proved to be a robust and accurate predictor of oyster habitat suitability in this estuary. The project provides a scientifically based and quantitatively validated HSI model, which can be used as an effective and efficient decision-making tool for the adaptive management of freshwater releases to this estuary and a strategic planning and evaluation tool for the CERP.

Emigration of Juvenile Snook and Tarpon from a Mosquito Control Impoundment Is Enhanced through a Draw-Down of Water Level in Summer

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The Florida Institute of Technology, Bonefish and Tarpon Trust, and Indian River Land Trust have partnered to examine the effects of mosquito impoundment management on juvenile sportfish. The Bee Gum impoundment in Vero Beach has a single culvert connection to the Indian River Lagoon. Using PIT tags and continuous antennas, we monitored the emigration of juvenile snook and tarpon from the impoundment during the culverts winter opening in accordance with typical management. We also monitored emigration during an experimental summer drawdown. Few fish emigrated during winter, but many did during the summer drawdown. This information may help influence future impoundment management.

Coastal Restoration: A Florida Master Naturalist Special Topic Program

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The mission of the Florida Master Naturalist Program is to promote awareness, understanding, and respect of Florida's natural world among Florida's citizens and visitors. The Florida Master Naturalist Program is an adult education UF/IFAS Extension program developed by the University of Florida and provided by many Extension offices and participating organizations throughout the state of Florida. FMNP training benefits persons interested in learning more about Florida's environment or wishing to increase their knowledge for use in education programs as volunteers, employees, ecotourism guides, and others. The FMNP Coastal Restoration module provides instruction on Florida estuarine habitat restoration including oyster reefs, mangroves, saltmarsh grasses, and living shorelines. Presentations focus on biology and ecosystem services, site design and implementation, and monitoring to evaluate success. This FMNP special topic module constitutes 24 contact hours which includes classroom instruction, guest speakers, hands-on activities, and field trips to restoration sites.

A Novel Interaction: The Thin Stripe Hermit Crab, *C. vittatus*, Kills the Florida Crown Conch, *M. corona*, for Its Shell

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Hermit crabs and marine snails, commonly found organisms throughout the Indian River Lagoon, have a unique relationship. Hermit crabs require a shell for protection and regulation of growth and reproduction. They cannot produce this shell and typically acquire shells left empty after snail mortality. Previous scientific literature has documented that hermit crabs cannot kill and obtain a shell directly from a live healthy marine snail. However, recent observations in the field and the lab demonstrate that the hermit crab *Clibanarius vittatus* may have the ability to kill and remove shells from live *Melongena corona*. My goal is to classify this interaction, determine if it is widespread throughout the Indian River Lagoon, and understand how it will affect the populations of both organisms. Understanding and correctly classifying interspecies relationships is crucial to maintaining the health of ecosystems such as the Indian River Lagoon.

Dolphin Abundance in the Vicinity of Land/Ocean Biogeochemical Observatories (LOBOs): Relationship to Water Quality

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The movement, ranges and behavior of the Bottlenose Dolphin (*Tursiops truncatus*) population in the Indian River Lagoon have been thoroughly documented. Social structure, reproduction and prey availability all influence these patterns. Additionally, the fluctuation of changing environmental parameters may be an alternative driver of dolphin movement patterns. This study utilized standardized photo identification surveys to record dolphin presence, abundance and behavior within a 300 meter radius of IRLON'S Link Port (IRL-LP) Land/Ocean Biogeochemical Observatory (LOBO). Environmental data from the LOBO unit including temperature, dissolved oxygen, and salinity were analyzed from before, during and after each survey. Statistical analysis revealed a positive correlation between dolphin presence and dissolved oxygen ($p = 0.03$) and a negative correlation with temperature ($p < 0.01$). These preliminary results demonstrate that certain environmental factors may influence movement patterns of dolphins and could provide additive measures for predicting fluctuations in dolphin populations within the Indian River Lagoon.

Research-Based Lagoon Protection and Restoration

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With 32 years of experience protecting and restoring coastal wetlands in St. Lucie County, staff speculated, in 2013, that the blooms and Lagoon collapse ongoing in the northern Lagoon were initially shoreline-associated, based on the MERIS satellite data, aerial photography and field observations. Since St. Lucie County had been managing coastal wetlands for CASS (coastal acid sulfate soils) successfully, using circulation and aeration techniques for over 30 years, it was hypothesized that CASS-management was the reason St. Lucie County did not experience the collapse. Findings of shoreline pH declines, the presence of CASS related compounds in higher concentrations, drop in aragonite saturation, loss of seagrasses and a decline in biological diversity were all suggestive of the future need to combat CASS

using aeration and circulation methods to prevent fish kills that contribute ammonia to the blooms and to reduce recycling by oxidizing acidified organic components of sediments.

Implementation of CUAHSI ODM2 Information Model for Data Management of the Indian River Lagoon Observatory Network of Environmental Sensors

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The Indian River Lagoon Observatory Network of Environmental Sensors (IRLON) requires a data management system that accommodates many data types from numeric to categorical both spatially and temporally. Data types generated by the network include *in situ* continuous data, supporting *ex situ* samples and equipment management. The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Observations Data Model 2 (ODM2) information model was selected due to its modular design featuring a core schema and numerous extension schema that allow customization for our current needs and flexibility for future data. IRLON is implementing ODM2 in Microsoft SQL Server on a Windows operating system and is compatible with current processing and management software including Microsoft InfoPath, R and Aquarius. Ultimately, implementing CUAHSI ODM2 as the IRLON data management system will facilitate data products, publications and visualizations.

Living to the Extremes: Examining the Degree of Salinity Variability in Southern Indian River Lagoon as Related to Seagrass Distribution

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Sessile species living in estuarine systems with distinct diurnal tidal variability need to acclimate to survive the extremes. Variability in water environment conditions in the southern Indian River Lagoon are also shaped by management of freshwater discharge into the system. Both of these dynamics modify salinity in the system in different extents and time scales. Using seagrass species composition from RECOVER monitoring data, this study examines variation in salinity conditions as a potential metric to predict seagrass species distribution in the southern Indian River Lagoon. Examining salinity variation responses may be a means to further understand the impacts of discharge quantity and duration on seagrass species distribution in this area of the lagoon.

Investigating Impacts of Estuarine Discharge within the St. Lucie Watershed Basin and IRL System on Local Coral Reef Ecosystems

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The northern extent of the Florida Reef Tract (FRT) and surrounding water systems face extreme environmental variations and anthropogenic influences. Weather variability, controlled freshwater releases, and agricultural runoff combine to impact the Southern Indian River Lagoon System and nearshore oceanic environments. This scenario provides an ecologically relevant system to investigate the impacts of watershed management and discharges on coral health. To better understand coral population structure and responses to these sublethal stressors, populations of the scleractinian coral *Montastraea cavernosa* were examined using a combination of genomic and transcriptomic techniques. The goals of this project are to quantify and predict coral responses to freshwater discharge, to provide insight into the fundamental metabolic processes that may enhance stress tolerance and coral resilience, and to promote data-driven management decisions that enhance conservation of these coral ecosystems.

Source of Freshwater Inflow and Water Quality at the Roosevelt Bridge, St. Lucie Estuary FL

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The Total Maximum Daily Load for the St. Lucie River and Estuary established concentration targets for total nitrogen (TN) and Total Phosphorus (TP) at the Roosevelt Bridge monitoring station (SE03). The relative influence of six sources of freshwater inflow (C44 Basin, C23 Basin, C24 Basin, Tidal Basin, Ten Mile Creek, and Lake Okeechobee) on water quality at SE03 was investigated using partial least squares regression. The first extracted factor accounted for the bulk of variability in concentration (about 50 %) that could be explained by total inflow and the percent contributions from the six sources. Higher Total discharge and contribution from the C23 and C24 basins were associated with higher nutrient concentrations. A higher contribution from the Tidal Basin and Ten Mile Creek was associated with relatively lower concentrations. These results suggest that local basins currently exert the most significant influence on TN and TP concentrations.

An Opportunistic Test of Living Shoreline Resistance to Hurricanes in the Indian River Lagoon

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A commonly cited reason for living shorelines is improved protection during extreme storm events. On 6 October, 2016, Hurricane Matthew passed within 12 miles of Florida's east coast with winds of 130 mph. This provided an opportunity to evaluate effectiveness of living shoreline projects to hurricane force winds and storm surge. Living shoreline sites ranged in post-restoration times from one to five years and were located in northern Indian River and Mosquito Lagoon. Oyster materials and deployed plants remained in place during the storm, although movement of oyster materials was observed at sites one to two years post-restoration. Young plants were affected more by storm surge, with mangroves and *Spartina alterniflora* observed dead in place and covered in wrack, suggesting small plants were submerged for extended period of time post-hurricane. Erosion and scarping was evident landward of living shorelines, however, was less severe at living shorelines compared to control shorelines.

Oyster Restoration Efforts in the Southern Indian River Lagoon – Incorporating Resiliency to Future Discharges

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Recovery of oyster resources in the St. Lucie River, lost during the 2013 Lake Okeechobee discharges, was initiated in 2014-2015. An important facet of this effort was to build resiliency to future discharge events. To achieve this, oyster reef habitat was constructed in 7 locations in the southern Indian River Lagoon, downstream from the St. Lucie River. In 2016, Lake discharges persisted for 9 months. Throughout this period, losses of oysters at these sites were minimal, reflective of higher salinities found at these sites. Timing of oyster reef construction at 4 sites coincided with high spatfall in May and remained consistent for 5 months following construction. Live oyster densities were extremely high (2000-10,000+ oysters m^{-2}). Although other factors may influence these sites' long-term persistence as oyster habitat, oysters at these sites were unaffected by the discharges. Future efforts will expand reef creation and continue monitoring of these sites' long-term success.

Breakpoint: Understanding How Bioeroders Impact Intertidal Oyster Restoration

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Bioeroding sponges capable of dissolving and chipping through calcium carbonate substrates have begun infecting natural and restored oyster reefs in Mosquito Lagoon due to recent sea level rise and storm-associated high water events that have submerged reefs for longer time periods. Sponge-infected shell clusters have been breaking off and washing up on reefs (64% of loose clusters on reefs restored before 2010 showed infection; 13% on newer restored reefs; 46% on natural reefs). Infected clusters tend to be larger and incorporate more live oysters than uninfected clusters. Sponge-infected shell is also weaker, withstanding only about one third of the compressive forces uninfected shell can withstand, suggesting a possible synergistic impact of sponge erosion and boat wakes on intertidal oyster reef restoration. This work will inform oyster restoration improvements aimed at prolonging reef lifespan and serve as a model for reef restoration in subtropical areas affected by bioeroding sponge.

Detection of the HAB Toxins Saxitoxin and Brevetoxin in Indian River Lagoon Dolphins, 2002-2016

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Exposure to harmful algal bloom (HAB) toxins is the most common cause of large-scale marine mammal mortality events, but sublethal impacts are poorly understood due to a lack of baseline toxin data for marine mammals in most regions. One such region, Florida's Indian River Lagoon (IRL), is home to HAB species that produce the neurotoxins known as saxitoxin and brevetoxin. The IRL is also home to a resident population of bottlenose dolphins (*Tursiops truncatus*), an important indicator species for ocean health. Here we present saxitoxin and brevetoxin levels detected in bottlenose dolphins stranding in the IRL region from 2002 to 2016. We compare toxin levels in dolphins sampled during various IRL HABs to levels detected during non-bloom conditions, and propose the first reference values for saxitoxin and brevetoxin accumulation in IRL dolphins. We anticipate these data to be useful for evaluating future HAB impacts on marine mammals in the IRL.

Fishing to Survive: Britain's Smyrnéa Settlement along the Northern Indian River Lagoon, 1766-1777

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Established by Dr. Andrew Turnbull, a Scottish physician and entrepreneur, the Smyrnéa settlement was an agricultural enterprise that existed along the northern Indian River Lagoon from 1766 to 1777 during the British occupation of Florida. Turnbull recruited approximately 1,100 indentured servants from the Mediterranean island of Minorca along with an additional 300 from Greece, Italy, Corsica, and Turkey. Although there is substantial historical documentation pertaining to this settlement, archaeologists have only recently begun to uncover its structural and material cultural remains. Analysis of approximately 5,000 animal bone remains from the Turnbull Colonists' House site, the first residence to be discovered, indicates that British food supplies were inadequate and that the colonists secured protein in their diet by primarily fishing in the then rich estuarine waters of the Indian River Lagoon. Ray-finned and cartilaginous fish were highly abundant in the examined faunal samples and included 26 taxa taken from the lagoon.

It Takes a Community: The Role of Epifaunal Diversity in Particle Removal in the IRL

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As a complement to the IRL Algal Blooms Investigation (IRLABI), we used settlement tiles containing natural assemblages of epifaunal filter feeders to assess the role that community diversity plays in particle removal. Communities were fed cultures of Picocyanobacteria and Pedinophyte from the 2011 superbloom; particle removal was monitored over 3 hours using flow cytometry. Each bloom species was isotopically (^{13}C or ^{15}N) labeled, allowing us (by $\delta^{13}C$ and $\delta^{15}N$ analysis) to determine the members of each community that were most efficient at removing and assimilating each bloom species. There was substantial variation in species richness across tiles (range of 4-22 species), with a strong relationship between community diversity and the removal of both particle types. Variation in the $\delta^{13}C$ and $\delta^{15}N$ values of different species suggests that some organisms are more efficient at particle removal. These data highlight the importance of epifaunal diversity in maintaining healthy ecosystems within the IRL.

The Indian River Lagoon Shoreline Restoration Project: Combatting Erosion and Maintaining Natural Lagoon Processes through Implementation of Living Shoreline Methods

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Since 1995, the Indian River Lagoon (IRL) Shoreline Restoration Project (SRP) has been implementing living shoreline and natural techniques, rather than traditional artificial armoring, to promote shoreline stabilization. Historically, developed coastlines, including the IRL, have used hardening techniques such as seawalls, bulkheads, and revetments to mitigate shoreline erosion. Such techniques inhibit natural lagoon processes and become inefficient solutions in the long run. The adaptive nature of the SRP has led to a multi-tier approach of using natural shoreline vegetation, as well as breakwater structures, to stabilize shorelines. These methods maintain natural ecosystem functions and habitats, without the negative effects.

Ventilation Rates of the Indian River Lagoon through Its Inlets

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Recent sea-grass die off, harmful algal blooms, marine mammal and fish death outbreaks in the Indian River Lagoon (IRL) call for the need to develop a greater understanding of toxic water fate and clean water exchanges between the IRL and the coastal ocean. Throughout the entire IRL only a total of three inlets allow for water renewal from the coastal sea. Therefore understanding the ventilation rates of the IRL through these inlets is critical. In order to understand the water exchange processes driven by 1) the tide, 2) the lower frequency seasonal forcing and 3) higher frequency pulse events over one full annual cycle, we have conducted measurements of different kinds in Fort Pierce Inlet that provided new insights in the ventilation of the IRL.

Assessing Genetic Diversity within Natural Populations of Smooth Cordgrass to Ensure Effective Restoration Efforts

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The Indian River Lagoon (IRL) is one of the most biodiverse estuary systems in North America making it a conservation priority and the focus of restoration efforts. Smooth cordgrass (*Spartina alterniflora)* is an indicator for ecosystem health that naturally occurs along the shorelines of the IRL. *Spartina alterniflora* is often used in shoreline restoration due to its extensive rooting capacity and ability to halt shoreline loss. Clonal species, such as *S. alterniflora*, are easy to raise, but using clonal species for restoration may lead to a lack of genetic diversity and long-term adaptability. To understand whether restored populations exhibit natural levels of genetic variation, we collected 35 individuals from each of 10 populations (four native, one greenhouse, five restored) and genotyped samples at 13 microsatellites. Overall, this study allows us to identify if our current method of restoration efforts will be successful for long-term genetic stability in the IRL.

Engaging Children (and Adults) to Care about the IRL through Oyster Yoga

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Yoga has traditionally been practiced for physical, mental and spiritual well-being. Here, we describe our new oyster yoga efforts to help children learn about the biology and importance of oyster reefs, all while being active. Our goal is to create a product that will be useful for all school grades and abilities – your help in shaping this will be invaluable.

Heritage Monitoring Scouts (HMS Florida): A Program Engaging the Public to Monitor Florida's At-Risk Heritage

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Along Florida's 8,000 miles of shoreline, nearly 4,000 archaeological sites and over 600 recorded historic cemeteries are at immediate risk from coastal erosion and rising sea levels. Along the Indian River Lagoon, archaeological and historical sites of national importance are particularly imperiled. The matter remains complex in Florida where despite the higher rate of sea level rise compared to the global average, "climate change" remains politically taboo. This paper will outline ongoing efforts to engage the public in monitoring coastal sites, the creation of the Heritage Monitoring Scout (HMS Florida) by the Florida Public Archaeology Network, and discuss outcomes of the first annual Tidally United conference held in August 2016.

Nutrient Levels in St. Lucie West's Lakes: Implications to Reduce Lake Okeechobee Discharges to the St. Lucie River and Southern Indian River Lagoon

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St. Lucie West, a 1990's DRI in St. Lucie County has 128 man-made stormwater lakes totaling 650 acres within a 4,700-acre housing, commercial, industrial, academic and sports facilities. Each lake was planted with native emergent and submergent vegetation [EAV and SAV], respectively. Stormwater runoff overflow enters either preserved wetlands or lakes as initial water quality treatments. Outflows from these

initial treatment areas are further reduced in total Nitrogen [TN] and total Phosphorus [TP] and suspended solid levels by intercepting man-made treatment wetlands. The most recent 6-year period of record of TN and TP levels at the eight site discharge outflows – whether outflowing or static – were 1030 parts per billion [ppb] TN and 68 ppb TP. The Maximum Total Daily Load [MTDL] for its receiving St. Lucie River is 81 ppb TP and 730 ppb TN. The current 12-year previous fertilization program for sod limited TP application but exceeded need by ~ 20% accounting for the TN MTDL excess. Implications for rejuvenation of Lake Okeechobee's water from current 120 ppb TP involves transferring the lessons learned from St. Lucie West. Lake Okeechobee's legacy TP and TN sediment load could be trapped into sealed islands within the lake and then shelf planted with SAV/EAV. Such action should reduce both in-lake and discharge concentrations of TN, TP and suspended solids significantly. The author is modelling water quality results from this demucking action.

Water Quality Assessment of the St. Lucie River Watershed

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Historical levels of flow, Total Phosphorus, Total Nitrogen and total suspended sediment from Lake Okeechobee and from the St. Lucie River and Estuary watershed were calculated, allowing an assessment of progress towards meeting the watershed's Total Maximum Daily Loads. In general, the water quality entering the St. Lucie River and Estuary was poor, and significant improvement is necessary to achieve the Phase 1 load reduction targets for nitrogen and phosphorus. These results are in stark contrast to the *2016 BMAP Progress Report* prepared by the Florida Deptartment of Environmental Protection (FDEP) which relies on simulated load reductions instead of using readily-available water quality data. Improvements to the FDEP assessment program are recommended, and a compliance method is proposed that allows basin-specific assessments and provides meaningful feedback to landowners.

Eight-Year Manatee Survey Looking at Seasonal Patterns of Frequently Observed Individuals in the Harbor Branch Channel Using Photo-Identification Techniques

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The manatee project at Harbor Branch Oceanographic Institute was established in 2009. Land-based observations and photo-identification techniques have been used over the last eight years. This has allowed us to recognize specific resident manatees that visit this location season after season. The photographs have been shared with the Manatee Photo-Identification System database and several matches were found, indicating some of the manatees are migrants. This project focuses on the seasonal patterns of frequently observed manatees in the Harbor Branch Oceanographic Institute channel. Knowing which manatees are residents allows us to preliminarily identify specific individuals that will be part of a future acoustic tagging project.

Modeling Seagrass Effects on the Hydrodynamics in the Southern Indian River Lagoon

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A hydrodynamic model based on the Delft3D modeling system has been developed for the southern Indian River Lagoon (IRL) including St. Lucie Estuary, Fort Pierce Inlet, and adjacent coastal area. The model has been calibrated with available *in situ* and monitoring data. In this presentation, we use this

model to investigate the effects of seagrass beds on the hydrodynamics in the southern IRL, focusing on the vicinity of Fort Pierce Inlet, where significant seagrass coverage can be found. The results suggest that seagrass beds have significant effects on bottom friction, tidal and sub-tidal currents, and tracer distributions. In particular, tidal and sub-tidal currents become weaker due to increased bottom friction from seagrass. The seagrass effects vary spatially (stronger in Intracoastal Waterway) and over tidal (stronger effects seen in flood and ebb tides) and seasonal (more significant in the summer than in winter) cycles.

Encouraging Stakeholder Participation in the Indian River Lagoon through Participatory GIS

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Through a new NSF Coupled Natural Human Systems grant at UCF, our team seeks to explore how community stakeholders view the Indian River Lagoon (IRL) and how emotionally connected or not they are to the lagoon It is important to compare local knowledge about sense of place with existing indicators of biophysical success or failure in the Lagoon to understand where views of the human and natural systems present opportunities or challenges In this interactive session, participants will contribute to a prototype of the Indian River Lagoon Community Mapping Platform to demonstrate the multiple ways in which sense of place data from stakeholders can contribute to an understanding of motivations for involvement (or not) in Lagoon restoration efforts. Our methods yield an innovative, community-driven mapping platform inclusive of local stakeholder voices, placing value on experiential local knowledge to support additional restoration efforts and stakeholder involvement in the IRL.

Ciliates of the IRL Muck Layer: A Novel Thriving Community

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The anoxic ‘muck’ sediments of the Indian River Lagoon have often been reported as a dead zone, abiotic except for the presence of some prokaryotes. A recent investigation into the eukaryotic microbial consortium has revealed a thriving, previously unknown, community. Our discovery provides the first evidence for anaerobic ciliates thriving within the muck layer. These single-celled eukaryotes are large at over 1 mm in size, and are well-adapted for life in an interstitial environment. As anaerobes, they dominate this system locally, providing the foundation of the foodwebs within the lagoon. Despite their huge biomass and ecological importance, they have gone unnoticed. Future ecological and conservational management must fully understand the ecosystem before enacting management practices. Studies such as these into the eukaryotic microbial assemblages may provide the underpinning by which to ask future questions concerning lagoon health.

Living Shorelines as Tools for Citizen Science and Runoff Mitigation

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Surface runoff from waterfront properties is a non-point source of nutrients for the Indian River Lagoon (IRL). Mitigating the eutrophication of the IRL will take a multi-prong approach; and this project seeks to engage waterfront citizens to help mitigate at the land-water interphase. Waterfront homes and retention ponds dominated by turfgrass in the Mosquito Lagoon watershed have been identified to be converted to homes boasting a living-shoreline of native vegetation. The converted shorelines will provide an avenue

to study the efficacy of native vegetation to sequester nutrients in surface run-off. This project is unique in that its framework is built on a real-world setting, and is designed to involve and educate the lagoon community. Presentation will be focused on methods to quantify nutrients in surface runoff buffered by different types of plants as well as our approach to recruit, engage, and educate citizens to be part of the project.

Observations and Modeling of Water Quality and Carbon Cycle in St. Lucie Estuary and Nearshore Coral Reefs

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From summer 2015 to spring 2016, four cruises were conducted to measure water quality and carbonate chemistry parameters (T, S, pH, *p*CO2, alkalinity) in St. Lucie Estuary and adjacent reefs using a tow vehicle outfitted with a number of sensors and traditional water samples at 10 stations. A coupled physical-biogeochemical model was also developed and a numerical simulation had been conducted for 2015. An analysis of the *in situ* data, model results, and a portion of the data collected at the IRLON stations indicate that, although highly variable, the freshwater discharges and associated carbon and nutrients inputs from Lake Okeechobee and local watershed strongly impact the water quality, including enhancing phytoplankton blooms and reducing pH (and hence aragonite solubility), both within the estuary and over the nearshore reefs. The transport and dispersion of nutrients and carbon follow complicated patterns due to the strong interactions between tidal movements and freshwater flows.

Land Crab Population in the Coastal Oaks Preserve

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Land crabs are vital to coastal areas because of the ecosystem services they provide. We mapped the distribution and abundance of land crabs (*Cardisoma guanhumi*) along mosquito impoundment dikes in the Coastal Oaks Preserve. At 10-m intervals along 100-m transects, the number and size of active and inactive burrows, the shape of the crab pellets, and sun exposure were recorded. Near the Lagoon shoreline the population of land crabs appeared to be low presumably due to extreme high tides, debris, and sandy soil. The abundance of crabs was greater along the inland impoundment dikes. Crab burrow activity was higher along mangroves than under oak trees and Australian pines. This study provides a useful baseline for the future management of the Coastal Oaks Preserve.

Links between Dissolved Nutrients, Environmental Variables, and Acidification in the Indian River Lagoon

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In the eutrophic waters of the Indian River Lagoon (IRL), there have been reported decreases in overall shellfish size, which may be related to coastal acidification. In order to understand the relationship between acidification and eutrophication, water samples from 20 sites spanning the IRL were collected and analyzed for dissolved nutrients and acidity (omega values) in spring (dry season) and fall (wet season), 2016. Additionally, three sites were sampled weekly to observe temporal variability of nutrients and acidity. For the IRL-wide dry season, sites with a higher nitrogen concentration were more acidic (some with omega values <2) with a slight negative relationship ($p=0.09$; $r2=0.12$). The time series data showed temporal variability in salinity and acidity with an overall positive linear relationship ($p=<0.0001$;

r2=0.52). This preliminary work suggests that salinity and dissolved nutrients have implications for acidification in the IRL and may be useful to water quality management and shellfish restoration.

Wetland Preservation and Mosquito Control: An Integrated Approach

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Mosquitoes on Florida's east coast are nuisance pests and competent disease vectors. Rotational impoundment management has been recently established as a control method that emphasizes periodic exchange and high water replication within impoundments in an attempt to limit the negative environmental health effects of prior methods. Yet, monitoring practices cease during the winter open exchange period, allowing for a significant knowledge gap. Water quality analyses were conducted within and alongside eight locations, each with an impounded and unimpounded component, across two impoundment structures in St. Lucie County, Florida during eight weeks of winter open exchange. Analyses displayed no statistical significance for any parameter at Impoundment 14C (Harbor Branch) and statistical significance only in dissolved oxygen at Impoundment 1 (Bear Point). This suggests inadequate flushing and exchange between the impoundment and peripheral lagoon. The application of additional culverts or spillways may help abate these issues and encourage more natural wetland function.

Genetic and Functional Trait Variation of Black Mangrove (*Avicennia germinans*) in the Indian River Lagoon, FL

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The Indian River Lagoon (IRL) is home to a biologically diverse array of organisms, but increased anthropogenic pressure continues to negatively impact this estuary. Along the shores of the IRL, mangroves serve as intertidal foundation species that influence both ecosystem function and associated community structure. Despite their ecological and economic importance, little is known about the genetic structure and diversity of mangroves in the IRL. We present findings of our assessment of both genetic and functional trait variation among thirteen black mangrove (*Avicennia germinans*) populations encompassing the entire IRL, using a combination of microsatellite molecular markers and functional leaf traits. Combining both genetic and functional traits provides a more complete view of the underlying factors (i.e., evolutionary and environmental) responsible for population differences. The results of this study contribute to our understanding of mangrove genetic structure in the IRL and provide baseline information that can help guide future conservation efforts.

Changes in Salinity in St. Lucie in Response to High Pulse Discharges from Lake Okeechobee

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Freshwater flow is a likely spawning cue for common snook (*Centropomus undecimalis)*, a euryhaline sportfish, to move between freshwater rivers and nearshore marine environments during the summer months. Higher salinity waters ensure egg buoyancy and sperm motility. During drought years, snook will spawn within a river instead of moving to ocean inlets. In wet years, Lake Okeechobee releases large pulse discharges of freshwater to avoid flooding during storm events. While common snook are relatively tolerant to salinity (0-40 ppt), there are osmoregulatory costs associated with changing salinities and movement. In order to understand the effects of these disturbances, we will compare changes in salinity patterns in St. Lucie River before, during, and after high pulse events using South Florida Water

Management's DBHYDRO and EPA's STORET environmental open-source databases, over multiple years. Future research will relate these salinity data patterns to other databases of common snook movement to further inform management.

The Role of Biotic and Environmental Factors in Spatial and Temporal Variability of Indian River Lagoon Copepod Communities

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From June 2013-June 2016 we surveyed the zooplankton community of the Northern Indian River Lagoon (N-IRL) to identify the driving forces behind its composition. Copepods comprised 76% of community. *Acartia tonsa*, *Oithona colcarva*, and *Parvocalanus crassirostris* make up >95% of the total copepod abundances. These species vary in their trophic strategies and seasonal patterns of occurrence resulting in different grazing impacts of the copepod community between the wet and dry seasons, and between locations. The abiotic factors (salinity, temperature, and Secchi depth) were correlated to changes in copepod densities, however did not appear to be large drivers of community composition. Intrazooplanktonic predators (*Sagitta* sp., *Mnemiopsis leidyi*, and larval fish) did not appear to drive copepod community composition. Variations in copepod densities between sites reflect those previously observed in algal communities. Of abiotic and biotic factors, copepod composition was most closely correlated to factors impacted by algal bloom events (R=0.41).

Freshwater Inflow and Sediment Type Influence Infaunal Community Assemblages in the St. Lucie Estuary

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The St. Lucie Estuary experiences periodic freshwater releases primarily through the C44 canal as part of the mitigation of water levels for Lake Okeechobee and the agricultural lands of central Florida. The RECOVER science program was initiated to monitor the two affected estuaries and determine their recovery as water inflow patterns change. The Smithsonian Marine Station Benthic Ecology Lab monitors the benthic infaunal communities of the St Lucie Estuary. Ponar grab samples have been taken quarterly for 10 years at 15 stations throughout the estuary and southern Indian River Lagoon. Salinity and sediment type are the most important factors regulating community composition. Species richness declines with rapid salinity changes resulting from discharge events and "muck" sediments have very few individuals present. Samples from the same location in shallower areas with "healthy" sediments have more diverse communities, indicating that sediment is type affecting community development.

Selective Avoidance by Copepods Grazing on Bloom-Forming Algal Species in the Indian River Lagoon

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Harmful Algal Blooms are becoming more frequent with longer durations in the Indian River Lagoon (IRL) estuary. Lab grazing experiments were conducted with *Parvocalanus crassirostris,* the most abundant herbivorous copepod in the IRL, to estimate the grazing rates and evaluate *P. crassirostris*' potential for exerting top-down pressure on algal blooms. We focused on species of phytoplankton dominating recent blooms. Results indicate that *P. crassirostris* can graze on bloom-forming species (e.g.

mean grazing rates range from 359 to 3204 cells $hr^{-1}copepod^{-1}$ when grazing on the "Superbloom" pedinophyte in different cell densities), but at peak grazing rates (3204±1194 cells $hr^{-1}copepod^{-1}$), it will not control the blooms. *P. crassirostris'* grazing on harmful algal species dropped precipitously when the copepods were offered alternative algae.

Blue Crab Population in Peril in the IRL: Does Polluted Water Habitats Raise Serum Glucose Levels in *Callinectes* Species?

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Serum glucose levels of Blue crabs exposed to a simulated impaired habitat was investigated. The test habitat mimicked declining IRL water quality due to common pollutants. Crabs were caught using traps baited with chicken or fish. Crab hemolymph was extracted using 27 gauge needles attached to 0.5 milliliter syringes and analyzed using a ONETOUCH Ultra2 human glucose monitor. Serum glucose levels were measured before and after exposure to the test habitat. A rise in glucose levels, indicating a rise in stress levels, was hypothesized to occur in response to exposure to the impaired habitat. Concurrently, the abundance and diversity of Blue crab species in Goat Creek were recorded as part of a 6-year population study. Data collected included crab species, sex, carapace size, presence/absence of markings or injuries, weight/mass and individual recapture counts. Environmental data such as air/water temperature, pH, and water clarity were also noted.

Pico and Nanophytoplankton Ecology in the Indian River Lagoon: An Understudied Component of an Estuary in Peril

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Phytoplankton are a critical and understudied component of the Indian River Lagoon (IRL) ecosystem. They constitute the base of the food web, color the water, cause anoxic events that kill fish, and produce toxic blooms that threaten wildlife, human health, and economic activity. The smallest phytoplankton, the pico and nanophytoplankton, are exceptionally abundant in the IRL yet very little is known about the diversity of these organisms or the ecology of resident populations. Using flow cytometry and epifluorescence microscopy, we have begun to classify important groups based on cell size and fluorescence, and measure their distribution and abundance. Initial results show substantial spatial and temporal variation that may be linked to rates of freshwater discharge, nutrient inputs, and rates of exchange with ocean waters. This group of algae could serve as important indicators of lagoon ecosystem structure and help with efforts to manage water quality.

The Presence of Pathogenic *Vibrio* spp. along Florida's East Coast Beaches and Their Physiological Response to Salinity Fluctuations

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Vibrio bacteria are responsible for 80,000 illnesses and 100 deaths in the United States each year, the majority of which occur in Florida. Infections result from consuming contaminated seafood or exposing a wound to water during recreational activities. These pathogens thrive in estuarine environments like the Indian River Lagoon (IRL) and exhibit a strong negative correlation with salinity. The goal of this study was to investigate *Vibrio* occurrence along a salinity gradient and determine if they can be encountered at public beaches along Florida's east coast. While most abundant inshore, these bacteria can be washed

onto coastal beaches at low tide and potentially contact swimmers. Furthermore, this study showed that, at least for short durations, *Vibrio* can tolerate high salinities. Future studies hope to investigate the physiological effects of unfavorably salinities on these pathogens and determine if anthropogenic freshwater releases can alter their distribution and abundance.

Quantifying Movement Patterns and Nursery Habitat Use of Endangered Scalloped Hammerhead Sharks along the Canaveral Bight

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Neonate scalloped hammerheads (*S. lewini* and the newly discovered S. *gilberti*) appear annually near Port Canaveral starting in April, but by August these juvenile sharks are gone (E. Reyier, pers. comm.). It is hypothesized that this coastal zone acts as critical nursery habitat for these endangered species, yet we lack fundamental understanding of how juvenile scalloped hammerhead sharks use this area as they grow; if, when, and why they disperse from this region, and how these populations and essential habitat can be managed and conserved. To address these knowledge gaps, we propose to use active acoustic telemetry to quantify daily movement patterns and nursery habitat use of these two closely related species around Port Canaveral. This project will generate knowledge regarding the nursery value of this region, inform the development of effective conservation and management strategies for these species, and create a blueprint to move scalloped hammerhead sharks toward sustainability.

Digital Holography: A Unique Approach to Studying Planktonic Species Distributions, Harmful Algal Blooms and Biophysical Interactions in the Indian River Lagoon

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Digital holography is an imaging technique that can be used to study particle/organism distributions and characteristics *in situ* in their undisturbed state. The unique nature of holography, i.e. its ability to provide complete spatial distributions of particles as well as the flow velocities over a 3-D sample volume at high resolution, is unmatched by other conventional imaging techniques. Prior applications of a submersible holographic imager (HOLOCAM) to study particle/phytoplankton distributions and algal blooms, within a size range of 1-10000 µm will be presented along with updates on the development of a new generation system capable of long-term, remote deployments (~1 month). The latest system would be uniquely poised to study several critical issues relevant to the health of the IRL, e.g. long-term monitoring of HABs and species composition, characterization of larval concentrations of important fish species, and biophysical interactions such as phytoplankton aggregation/movement in a turbulent flow field.

Did a Disturbance Event Impact the Overwintering Home Range of Common Snook?

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Disturbance events (ex: wildfires, extreme temperature shifts, disease) are occurrences that have increased magnitude, duration, and/or frequency compared to disturbances within the normal disturbance regime. The effects of disturbance events can include changes in behavior, like altering home range. Home range is the space most utilized in an area by an individual; it can include their movements year round or be limited to season. Previous studies have described spawning sites of common snook (*C. undecimalis*),

however overwintering home range within the Indian River Lagoon is still unknown. With the use of acoustic telemetry data this project will identify overwintering home ranges of common snook and describe the changes in their overwintering home range size during the 2010 extreme cold event. It will be focused on the time period of the event (Jan 2-13) between years 2009-2012. The goal is to understand fine-scale movements under normal and disturbance event conditions.

Investigating the Diet of the Invasive Lionfish off Florida's Treasure Coast through DNA Barcoding

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Species of red lionfish have increasing numbers in the Western Atlantic waters. These lionfish numbers cause concern for the native species populations and consequently the fragile balance of the ecosystems. Individual lionfish were caught from two lionfish derbies located off Florida's central Atlantic coast through volunteers. Each lionfish was measured and weighed. The stomachs contents of the lionfish were dissected to later analyze the contents through visual identification and DNA analysis for species confirmation. All prey items were analyzed using BioRad's Fish DNA Barcoding Kit. Each kit enabled us to run DNA extractions, amplify select regions, and confirm successful extractions via gel electrophoresis. Successful reactions were sequenced by Sequetech, and entered into BLAST to determine the species of the prey item. This barcoding technique is significant due to its accuracy and the results we gain by being able to determine the species being consumed by the invasive red lionfish.

Effectiveness of Public Education at Controlling Nonpoint Source Pollution along the Mosquito Lagoon

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Surface runoff from waterfront homes and ponds in the cities along the northern part of the Mosquito Lagoon adds direct sources of nutrients and pollutants into the estuarine system. The project goal is to assess and enhance the waterfront communities' perception on their roles in contributing to and controlling nonpoint source pollution in the Mosquito Lagoon ecosystem. Public education through workshops, exhibits, and long-term engagement with homeowners involved in the project will focus on benefits of living shorelines using native plants and reducing amounts of fertilizer and water. Pre and post surveys will be conducted to assess effectiveness of the public education on their awareness of factors affecting the health of the lagoon.

The Development of a Standardized Sampling Program to Enhance Monitoring of Age-1 Common Snook in Florida Estuaries – What Else Is in the Bag?

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In early 2013, the Fish and Wildlife Research Institute's Fisheries Independent Monitoring program (FIM) began an expansion of sampling efforts to improve abundance estimates of juvenile Common Snook (with focus on age-1 fish) for stock assessments. Although designed to assess juvenile Common Snook, this new sampling effort included habitats and geographic areas (i.e., backwater and tidal creek

habitats; southern Indian River Lagoon) that had been under-sampled by the traditional FIM program. In addition to Common Snook, this new sampling has provided data on a wide variety of other species. These data may prove useful in the preservation of habitat critical for their conservation, as some of these non-targeted are considered threatened species (e.g., Opossum Pipefish) or of important fisheries value (e.g., Atlantic Croaker, Sheepshead, Shrimp, Snapper species).

Validation of a Human-Associated qPCR Assay Used to Assess Fecal Pollution in Environmental Waters

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Fecal waste can pollute environmental waters through sources including septic tanks, agricultural runoff, and wildlife. Fecal indicator bacteria (FIB) are used to assess recreational water quality, but cannot determine the source of fecal pollution. Microbial source tracking (MST) allows the identification of polluting sources using qPCR to target bacterial genetic markers associated with the gut of humans and animals. We are monitoring FIB in water and sediment throughout the St. Lucie Estuary and southern Indian River Lagoon over the course of a year. DNA is being extracted from environmental samples and preserved for MST. We are validating the performance of a qPCR assay to ensure accurate detection in terms of sensitivity and host specificity of human-associated *Bacteroides* HF183. These methods are important for comprehensive water quality assessment and long-term ecosystem monitoring.

What Our Eyes Can't See: Distribution of Microplastic Pollution within Mosquito Lagoon and the Eastern Coast of Central Florida

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Microplastics are a pervasive pollutant, though research focused locally is lacking. We assessed the distribution of microplastics along Mosquito Lagoon and the eastern coast of Central Florida. We hypothesized that samples from the coast would have higher concentrations and that the closest inlet was the primary source of microplastics in Mosquito Lagoon. We collected three water samples (1 liter) from eight locations along the coast and lagoon, ranging from Ponce de Leon Inlet through Canaveral National Seashore, on three separate days in the spring of 2016 (n=144). Using a 0.45 micron filter and 20x magnification, we filtered, counted, and assigned microplastics to commonly used groups; film, fiber, fragment, and microbead. We found no differences in abundance between the coast and lagoon or in samples along the distance gradient from the inlet. Fibers were most prevalent, accounting for 39% and 41% of the findings in the lagoon and coast samples, respectively.

Assessing Damage of *Sphaeroma terebrans* on *Rhizophora mangle* Prop Root Fouling Communities

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The focus of this study will be on the three types of symbiotic relationships found in mangrove systems: commensal, parasitic, and mutualistic. Integral to studying these relationships in mangrove systems is *Sphaeroma terebrans,* a wood burrowing isopod found in mangroves worldwide. *S. terebrans* bores into the aerial roots in mangrove trees causing changes in the root architecture, a reduction in root production, and increased root atrophy. Damage from *S. terebrans* can result in mangrove trees falling over, affecting substantial proportions of stands of trees. These adverse changes to the mangrove tree prop root system do not only affect the mangrove trees themselves but also the organisms that use the prop roots as habitat

and protection. This study is the first to investigate the prop root habitat of red mangroves, an ecologically critical habitat.

Maintenance Dredging of KSC Navigational Channels and Muck Removal

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Kennedy Space Center is dredging navigational channels in the Banana River between the Barge Canal and Vehicle Assembly Building. Sampling prior to dredging shows that potential "muck" sediments exist and KSC may be able to pursue TMDL related nutrient reduction credit as a byproduct of this dredging. If successful, this program may be expanded to other areas in the Banana River.

Changing Times: Abundance and Distribution of Manatees and Seagrass in the Waters Surrounding the Kennedy Space Center, Past, Present, and Future (?)

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The Kennedy Space Center has monitored manatee abundance and seagrasses since 1984 in the Banana River. Starting in 2012, several shifts in manatee use patterns emerged, possibly related to seagrass changes resulting from intense, sustained algal blooms. The density of seagrass drastically declined in 2012, while animal numbers markedly increased. This was contrary to expectations that manatee numbers would decrease as animals redistributed towards other seagrass sites. The following year, the number of manatees did sharply decrease and then steadily increased until 2015. Seagrass density also increased from 2013- 2015. After the 2015/2016 bloom, seagrass density dropped dramatically to below 1% cover and manatee abundance in the northern Banana River reached a 25-year low. Historically manatee usage of the nearby Mosquito Lagoon was common but not remarkable. However, recent aerial surveys and other reports indicate that manatees are now observed in very large numbers in Mosquito Lagoon.

Status of the Florida Atlantic Coast Telemetry (FACT) Array: Expanding Coverage and Collaboration

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Increased utilization of scalable autonomous acoustic telemetry systems now allows the movements of aquatic animals to be resolved over ever-larger distances and extended time periods. From modest beginnings, the Florida Atlantic Coast Telemetry (FACT) Array has grown into one of the largest acoustic arrays in the world, with 24 partner groups located from south Florida though South Carolina, the Bahamas, and Caribbean. FACT members collectively maintain >750 acoustic receivers deployed along a continuum from freshwater to nearshore habitats, and are working to reveal habitat preferences, migration patterns, and reproductive strategies of >50 of our region's most valuable sportfish, shark, and sea turtle species. Of equal importance, the FACT Array has greatly enhanced collaboration among our members, spurring ambitious life history studies once considered unrealistic. Moving forward, the FACT Array is well positioned for assessing the effects of both natural and human disturbances on mobile fauna in the Indian River Lagoon.

Mapping and Trend Analysis of Seagrass Beds along the Coastal Oaks Preserve

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Tracking seagrass cover is important for identifying changes in this critical habitat. We have mapped and compared seagrass cover along the Coastal Oaks Preserve (COP) in the Indian River Lagoon (IRL) from fall 2014 and fall 2016 using ArcGIS. ArcGIS maps were ground-truthed along 8 transects perpendicular to the shoreline, each 100-150 m long, using a $1m^2$ quadrat laid every 10 m. In each quadrat we determined the percent cover, shoot counts, and canopy height of individual seagrass species. *Halodule wrightii* was the most abundant seagrass overall, but *Thalassia testudinum* had the highest percent cover in deeper waters. These maps will provide baseline data to be used to monitor impacts from a proposed restoration project which will reconnect the adjacent mosquito impoundments at the COP to the Lagoon via exchange culverts.

Determining Physical and Ecological Factors Affecting Abundances of Juvenile Indicator Species

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The Indian River Lagoon (IRL), located on the East coast of Central Florida, is the most diverse estuary in the world with over 397 species of fish inhabiting its waters (Gilmore 1995). The IRL generates nearly four billion dollars of annual economic income for Central Florida due to the large number of recreational and commercial fishermen attracted to the diverse waterway (SJRWMD 2016). In order to assess the ecological health of the IRL, young of the year (YOY) *Cynoscion nebulosus* (Spotted Seatrout) and *Lagodon rhomboides* (Pinfish) were collected via seines, measured, and aged. Physical conditions were recorded in order to determine what environmental factors influence the abundance of YOY Spotted Seatrout and Pinfish. In years following high YOY Pinfish recruitment high recruitment of Spotted Seatrout was recorded. The presence of SAV was the most significant factor impacting Pinfish abundance. Other factors impacting abundance were presence of mangrove shoreline between zones D and H, and water temperature due to migrations through Sebastian Inlet.

Following the Oyster Restoration Footprint: Does Oyster Restoration in Mosquito Lagoon Positively Impact Local Bird Communities?

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Intertidal oyster reef restoration has been implemented in Mosquito Lagoon since 2009 and has resulted in increased natural oyster populations in locations previously damaged by recreational boat wakes. The indirect effects of this restoration on surrounding biodiversity are largely unknown, especially in regards to local bird communities. We conducted observational bird surveys within Mosquito Lagoon to evaluate how oyster reef restoration is affecting wading and aquatic bird species. Beginning in September 2016, 16 restored reefs (4 year classes), 4 natural reefs, 4 damaged reefs and 4 reefs proposed for restoration in 2017 were surveyed monthly, recording species abundance, diversity and behaviors. Abiotic variables (wind speed, air and water temperature, salinity) were also collected. This on-going research will build upon a foundation of knowledge on a decade of oyster reef restoration and can be utilized in conservation efforts by coastal resource managers.

Ecosystem Health and Environmental Influences on Innate Immune Function in the Green Sea Turtle (*Chelonia mydas*)

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Green sea turtles (*Chelonia mydas*) recruit to nearshore environments as juveniles. These often degraded habitats are associated with emerging diseases including green turtle fibropapillomatosis (GTFP), however there are few studies on immune function in sea turtles. In this research we quantified phagocytosis in the innate immune system. Phagocytosis was measured by flow cytometry in animals from a degraded habitat (Indian River Lagoon, FL) and a more pristine environment (Trident Basin, Port Canaveral, FL), in animals sampled year-round. Immune function overall was higher in summer than winter. Rates of phagocytosis in sea turtles with GTFP and from degraded environments with increased prevalence of GTFP were low compared to animals from the more pristine environment, suggesting that the environment can alter innate immunological function and thus contribute to the development of disease. These results are similar to earlier studies of adaptive immunity, which was also less robust in turtles from the IRL.

Ecological Disturbances in the St. Lucie Estuary and the Southern Indian River Lagoon, Elucidated through Macrobenthic Monitoring

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Benthic infauna are important indicators of water quality and are used in a variety of monitoring programs to assess overall estuarine health and to follow long-term trends in estuarine communities related to anthropogenic impacts. The infaunal communities in the St. Lucie Estuary (SLE) and southern Indian River Lagoon (IRL) offer several positive attributes: they are relatively sedentary and long-lived, they occupy an important intermediate trophic position, and they respond differently to varying environmental conditions. Fauna and environmental variables have been quantitatively monitored quarterly since February 2005 from 9 sites in the SLE and the IRL. Monitoring data indicate the SLE is ecologically degraded. Considerable negative conditions exist in the South Fork and SLE, which receive frequent freshwater discharges from the C-44 canal. The data clearly indicate that the benthic communities respond quickly to environmental changes and that they reflect changes within the monitored areas in the SLE and IRL.

Examining the Spatial Variability of the Indian River Lagoon

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The Indian River Lagoon is a highly dynamic system, comprising several interconnected bodies of water with multiple inlets on the ocean side and numerous freshwater inputs from rivers, creeks, and canals. These elements, combined with other environmental factors, result in an ecosystem that displays a high level of variation, both over surface areas and with depth. A unique instrument package was assembled to make optical measurements of underway horizontal transects and stationary vertical profiles. These measurements are examined to better understand the causes of horizontal and vertical spatial variability in the IRL and the effect this variability has on the ecosystem as a whole. The importance of spatial variability in the IRL and the effectiveness of this measurement technique for detecting it is also considered as an approach to enhance existing monitoring protocols and technology.

Hydraulic Impact on the St. Lucie Estuary from Lake Releases

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Will freshwater releases from Lake Okeechobee (LO) through S80 create a hydraulic wall at the confluences of South Fork (SF) and North Fork (NF) in the St. Lucie Estuary (SLE)? Will the North Fork act as a lake? A well calibrated hydrodynamic model, CH3D (Curvilinear Hydrodynamic Three Dimensional), was used to study the freshwater release impact on residence time in the NF and the entire SLE. Residence time was calculated for the NF and for the entire estuary for a number of LO discharge rates during both wet and dry seasons. Model results show that during the wet season residence time for the entire estuary decreased with increasing LO discharges, while residence time for the NF did not decrease or increase. During the dry season, residence time decreased with increasing LO discharges for both the entire estuary and the NF. These results suggest that lake discharge would not create a hydraulic wall for the NF during either dry or wet season. In fact, lake release would help flushing in the NF during the dry season. Therefore it's unlikely that lake releases to the SLE through S-80 would result in or enhance algal bloom conditions in the NF.

A Tale of Two Ports: Comparing Distributions of Microbes and Macrofoulers from Indian River Lagoon Inlets

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Transport and establishment of macrofoulers between neighboring ports is a key step in the marine coastal bioinvasion process, and may be regulated by the composition of biofilms that colonize all submerged surfaces. However, it is unclear how biofilms in ports are distributed on resident and imported surfaces and how they might alter subsequent macrofouling colonization. This study documents the distributions of bacteria, diatoms and macrofouling organisms at neighboring inlets. Bacteria were the primary contributors of biofilm variation among locations, while diatoms drove differences between resident and imported biofilms. Fourteen individual macrofoulers from eight phyla demonstrated selectivity for biofilms based on their origin. These results provide further evidence that macrofoulers can detect and respond to differences in benthic microbial communities. Macrofoulers transported between ports will encounter and discriminate among biofilms during recruitment, and understanding biofilm spatial heterogeneity can help clarify how exotic macrofoulers are introduced and established.

From Fragments to Meadows: Seagrass Restoration in the Indian River Lagoon from Nursery Grown Seagrass Fragments

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Florida Oceanographic Society has launched a community-based seagrass restoration program to re-establish seagrass habitat within the Indian River Lagoon (IRL). Seagrass habitats in the southern IRL have declined by 31% in the last year due to impacts from freshwater discharges from Lake Okeechobee and cyanobacterial blooms. The program is based on the non-destructive collection and propagation of detached floating and washed-ashore seagrass fragments in a land-based tank system to provide a seagrass source for restoration efforts. Propagating seagrasses in land-based nurseries may become a critical

necessity if natural seagrass populations continue to decline. In 2016, we propagated and deployed seagrass fragments at four sites in the southern IRL (Stuart and Jensen Beach, Florida). We tested the effect of restored oyster reefs and different planting unit types (bare rhizome, shoot bundles, and seagrass mats) on seagrass restoration success. Success metrics used were survival, shoot density, canopy height, and spread.

Blood Mercury Concentrations in Common Bottlenose Dolphins from the Indian River Lagoon, Florida: Patterns of Social Distribution

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Common bottlenose dolphins inhabiting the Indian River Lagoon (IRL) have among the highest concentrations of total mercury (THg) in blood reported worldwide. We used social network analysis to examine the relationship between THg concentrations in IRL dolphins and their social affiliations. Whole blood samples from 98 individual dolphins with photo-identification sighting histories were collected between 2003-2012. Dolphins were categorized into approximate tertiles of low, medium and high THg exposure. Social network measures and association indices of individuals were examined to determine differences across THg exposure categories. Strong social affiliations of individuals within the highest category of THg were found suggesting shared exposures among dolphins foraging in specific areas of the estuary. Network measures of strength and affinity were significantly higher in the highest exposure category in general. This report used a novel method, social network analysis, to examine exposure to an environmental contaminant in a cetacean population.

Assessing Patterns of Fish Community Diversity in the Indian River Lagoon

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The Indian River Lagoon (IRL) has the most diverse fish community of any estuary in North America. However, it is unclear if patterns of diversity have changed since the seminal work of Gilmore (1977) and Snelson (1983). Here we quantify patterns of fish diversity in different IRL benthic habitats to improve our fundamental understanding of the inhabiting fish communities. We will investigate the efficacy of existing methodologies to assess fish diversity across multiple essential fish habitat-types of the IRL, including restoration sites such as oyster reefs and living shorelines. In addition, we will use a 25-year dataset collected by the Florida Fish and Wildlife Conservation Commission fisheries-independent monitoring program to explore regional-scale patterns of community diversity. These data will be used to quantify fish communities and identify changes in alpha, beta, and gamma diversity over time, ultimately providing novel insights into fish diversity dynamics within the IRL.

Excess Nutrients Can Impact the IRL through Various Pathways: Experimental Evidence

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Two very different experiments illustrate the impact of excess nutrients on the IRL. Experiment 1 used small microcosms (bottles) of water with various levels of nutrients added, then “seeded” with IRL

phytoplankters. Result: there was no response. A full 7 months later, these same bottles were seeded again, this time with IRL water from a bloom area. Result: high nutrients resulted in a bloom in 4 days. In Experiment 2, using mesocosms with pots of the seagrass *Halodule wrightii*, various levels of nutrients were added. Result: high nutrients resulted in seagrass blades becoming covered with a thick layer of epiphytic algae, and this seagrass died in 9 weeks. In conclusion, seagrass can be killed by excess nutrients, whether nutrients are utilized by phytoplankton or by epiphytic algae.

Indian River Lagoon through a Microscope: Microplastics in the Organic Tissues of Oysters and Crabs

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Microplastics are widespread and abundant. Few studies have examined the diversity and abundance of microplastics in wild organisms. The objective of this study was to determine to the quantity and types of microplastics in the organic tissues of eastern oyster *Crassostrea virginica* and the Atlantic mud crab *Panopeus herbstii* from the Indian River Lagoon. The study will also determine whether distance from anthropogenic activities has an effect on the quantity and types of microplastics. Soft organic tissue from oysters and crabs were chemically digested using hydrogen peroxide and a shaking incubator, filtered, and examined for microplastics. Preliminary results show that fibers are the main type of microplastic found in the crab and oysters, with oysters having a higher concentration of microplastics. This research will provide a better understanding of microplastics found in the Indian River Lagoon and how anthropogenic activities effect their abundance and diversity.

Removal of Nutrients from Dredged Muck Residuals Utilizing High-Valence Iron (FeO_4^{2-})

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Dredging of muck in the Indian River Lagoon to reduce cycling of nutrients is underway, and is projected to continue for many years. The dredging process liquefies the sediments, and this slurry is pumped on-shore to large ponds where the easily-settled components are separated. However, a significant amount of the nutrients in the muck slurry will be re-suspended or dissolved within the dredge-water that is returned to the lagoon. Our laboratory is exploring the use of an innovative iron compound (FeO_4^{2-}) to treat this nutrient rich waste stream from the dredging process. This unique compound has the ability to oxidize reduced nitrogen compounds and to precipitate phosphate compounds. Initial treatment results have demonstrated concurrent removal efficiencies of > 99% for both phosphate and ammonia. This paper will describe the ferrate chemistry responsible this high level of treatment, and engineering design concepts for utilizing ferrate systems to treat muck dredge water.

Oysters and Brown Tide in Mosquito Lagoon

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To better understand the relationship between the oyster *Crassostrea virginica* in Mosquito Lagoon and the brown tide *Aureoumbra lagunensis*, we have tracked monthly oyster recruitment since the summer of 2013 when the second bloom of *A. lagunensis* was occurring. A third intense bloom occurred near our monitored oyster reefs from February to November 2016. Our data provide strong evidence of a negative relationship between oyster recruitment and brown tide.

A Short-term Change in Community Structure Due to a Large Meteorological Event in the Indian River Lagoon

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Monitoring of benthic communities can provide a baseline from which to detect changes in a system. Monthly assessments of the fouling community at two test sites, one just north of Sebastian Inlet in the Indian River Lagoon and the other in Port Canaveral, have been performed since June of 2009 and August of 2013, respectively. Previously, these data were used to link shifts in community composition to extreme events due to the decline in health of the lagoon. However, this data set can also be used to examine changes in the fouling community due to short-term exposure to large meteorological events in the lagoon. For example, there was a large die-off of soft-bodied organisms from the fouling community shortly after Hurricane Matthew. The community began to recover by the next assessment period with the recruitment of tunicates and barnacles.

Florida's Fish Kill Hotline: Reporting Sick or Dead Fish for Science

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The Florida Fish and Wildlife Conservation Commission's (FWC) Fish Kill Hotline allows the public and other agencies to report marine fish kills and abnormal fish via phone or online. Fish kills and related fish health issues are recorded in a statewide database. FWC Fish and Wildlife Health staff collaborates with the public, researchers, law enforcement and resource managers to collect samples, obtain data and diagnose causes of mortality and disease events. Fish health is also assessed during FWC's Fisheries Independent Monitoring (FIM) program's population monitoring statewide. In 2015, 264,515 fish ≥75 millimeters (standard length) were collected during FIM sampling with 1,635 (0.6%, 36 taxa) observed to have a gross external abnormality (GEA). Statewide, northern Indian River Lagoon specimens had the highest incidence of GEA's (2.4%). The most common GEA (94.0%) was parasitic infestation. Reporting fish health issues supports FWC in effective assessment of fish and ecosystem health in Florida waters.

Health of Oyster (*Crassostrea Virginica)* Populations in Natural and Restored Reefs along a North to South Gradient in the Indian River Lagoon (IRL), Florida

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The eastern oyster is both a commercially and ecologically valuable species. As a sessile, sentinel species, oysters are often used as indicators of a health ecosystem. Due to the ecosystem services they provide oyster restoration is of prime importance in the Indian River Lagoon (IRL). This aim of this ongoing study is to investigate the seasonal health of both natural and restored oyster reefs in the IRL along a north to south gradient (Mosquito Lagoon to the Jupiter Inlet). Health indices in this study include size and weight measurements, physiological conditions, sex determination, presence of abnormalities, presence of pests (i.e., *Polydora*, *Pinnotheres*, etc.) and prevalence of parasites (*Perkinsus marinus, Bonamia* spp., trematodes, etc.). Data collected to date (Summer 2016, Fall 2016) will be presented.

Benthic Foraminiferal Distributions in the Indian River Lagoon and the Influence of Environmental Factors

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Foraminiferal assemblages were measured in Turkey Creek, Crane Creek, and the nearby IRL. Spatial population patterns were compared with silt/clay content, organic material (OM) content, and environmental factors including salinity, temperature, and dissolved oxygen (DO). Within 145 samples, four species made up >90% of the foraminiferal assemblages, with *Ammonia tepida* dominating at all sites. The average foraminiferal density was between 124.18 (+/-35.03) and 291.85 (+/-90.92) individuals ml^{-1} of wet sediment in the low organic sediments of the IRL near Crane Creek and Turkey Creek, respectively. This was lower ($p<0.01$) than the 754.21 (+/-181.47) individuals ml^{-1} in the intermediate organic sediments in Turkey Creek, and higher ($p<0.01$) than the 20.52 (+/-19.01) individuals ml^{-1} in the channels containing muck. In general, foraminiferal densities correspond strongly to OM and DO, with highest densities occurring between 2-6 mgl^{-1} DO and 2-10% OM. Benthic foraminifera are potentially useful tools for assessing and monitoring estuarine ecosystems.