# Abstracts of Technical Presentations


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## Key Note Address

### *Quo Vadis* Northern Indian River Lagoon? What Recent Conditions Might Tell Us about the Future

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In 2011, the northern Indian River Lagoon experienced unusual blooms of phytoplankton. One bloom, dominated by picocyanobacteria and an unidentified green nanoplankter, was longer and more intense than blooms during the previous two decades. This bloom shaded seagrass, which led to a loss of over 30,000 acres. This event spurred analyses of available data to identify potential triggers, and subsequently, an investment in improving our understanding of key aspects of the system. Since 2011, the lagoon has experienced additional phytoplankton blooms, unusual mortality events, a massive fish kill, and further loss of seagrass. Investigations into conditions in the lagoon have yielded valuable insights into sources of nutrients; changes in the composition of phytoplankton assemblages; cycling of nutrients among major primary producers; the role of grazers; and other aspects of the system. These new insights should prove valuable as efforts to restore the health of the Indian River Lagoon proceed.

## Contributed Papers (Oral and Poster Presentations)

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

### Accumulation of Organic Sunscreen Chemicals in Sharks and Teleost Fish Species

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Sunscreen agents or ultraviolet-filters (UV-filters) are predominantly discharged into the environment through wastewater effluent and recreational activities (e.g., beach use). Some of these chemicals have been shown to be toxic to corals at relatively low concentrations and toxicity endpoints have also been established for other aquatic organisms. These concerns led to the recent ban on the sale of sunscreens containing oxybenzone and octinoxate in Hawaii effective in 2021. We measured concentrations of multiple organic UV-filters in estuarine fish species from the Indian River Lagoon (Florida), which is expected to be impacted by UV-filters through discharge of wastewater effluent and recreational activities. These results will explore trophic level correlations and be the first to examine these contaminants in the ecosystem.

### Population Decline of a Sentinel Fish Species in the Indian River Lagoon: Habitat Shifts and Ecosystem Stressors

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Loss of critical estuarine habitats and degraded water quality due to human activities have impacted some estuarine fish populations. The Gulf Pipefish, *Syngnathus scovelli*, is an estuarine resident species in the southeastern U.S. that is commonly found within seagrass areas and adjacent habitats. Long-term quantitative data indicate the relative abundance and spatial distribution of this species has been declining within the Indian River Lagoon (IRL). Trends in anthropogenic stressors and changes in seagrass or algae abundance in the IRL have been significant in recent years. Pipefish population declines mirror seagrass reductions within the IRL. Preliminary results suggest that reproductive output may be influenced by ongoing environmental changes and that current ecosystem stressors observed in the IRL could lead to sublethal effects with long-term implications on population dynamics of this species.

### Seagrass along the Coastal Oaks Preserve

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Seagrass serves as an indicator of the health within the Indian River Lagoon (IRL). The analysis of three surveys (fall season of 2014-15, 2016, and 2018) shows the trends of seagrass over time in the IRL adjacent to the Coastal Oaks Preserve (COP). Percent cover, shoot counts, and canopy height of individual seagrass species were quantified in quadrats along 8 transects perpendicular to shoreline. While there was some intraannual variability, seagrass beds composed primarily of *Halodule wrightii* and *Thalassia testudinum* were stable. But over these three surveys, there was a change in relative abundance with *Thalassia* declining and *Halodule* increasing. This data can be compared to future observations to monitor impacts from a current restoration project which has reconnected the adjacent mosquito impoundments at the COP to the Lagoon via exchange culverts.

**Understanding the Extremes: Hurricanes and Sediment Microbial Community Resilience**

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Management agencies concerned about how a system is progressing need to consider natural disturbances such as hurricanes that can have massive immediate and sustained impacts on the environment. The data presented here is from three surveys conducted in 2017 (August 31, September 15, and October 31) at four sites in the Indian River Lagoon, FL. Hurricane Irma hit Florida on September 10 as a Category 3 storm and caused precipitous drops in water salinity (>15 ppt) and porewater salinity (>13 ppt) at all sites. Using next generation sequencing we assessed the response of sediment microbial communities to these changes. The microbiome showed major shifts in composition between the three sampling events corresponding primarily to changes in sediment characteristics as well as salinities. This study allowed us to see the effects of sustained water drainage on prokaryotic communities that can be used by agencies to inform decisions regarding water management.

**DNAngler: Using Citizen Scientists and Innovative Molecular Techniques to Monitor Fish in the Indian River Lagoon**

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Citizen science is an emerging field that engages the general public and allows them to make a direct contribution to research. FAU Harbor Branch has recently established its first citizen science program, called DNAngler, which uses environmental DNA (eDNA) to assess fish diversity in the Indian River Lagoon. Two events were hosted at local parks where over 60 anglers were asked to fish for at least one hour, record all fish caught or observed, and take a water sample. Researchers then extracted eDNA from the samples and used metabarcoding in order to detect individual species that were present at the fishing location. Once available, this data will be accessible to the public via a website so that they can track the results from their samples. Positive evaluation feedback has demonstrated the success of this program and its ultimate findings have important implications for managing and conserving local fish populations.

**Wrack: Is It Good or Bad for Living Shorelines? Nutrient Contributions and $CO_2$ Fluxes from Mangrove and Seagrass Wrack in Canaveral National Seashore**

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Volunteers have restored more than 1 km of living shorelines in Indian River Lagoon in the past 7 years. Mangrove and seagrass leaf litter accumulates along these shorelines seasonally and after large storms. We quantified nutrient fluxes from litter to determine its availability for plant uptake and stimulation of microbial respiration of soil organic matter. We conducted a two-month microcosm experiment combining mangrove and seagrass leaves with organic and sandy soils. Treatments were subjected to tidal cycles; at low tide, measurements were made of soil respiration and drainage water was collected for nutrient analyses. Seagrass provided substantial dissolved inorganic nitrogen and soluble reactive phosphorus, while mangrove leaves did not. Similarly, the $CO_2$ flux from seagrass leaves was twice as high as that from mangrove leaves per unit of dry mass. Overall, nutrient fluxes increased and $CO_2$ fluxes decreased in the combined litter+soil treatments compared to summed fluxes from isolated treatments.

**Urban Water Quality in the IRL Watershed: What is Going on in Port St. Lucie?**

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The Indian River Lagoon (IRL) has become increasingly urbanized, during which the water quality has diminished. Urban water quality is a complex issue affected by population, wastewater management, stormwater runoff, fertilizers, and more. The City of Port St. Lucie (CPSL) is the 8th largest city in Florida and growing, meanwhile water quality in the North Fork of the St. Lucie River (North Fork) has experienced persistent bacterial and nutrient pollution. The North Fork terminates into St. Lucie Estuary and thus water quality in the river is relevant to IRL health. CPSL has proactively sought to improve water quality in the North Fork by a thorough examination of sources contributing to the degradation. The data revealed: 1) wastewater is ubiquitously present in the North Fork, 2) residential canals and tributaries are pollutant sources, and 3) that runoff also contributes to the degradation. Next steps will investigate groundwater-surface water interactions in CPSL.

**Influence of Culverts on Mangrove Invertebrate Communities in the Indian River Lagoon**

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The Indian River Lagoon houses a variety of invertebrates, which are ecologically beneficial because they are the basis of the food chain. These invertebrates may be found in mangrove fouling communities and may be affected by culverts – pipes that connect the lagoon to impounded wetlands. In the Coastal Oaks Preserve, new culverts were recently opened to improve connectivity by increasing the natural water flow. Collection plates were installed near existing and new culverts, along with two control sites, to track the recruitment and growth of species in mangrove communities. Images of the plates were taken each week and analyzed using CPCe software to quantify the different species. The community structure of the new culverts is more similar to that of existing culverts than that of controls, and over time they are expected to become equal. Our results justify why new culverts are beneficial to the lagoon's health.

**Food or Trash? Plastic Pollution in Birds of Prey**

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Plastic pollution is unavoidable in the natural environment. Consequences of plastic ingestion include exposure to environmental pollutants and toxin accumulation, causing inflammatory and physiological stress in organisms. Microplastics have been shown to transfer across food webs, however, few studies have examined plastic pollution in apex predatory animals. A study was conducted to determine the abundance of plastic pollution in the gastrointestinal tract in birds of prey. Two species were investigated that have foraging habits around the Indian River Lagoon including *Buteo lineatus (*red-shouldered hawk) and *Pandion haliaetus* (osprey). The gastrointestinal tract was necropsied, chemically digested, and examined for microplastic prevalence. *Buteo lineatus* averaged 36 fibers and 13 fragments per bird while *P. haliaetus* averaged 17 fibers and 6 fragments per bird. FTIR spectroscopy was used for polymer identification. This study offers insight on microplastic pollution in avian predators for plastic management plans in coastal and inland areas.

**Improvements in Water Quality with the Opening of an IRL Impoundment Culvert**

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For over 50 years, water flow between the Indian River Lagoon (IRL) and the South Bills impoundment has been closed. This project measured the change in water quality (dissolved oxygen, pH, temperature, color, depth, conductivity, salinity, and nutrients) at 6 sites in the impoundment and 1 adjacent site in the IRL after the culvert was opened. Continuous water quality data (conductivity, salinity, depth, dissolved oxygen, and temperature) was measured adjacent to the culvert inside the impoundment. Before the opening of the culvert, water in the impoundment was hypoxic, concentrated with organic matter, and had stagnant salinity levels. The opening of the culverts led to an increased dissolved oxygen, increased salinity, and decreased Total Dissolved Nitrogen. The speed of these water quality changes were determined by the culvert's proximity to the IRL. With the improvement of water quality, the impoundment is better suited to support life and benefit the health of the Indian River Lagoon.

**Impacts of Scleractinian Tissue Loss Disease on Corals in Southeast Florida**

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An unprecedented disease outbreak throughout the Florida Reef Tract (FRT) is contributing to the decline of reef-building scleractinian corals. Characterized as scleractinian tissue loss disease, this unknown pathogen affects at least 22 species of coral and has rapidly spread throughout the FRT. Infected colonies are being fate-tracked at two different locations within the northern FRT. We have optimized and employed a low-cost and time-effective protocol for generation of 3D models to assess disease progression rate and percent mortality of the infected coral colonies. Transcriptomic responses of coral's to disease will be analyzed using RNA-Seq to identify potential gene markers indicative of initial infection and coral stress responses. Coupled with quantitative data regarding disease progression from 3D models, corresponding coral physiological responses to this pathogen will provide novel information that may influence mitigation and management strategies for current and future coral disease outbreaks.

**Save Our Indian River Lagoon (SOIRL) Living Shoreline Monitoring for Brevard County**

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To evaluate the efforts of the Save Our Indian River Lagoon restoration projects in Brevard County, UCF is conducting monitoring at 1, 3, 6, and 12 months post-restoration. Monitoring has happened at 3 locations in Brevard County thus far: 1 oyster breakwater site and 2 vegetation-only sites. Oyster breakwater site monitoring included visual census of intact shell bags and more exhaustive data collection for emptied shell bags. For both, we recorded number of live oysters, shell lengths, and presence of live competitors and predators. At vegetation-only sites, mangroves and cordgrass planted within the restoration areas were counted to determine plant survival. One-month monitoring at the oyster breakwater site found 84% oyster survival, while 3-month monitoring at vegetation-only sites found 72-91% survival of mangroves and 56-87% survival of cordgrass. As we continue monitoring, this data will help Brevard County evaluate their plans to meet the county's water quality goals.

**What is the Coastal Program?**

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The Coastal Program provides technical and financial assistance in the form of cooperative agreements to agencies and landowners to restore and protect fish and wildlife habitat in several focal areas in Florida. The Indian River Lagoon is a focal area for both the North Florida and South Florida Coastal Programs. Our typical projects average around $30,000, result in ecological restoration, and have in-kind or cash match (1:1). We also prioritize projects that would significantly contribute to not listing, downlisting, or delisting federally listed or at-risk species, which are species that have been petitioned for listing. Projects that do not involve federally listed or at-risk species are unlikely to receive funding.

**Impacts of Oyster (*Crassostrea virginica*) Reef Restoration on Threatened and Endangered Bird Populations in Mosquito Lagoon**

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Birds are often used as indicators of ecosystem health. Extensive oyster reef restoration efforts have taken place in Mosquito Lagoon; however, little is known about the impact of restoration on bird populations. Mosquito Lagoon is home to numerous threatened and charismatic bird species, such as the American oystercatcher, which are important drivers of ecotourism in the area. The goal of our study is to use data from both monthly bird surveys and citizen scientists to determine if and when the abundance and behavior of birds on the restored reefs becomes similar to natural, intact reefs. Based on the first year of survey data, we found that while community structure was similar across reef types, significantly more foraging behavior was observed on the natural and restored reefs. We are continuing to track these, plus more recently restored reefs, as they change over time.

**Habitat Selection and Movement Patterns of Juvenile Goliath Grouper (*Epinephelus itajara*) in the Southern Indian River Lagoon**

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Goliath grouper populations have rebounded in U.S. waters from near extinction to an unknown level of recovery following the closure of the fishery in 1990. Population estimates that often rely on traditional stock assessment methods are not available for this species and thus alternative methods must be utilized to address knowledge gaps. Most research efforts to date have focused on adults residing offshore along reefs and their associated spawning aggregations, but little information exists on Goliath grouper during their inshore, juvenile stage when they are dependent on estuary nursery habitat. This ongoing project that began in 2017 utilizes acoustic telemetry along with genetic analysis and traditional tagging methods to monitor juvenile Goliath grouper population dynamics in the southern Indian River Lagoon as they undergo their ontogenetic shift in habitat utilization. Results will help to better understand the ecology and life history of this iconic species.

**The Indian River Lagoon: A Microplastics Hotspot?**

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Microplastics, plastic pieces less than 5 mm in size, have been found in a myriad of environments and organisms across the world. Previously, record concentrations of microplastics have been documented in invertebrates and water collected from Mosquito Lagoon, the northernmost portion of the Indian River Lagoon. Our objectives are to determine if microplastics are as pervasive through the Indian River Lagoon system, from Ponce de Leon inlet to Jupiter inlet. We will collect and examine monthly water samples, quarterly organismal tissue, and excretions from eastern oysters, *Crassostrea virginica*, to quantify microplastics. Using FTIR analysis we will examine the polymer composition of found microplastics. Through the power of partnership and citizen science, we aim to address the importance of spatial and temporal variation of sampling, the ability of *C. virginica* to excrete microplastics, and if there is a correlation between microplastic abundance in the water column and *C. virginica*.

**Indian River Lagoon: Quo Vadis? The Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) Revision – Looking Ahead to 2030**

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The Indian River Lagoon National Estuary Program (IRLNEP) Management Conference developed a full revision draft of the 2008 IRL CCMP during the IRL Council Fiscal Year 2017-2018. The heart of the new CCMP is centered around 32 vital signs for Indian River Lagoon health that align with the IRLNEP Mission: “One Lagoon – One Community – One Voice”. The presentation will: share details about the new CCMP and how it addresses current and emerging IRL issues; provide an update on the current status of the CCMP revision and adoption process; discuss IRLNEP priority milestones and actions for 2019; and look ahead over the next decade towards 2030.

**Central-place Foraging by GPS-tagged Manatees around Warm-water Refuges in the Northern Indian River Lagoon**

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Florida manatees require access to thermal refuges during winter because of their vulnerability to cold-related stress and mortality. Manatee attendance patterns at warm-water sites, foraging movements, and thermal regimes were investigated in the northern Indian River Lagoon (NIRL) during 5 winters (2010-2015) by tracking 57 manatees outfitted with Argos-linked GPS tags. Time spent sheltering at warm-water sites in the NIRL increased as ambient water temperature declined below 21°C, reaching ~80-90% when temperatures dropped to <15°C. During prolonged cold weather, visits to thermal refuges commonly lasted a week in duration (up to 32 days), during which time manatees fasted. Central-place foraging was mostly directed to seagrass beds within ~30 km of warm-water sites. Manatee foraging range was constrained by water temperature, shrinking considerably during cold weather, when foraging trips were often brief. Manatee winter distribution within the NIRL shifted after drastic loss of seagrass due to the microalgal ‘superbloom’ in 2011.

**Shoreline Characterization in the Northern Indian River Lagoon**

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The purpose of this project was to evaluate current conditions of estuarine shorelines in the northern section of the Indian River Lagoon system, including Mosquito Lagoon, north Indian River, and Banana River. From January 2016 through June 2018, we evaluated structural and functional characteristics of 374 miles of shoreline, from Ponce Inlet in Volusia County to Sebastian Inlet in Brevard County (11,000+ data points). Hard-armoring accounted for approximately 50% of total shoreline, evenly divided between shoreline with bulkheads (25%) and hardened slopes (25%). Forty-five percent of shoreline without hard-armoring had anthropogenic alterations (i.e. mosquito impoundments, railroads and roadways, residential and commercial development); only 5% of non-armored shoreline was classified as wetland habitat, with minimal slope and a native plant community. We are working with local governments and stakeholders to utilize this dataset in the development of a restoration suitability model to support restoration and conservation in this region.

**Comparing Groundwater Nutrient Concentrations in Turkey Creek Neighborhoods with Septic Tanks, Sewer, and Reclaimed Irrigation**

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Reducing nutrient loads is a major focus of regional restoration initiatives for the IRL. In late 2016, Florida Institute of Technology, Marine Resources Council, and Applied Ecology, Inc. initiated a pilot study to develop a methodology for allocating groundwater sources of nutrients as may contribute as much as 25% to 50% of nutrient loads. Eleven shallow groundwater monitoring wells were installed in the Turkey Creek watershed, a tributary to the Indian River Lagoon. Four treatment areas (septic, sanitary sewer, reclaimed water, and natural), were selected based on similar soil and flow dynamics. Results from 15-months of water quality sampling for nutrients and fecal coliforms and statistical comparisons will be presented for each treatment type. Results from this project will improve the understanding of groundwater nutrient sources and refine groundwater loading models used to advise priority areas for septic to sewer conversions, updates to wastewater treatment facilities, and sewage infrastructure retrofits.

**Mercury Exposure and Tissue Concentrations among Elasmobranchs in the Southern Indian River Lagoon, Florida**

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Mercury is a heavy metal that poses a threat to the health of humans and marine organisms. Due to their position as upper level predators, elasmobranchs are at a higher risk for mercury accumulation due to biomagnification in the food web. Previous studies demonstrated that sharks contain high mercury concentrations, but less is known about the accumulation in other elasmobranchs such as rays. Total mercury concentrations from 12 species of elasmobranchs caught throughout the southern Indian River Lagoon between 2016 and 2018. There were significant differences in mercury concentrations among the species sampled. Concentrations were examined for differences across species, life stage, gender,

geographic location and habitat will be presented. Additional data are needed to evaluate temporal and spatial trends along with the potential health implications of exposure.

**A Living Shoreline Suitability Model for Indian River Lagoon: Integrating Hydrodynamic Frequency Analysis with Shoreline Surveys to Target Site-Specific Stabilization Techniques**

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Shoreline erosion is a threat to both property and lagoon ecosystem functionality. An integrated restoration suitability model combines high-resolution field survey data with long-term wave modeling and risk analysis to identify and prioritize vulnerable shorelines. Using atmospheric reanalysis data and observed water levels, we conducted long-term frequency analyses of lagoon water level, wind speed, and direction. Wind and water level data were applied as inputs to the Simulating WAves Nearshore (SWAN) model, and historical frequency distributions of wave height were created for every 100 m of shoreline. Risk of boat wake incidence was assessed at the same resolution. Modeled hydrodynamic data were integrated with surveys conducted on the ground, such that specific sites are matched to stabilization methods likely to be robust within prevailing hydrodynamic conditions. This planning tool will assist managers in directing successful shoreline stabilization projects. Methods developed are transferable to other regions with mangrove vegetation and/or oyster.

**Modeling Patterns of Occurrence in Eastern Oysters (*Crassostrea virginica*) Growing on Alternative Intertidal Substrate**

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Eastern oysters are a keystone species in estuaries. Most studies focus on the services provided by biogenic oyster reefs, but research shows oysters growing on alternative substrates such as mangrove prop roots and seawalls provide many of the same benefits. The goal of this project is to create a predictive model to understand where eastern oysters growing on alternative substrates occur. Metadata collected by UCF, USGS and SJRWMD was used to assign water depth, distance to a natural reef, slope, intertidal width, shoreline substrate, water temperature, specific conductance, pH, dissolved oxygen, turbidity, total chlorophyll fluorescence, and phycocyanin fluorescence to 1208 shoreline points that either lacked or included oysters growing on alternative substrate. A logistic regression was ran in Rstudio to determine which factors significantly predicted the occurrence of these oysters, which were then used to create a model in ArcMap10.6 showing where oysters on alternative substrate are likely to occur.

**Options for Remediation of Fine-Grained, Organic-Rich Sediments in the IRL System**

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Benthic fluxes of nitrogen (N) and phosphorus (P) from fine-grained, organic-rich sediments, locally called “muck”, contribute 30 to >40% of the annual inputs of these nutrient elements to the central and northern IRL. As part of multifaceted remediation efforts, this internal source of N and P must be decreased. At present, dredging is the only generally practiced method for muck remediation; however, we are investigating aeration and subaqueous sand capping to complement or substitute for environmental dredging. These other techniques may be useful, especially in harbors and canals where dredging is

limited by proximity to docks and seawalls. Results from aeration showed 50% lower benthic fluxes of N and P in an aerated canal relative to a control canal when atmospheric oxygen was effectively delivered to the sediments. Preliminary results from sand capping show reduced fluxes plus the addition of a sandy bottom at depths still within the photic zone.

**Adventures of Seagrass Wrack: How Wrack Effects Growth and Survival of Mangroves along Living Shoreline Restoration**

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Mangroves are essential for preventing shoreline erosion. Three studies were conducted on how wrack accumulation within Mosquito Lagoon affects the growth and survival of *Laguncularia racemosa* (white mangroves), *Avicennia germinans* (black mangroves), and *Rhizophora m*angle (red mangroves). The first goal was to determine seasonal wrack abundance and diversity in Mosquito Lagoon. We found that wrack varies throughout the year with the highest amount of wrack accumulation in the fall. Experiments focused on the impact of wrack on mangrove propagule and juvenile plant survival and growth. Each pot contained one *A. germinans*, *L. racemosa*, or *R. mangle* propagule or juvenile plant either floating in water or just blank pot or covered with wrack or mimic wrack. Wrack positively influenced all three species of mangrove propagules and juvenile plants. This study offers insight for restoration efforts in areas with high seasonal wrack.

**A Holistic Approach to Shoreline Restoration: Factoring for Shoreline Nesting Species in Our Living Shoreline Projects**

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Living shorelines have become a growing trend in coastal restoration and sea level rise initiatives across the country, including along the Indian River Lagoon (IRL). The use of native vegetation and/or living reef to mitigate for erosion of high energy shoreline can be much more environmentally beneficial than traditional armoring techniques, such as seawalls. While bare sandy shorelines are sometimes prime candidates for restoration or enhancement, they are also prime nesting sites for some IRL faunal species. Seabirds, shorebirds, diamondback terrapins (*Malaclemys terrapin tequesta*), and Atlantic horseshoe crabs (*Limulus polyphemus*) seek bare, unobstructed sandy shorelines for nesting. These open beaches are also used as loafing and foraging areas by some species. These types of habitat use should be considered during living shoreline project development and site selection.

**eDNA Surveys in the Indian River Lagoon: Baseline Data for Long-term Monitoring of Fishery Resources in the Face of a Changing Ocean**

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For over 20 years the FWC has been conducting monthly seine and trawl surveys in the IRL. The resulting data are the mainstay on which fisheries and conservation decisions are based. Despite this intensive effort, many key species are systematically missed because of gear bias and a focus on soft bottom habitats. Through recent advances in sequencing and molecular techniques, a new approach offers great promise for the rapid and cost-effective monitoring. Detection of environmental DNA (eDNA) – free-floating DNA that is passively shed by all aquatic organisms – will circumvent many of the

challenges of traditional survey methods and can be used across any habitat type. We propose a detailed survey of the IRL using eDNA sampling. We are working directly with stakeholders at FWC and the KSCEP to leverage their ongoing efforts while using existing habitat maps to expand sampling across habitat types not available to traditional FWC survey techniques.

**Effects of Toxic *Pyrodinium bahamense* on the Clearance Rate of Eastern Oysters and Hard Clams**

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The toxic dinoflagellate, *Pyrodinium bahamense*, blooms most summers in the Indian River Lagoon (IRL). It is a relatively slow growing alga yet forms high biomass blooms, suggesting contributions to losses (e.g., grazing, transport) are low. Restoration efforts of filter-feeding bivalves, therefore, could potentially serve as a tool for bloom mitigation if bivalves can effectively consume this alga. We investigated clearance rate responses by shellfish species native to Florida – eastern oysters (*Crassostrea virginica*) and hard clams (*Mercenaria* spp.) – when fed an IRL isolate of *P. bahamense*. The bivalves successfully consumed *P. bahamense*, but grazing was higher on nontoxic algae. Clearance rates were high enough to suggest bivalve grazing could result in significant removal of *P. bahamense* during blooms; however, the dinoflagellate cells in feces were often still intact. Future experiments will investigate viability of cells in feces as well as toxin accumulation and clearance rates in response to extended exposure time.

**Is the South Central Indian River Lagoon the IRL's Ark?**

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In the last eight years, the northern Indian River Lagoon has experienced a series of unprecedented events, beginning with the 2011 "Superbloom" and the 2012 brown tide which led to large losses in IRL seagrass and a catastrophic fish kill in 2016. To the south, Lake Okeechobee discharges occur every 3-5 years in "wet years" with devastating loses to seagrass beds, oyster reefs, and other biological resources in the St. Lucie Estuary and nearby IRL. Over the last 10 years, seagrass beds in the South Central IRL (SCIRL) have remained relatively stable despite significant environmental stressors. The SCIRL is an important refugium for seagrass beds and the organisms they support. Continued research on seagrass beds in the SCIRL will further enhance understanding of the resilience of IRL biota and their ability to respond to environmental changes that are happening at an increasing frequency and intensity though the IRL system.

**Benthic Flux Measures in the Loxahatchee River Estuary**

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Seagrasses in the Loxahatchee River estuary (southern IRL) are on the decline. Seagrass in the Loxahatchee is often considered 'diminutive' in nature, prompting us to question the loss of ecosystem function associated with the loss of these seagrasses. In a pilot study, we used paired light/dark benthic flux chambers to quantify primary productivity (PP; light chambers) and sediment oxygen consumption (SOC; dark chambers) in the Loxahatchee River Estuary. This preliminary work identified a flux of 3,000-7,000 mmol $O_2$ $m^{-2}$ $h^{-1}$ in mixed species (*H. johnsoni* and *H. wrighti*) seagrass beds with shoot densities ranging 200 - 1,300 individuals $m^{-2}$, comparable to lush, valued *Zostera* beds. Although we measured high PP, SOC was quite low (< 1,000 mmol $O_2$ $m^{-2}$ $h^{-1}$ flux). More work is needed to further

quantify variations in PP and SOC, but these results suggest that even diminutive seagrasses play an important role in PP.

**Florida East Coast Diamondback Terrapin in the Southern Indian River Lagoon**

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The Florida East Coast Diamondback Terrapin is a terrapin subspecies found from St. Johns Country to Biscayne Bay. While studies in the early 1980s reported a large population of terrapins in the northern IRL, by 1993 this population was shown to be experiencing a severe decline. A recent project by the Brevard Zoo has begun studying populations in the northern IRL, but very little is known about terrapin populations in the southern IRL. There is concern about the conservation status of this species and subspecies. Our goals for this project are to conduct searches for terrapins in the southern IRL, collect tissue samples for a genetics study of this species, and determine habitat usage, population dynamics, and fecundity rates for this species. With this data we will be able to establish baseline information on current terrapin populations in the southern IRL.

**The Lagoon Science Bus: Rolling out Science and Engineering to Local Schools**

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The Science Bus is a refurbished RV with a self-contained laboratory and research equipment. Florida Tech faculty and graduate students use the Science Bus to visit local schools, teaching children the importance of our coastal waters from both a science and engineering perspective. Equipment housed inside of the Science Bus includes microscopes, computers, water quality sampling units, handheld spectrometers, a water-proof drone, a meteorological station, plankton nets, and seine nets. Multiple hands-on stations inside and outside of the Science Bus allow for interactive learning, with specifics on water quality, density, oysters, seagrass beds, sediment transportation, plankton, and instrumentation. In a collaboration with the Launch STEM Careers Project, the Science Bus will visit eight Brevard County schools in 2018-2019 to engage girls and young women in STEM related activities focused on the Indian River Lagoon.

**Developing Biogeochemical Indicators of Oyster Reef Restoration Success: Changes in Carbon Cycling and Microbial Dynamics**

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Oyster reefs provide a wide variety of ecosystem services, but despite their many benefits over 20% of oyster reefs in Mosquito Lagoon have been degraded, primarily due to boat wakes that redistribute oysters above the intertidal zone. Ongoing reef rehabilitation provides a valuable opportunity to develop and measure biogeochemical indicators of restoration success, which are currently nonexistent. Utilizing a BACI (Before-After-Control-Impact) sampling design, sediment cores from dead, live, and restored oyster reefs were analyzed to evaluate changes in $CO_2$ flux and microbial community dynamics. Within the first year of restoration restored reefs exhibited the most change, with a ~500% increase in $CO_2$ flux and a 650% increase in microbial enzyme activity, suggesting that these biogeochemical indicators can be important metrics of restoration success. Evaluating how reef restoration influences carbon cycling and

soil microbial communities can provide additional metrics of success that are critical to reef function, but often overlooked.

**Culverts Work: A Case Study into Enhanced Water Flow in Impounded Wetlands**

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In the quest for a healthier Lagoon, the Indian River Land Trust is investigating new approaches to improve water quality in the impounded wetlands bordering the Indian River Lagoon (IRL) in Vero Beach. New culverts were installed in 2017, which allowed for the comparison of various parameters that indicate the viability of the Coastal Oaks Preserve (COP) over two years. Seven sites were sampled for the following: nutrients (nitrogen and phosphorus), pH, salinity, dissolved oxygen (DO), temperature, and *Enterococci* (fecal indicator bacteria). The opening of new culverts led to higher DO, pH, and salinity, as well as lower *Enterococci* counts. The enhanced flow of water has significantly improved the tidal exchange and water quality in the impoundments, completing one of the management goals of the Indian River Land Trust.

**Source and Concentrations of Surface Water Nutrients from Residential Waterfront Homes in Brevard County, Florida**

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Development along the Indian River Lagoon (IRL) in East Central Florida has resulted in significant degradation in water quality over time. These impacts have culminated in fish kills and large-scale algae blooms. In urban environments, numerous sources of nutrients have contributed to increased nutrient loads in surface waters including stormwater, organic materials, and urban fertilizer. Nitrogen and phosphorus pollution from urban fertilizer use has been addressed at the state, county, and municipality level. Yet the success of these efforts are rarely evaluated. This project seeks to validate these efforts in partnership with residents at Tortoise Island, Satellite Beach. The project is designed to assess the source and concentration of nutrients from surface water associated with waterfront homes with or without Florida Friendly Landscaping™. Surface water samples from these waterfront homes were collected from homeowners and Master Gardener volunteers during the wet and dry season and analyzed for concentrations of nitrogen forms and nitrogen and oxygen isotopes of nitrate. The sampling is designed to compare nutrient concentrations in runoff from differing landscape designs, compare the nitrogen isotopic signature to that of known nitrogen sources in surface waters, and evaluate the impact of the fertilizer ordinance blackout that is in effect during the wet season (June 1-September 30).

**Quantifying the Relationship among Dissolved Oxygen, Algal Blooms, and Fish Kills in the Indian River Lagoon**

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The aim of this study is to quantify the spatial and temporal dynamics of dissolved oxygen (DO, mg/L) and chlorophyll *a* levels (*u*g/L, as a proxy for algal blooms) in the Indian River Lagoon. These data in turn will be used to model the correlative relationships among algal blooms, DO, and fish kills throughout the lagoon. More specifically I will explore the response of fish community dynamics before, during, and after hypoxic events (i.e., when DO drops < 2 mg/l). This study will provide a greater understanding of fish community responses to algal bloom-related disturbances by quantifying the spatial and temporal

response of the fish community to hypoxia, through an assessment of the relationship among the abiotic changes caused by algal blooms. This information will help guide the development of management and restoration strategies to increase the resilience of the IRL fish community to future disturbances.

**Anthropogenic Contaminants in Stranded Cetaceans: How Our Addiction to Convenience is Affecting Charismatic Marine Megafauna**

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Contaminants are released into coastal environments from human activities, including manufacturing and the use of consumer products. These anthropogenic contaminants biodegrade slowly, bioaccumulate in organisms, and can cause reproductive, immune, and developmental effects on wildlife; however, the biological effects of many of these contaminants remain unknown. This study aims to expand the knowledge base concerning concentrations and biological effects of anthropogenic contaminants in stranded cetaceans. We analyzed 66 cases of stranded odontocetes. Representative liver samples were evaluated for 12 inorganic toxicants, and blubber samples were analyzed for 5 known endocrine disrupters. Histopathologic findings included: pheochromocytomas, pituitary periadenitis, and multifocal centrilobular hepatocellular necrosis, which positively correlated to elevated concentrations of BPA, triclosan, and mercury, respectively. Results from this study provide information on possible sublethal effects of exposure to certain contaminants and suggests detrimental health effects that could impact population trends for organisms in ecosystems like the Indian River Lagoon.

**Community and Trophic Dynamics of Sportfish in Response to Restoration in the Indian River Lagoon**

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Coastal habitat restoration improves habitat degraded by anthropogenic disturbances, thus improving ecosystem structure and function. Furthermore, restored habitat provides foraging opportunities for predators, thereby improving trophic structure. Declining oyster reefs in the Indian River Lagoon (IRL) have impacted economically important fisheries, resulting in dedicated oyster reef restoration projects. To assess the impact of this habitat restoration on sportfish communities and trophic structure, we quantified sportfish diversity and abundance, gut contents and stable isotopic signatures in a Before-After-Control-Impact experiment. Ten species of sportfish associate with restoration, with variable abundances over time. Further, mangrove snapper *Lutjanus griseus* consume more fish at live oyster reefs compared to dead, with restored reefs intermediate to these controls. Similarly, stable isotope composition of fish at live reefs are carbon enriched compared to dead, with restored reefs gradually intermediate. These results can be utilized to develop more effective restoration-based solutions to guide management and conservation of IRL sportfish.

**Does Oyster Age Matter? Filtering Ability and Nutrient Release from Young versus Mature Oysters**

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Eastern oysters from Mosquito Lagoon were used in a controlled laboratory study to test for the influence of age class on filtration and biodeposit nutrient content. Oysters were classified into two age groups: one year old or less, which were collected from a recently restored section of reef and greater than one year old, which were collected from a natural, undisturbed section of the same reef. Oyster clusters were placed into 20 gallon tanks and allowed to filter lagoon water for a 24 hour period during which chlorophyll-*a*, total suspended solids, and dissolved nutrient removal were measured. After the filtration period, oyster feces and pseudofeces from each tank were collected in glass jars and analyzed for carbon, nitrogen, phosphorous and chlorophyll-*a* content. This study tested the hypothesis that differences in sediment nutrients between restored and natural reefs are due to a difference in the filtering ability of young versus mature oysters.

**Biological Responses to Aeration in an Estuarine Canal with Fine-Grained Organic-Rich Sediments**

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Fine-grained organic-rich sediments (FGORS), or "muck", are accumulating in the Indian River Lagoon (IRL). IRL muck fluxes nutrients into the water column and fuels algal blooms. One unproven restoration method is water column aeration, introducing oxygen to neutralize organics and toxic gasses. A pilot aeration experiment has been initiated in Redwood canal (Satellite Beach, Brevard County, Florida), a residential canal connected to the IRL estuary. To verify the efficacy of aeration for reducing muck and toxicity, phytoplankton and benthic infauna were monitored before, during and after aeration. Results were compared to those of a control canal. It was found that the planktonic communities in the two canals did not diverge. However, in the winter, the aerated canal developed a benthic community that was absent in the control canal. This community included polychaetas, bivalves and crustaceans. These results may be useful for evaluating aeration as an ecological restoration technique.

**Abundance and Community Richness of Benthic Amphipods in a Shallow Subtropical Estuary**

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Accumulation of Fine-Grained Organic Rich Sediments (or "muck") in the Indian River Lagoon (IRL) creates stressful, sometimes uninhabitable conditions for benthic flora and fauna, with far-reaching ancillary ecosystem impacts. In an attempt to ameliorate the condition of IRL sediments, environmental muck dredging was undertaken in Palm Bay of Turkey Creek, a tributary to the Indian River Lagoon (Brevard County, Florida). Amphipod community richness and species' abundances were followed and compared under shifting sediment conditions. Eight amphipod species were observed during the study: *Eusirus cuspidatus*, *Cymadusa compta*, *Grandidierella bonnieroides*, *Gammarus macronatus*, *Cerapus tubularis*, *Corophium* sp., *Grandidierella* sp., and *Jassa* sp. Amphipod densities ranged from 18±10 - 668±587 individuals $m^{-2}$ in sandy sediments to 0±0–11±11 individuals $m^{-2}$ in muck. *Cymadusae compta* appeared in muck sites only after the dredging. Sediment characteristics have modest correlations with amphipod community richness: organic matter ($R^2$ = 0.28, p-value <0.001), water content ($R^2$ = 0.28, p- value <0.001) and silt-clay content ($R^2$ = 0.25, p-value <0.001).

**Ecosystem Trends in Mosquito Lagoon: Are Oyster Reefs Being Replaced by Mangrove Islands?**
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Ecosystem shifts have been observed in many coastal systems: mangroves shift to salt marshes and vice versa, kelp forests convert to sea urchin barrens. However, a conversion from oyster reefs to mangrove islands has yet to be documented anywhere except anecdotally in Tampa Bay. We used aerial and satellite imagery to determine if there was a significant colonization of oyster reefs by mangrove trees in northern Mosquito Lagoon. ArcGIS was employed to digitize oyster reef area and 'mangrove stands on oyster reef' area for multiple years from 1943 to 2017. The 1943 areas were used as the base for any change seen in subsequent years. Preliminary results show a significant increase in the mangrove: oyster area over the 74 years. We are currently determining if the shift is naturally or anthropogenically induced and if these patterns are an indicator of larger ecosystem changes.

**Can Elevated Salinity Trigger the Viable But Nonculturable State in the Marine Pathogen *Vibrio vulnificus*?**
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Bacteria from the genus *Vibrio* cause 80,000 illnesses in the United States every year, the majority of which occur in Florida. One species, *Vibrio vulnificus*, which can cause potentially fatal wound infections, is frequently found in the Indian River Lagoon. This pathogen shows a strong negative correlation with salinity, rarely being found in areas approaching 35 ppt. *V. vulnificus* incubated at elevated salinity showed a decline in culturable cells but was shown to remain viable when observed using fluorescent staining and high content imaging. These data indicate *V. vulnificus* may enter the Viable But Nonculturable (VBNC) state in response to this unfavorable environmental condition. This is highly significant to the Indian River Lagoon, where salinity fluctuations occur due to tides, rainfall and freshwater releases, bringing these pathogens in and out of their optimal salinity range, and potentially triggering the VBNC state as a survival mechanism.

**2007-2018 Changes in Seagrass Distribution in the Loxahatchee River Estuary**
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Seagrass studies from around the globe, including the Indian River Lagoon (IRL), have reported that seagrass presence is declining at an alarming rate. These declines are often attributed to anthropogenic activities including coastal development, urban and agricultural runoff, and altered salinities. Here we quantify changes in the distribution of seagrasses in the Loxahatchee River estuary, located in the southern IRL. From 2007 to 2018 over half (65%) of the 233 sample points that had seagrass present in 2007 showed a loss of seagrass. 36% of this loss was extreme, going from a continuous seagrass bed to completely bare. Despite being outside the influence of factors impacting other regions of the IRL, the Loxahatchee River estuary has shown a significant decline in seagrass since 2007.

**Pulling Back the Curtain on Biosynthesis in Harmful Algal Blooms**

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The prevalence and intensity of Harmful Algal Blooms (HABs) in the Indian River Lagoon (IRL) has been increasing. The mechanisms by which these algal blooms become toxic are not well understood. Identifying the taxonomic composition of the surrounding water and the presence of gene clusters involved in the biosynthesis of HAB toxins gives greater insight into the environment of HABs and their functional pathways. In order to accomplish this, total DNA extracted from water samples collected from 20 locations along the IRL will be sequenced using high-throughput sequencing technologies. These DNA sequence data provide snapshots into the biomolecular environment of the HABs. A novel workflow will be developed integrating DNA sequence data with molecular biology methods to enhance the taxonomic identification and genetic environment of toxin biosynthesis. This will lead to a better understanding of the biomolecular dynamics responsible for HAB toxin production and potentially prevention.

**Business in the Estuary, Party in the Sea: Striped Mullet (*Mugil cephalus)* in the Indian River Lagoon**

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Environmental enterprises in the Indian River Lagoon (IRL) supply nearly 10,000 jobs and generate $1.6 billion dollars a year. The waters contain iconic species of sportfish, including red drum and sea trout as well as their lower trophic level prey such as snapper and mullet. Striped mullet (*Mugil cephalus*) are both commercially valuable and an indicator of ecosystem health. In the fall, mullet in the IRL undergo an annual migration from inshore foraging habitats to oceanic spawning sites. However, their actual migratory pathways remain unknown. To address this knowledge gap, I utilized passive acoustic telemetry to assess migration patterns of *M. cephalus* within the IRL. Network analyses were performed to highlight potential conservation areas of interest and identify sites in need of management. The knowledge generated from this project will inform the development of future management strategies for striped mullet and provide a framework for sustainably managing other migratory baitfish.

**Genetic Differences in the Immune Response of Coastal and Indian River Lagoon Dolphins to Pathogens**

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The bottlenose dolphin, *Tursiops truncatus*, is an apex predator whose health status is indicative of anthropogenic impacts on the Indian River Lagoon. We characterized variation in immune response genes between estuarine and coastal populations. The vertebrate immune response is mediated through cell surface receptors, the major histocompatibility complex (MHC). MHC molecules bind a diverse array of pathogenic molecules and trigger a cascade of defenses. Positive selection was observed for the coding regions of two MHC genes while both coding and promoter regions exhibited geographic differences that likely indicate diversifying selection across habitats. These findings are the first published analysis of cetacean MHC regulatory motifs, which may divulge unique immunogenetic strategies among cetaceans. They also provide a new genetic context for distinct vulnerability profiles between populations, which are key concerns for health and risk management. Our ongoing work will directly relate genetic differences to known pathogenic threats for dolphins.

**Severe Pneumonia and Lymphoid Depletion in a Stranded Bottlenose Dolphin (*Tursiops truncatus*) from the Indian River Lagoon**

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An adult male bottlenose dolphin (*Tursiops truncatus*) was found dead in the Indian River Lagoon, Florida. Pathologic examination revealed chronic, severe, bilateral, suppurative verminous pneumonia characterized by intrabronchiolar nematodiasis (*Halocercus* sp.). Histologically, this fibronecrotizing, hemorrhagic pneumonia exhibited intralesional gram-positive coccobacilli and fungal hyphae. Multiple visceral lymph nodes were grossly enlarged, but histologically characterized by lymphoid depletion. There was prominent follicular lymphoid hyperplasia throughout the spleen. The liver was edematous with sinusoidal inflammation, due to circulating leukocytosis and/or early sepsis, and there was generalized hepatocellular atrophy, indicative of chronic negative energy balance. Via PCR, lung samples tested positive for *Mycoplasma gallinaceum*., and negative for morbillivirus, influenza A, coronavirus, Paramyxoviridae, *Mycobacterium* spp., and *Erysipelothrix* spp. Pulmonary mycoplasmosis, a potentially zoonotic disease, is an uncommon diagnosis in wild dolphins; in this case death is likely attributable to parasitic, bacterial, and possibly fungal co-infections causing severe pneumonia and subsequent lymphoid depletion followed by sepsis.

**Searching for a Harbinger of Change within a Long-term Fisheries Database**

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Estuaries are under stress from intensifying inputs and forcing factors that negatively influence their sustainability. In the Indian River Lagoon (IRL), seagrass has historically been used as a biotic indicator of estuarine health. One fish species that has also been cited as an indicator is the Spotted Seatrout. We suggest that another fish species (e.g., Gulf Pipefish) may also be suitable as an indicator of system health. While not as long-lived as Spotted Seatrout, the Gulf Pipefish is critically dependent upon seagrass and drift algae communities for survival and differs in reproductive biology and feeding ecology. Long-term trends indicate that this species responds quickly to environmental stressors and changes in seagrass or algae abundance in the IRL. In addition, examination of reproductive characteristics indicate that the current environmental stressors observed in the IRL may have sublethal effects which may have long-term implications in the recovery of the systems' faunal communities.

**Results of a Risk-based Vulnerability Assessment of the Indian River Lagoon to Climate Change**

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A risk-based vulnerability assessment of the IRLNEP CCMP indicate 154 management objectives are at risk to five climate change stressors: warmer temperature, changing precipitation, increased storminess, acidification, and sea level rise. Each risk was ranked by numerical score and prioritized as higher, high, and moderate based upon: magnitude of consequence, likelihood, spatial scale, and time horizon. Seventy-eight management objectives were determined to be at higher risk to climate change (i.e., decreased DO), 62 at high risk (i.e., decreased volunteer participation in activities), and 14 at moderate risk (i.e., accelerated spread of exotic and invasive species). Assessment results were informed by stakeholder input in a variety of formats including personal interviews, meetings, real-time polling, and on-line surveys. The next step in this effort to become an EPA sanctioned Climate Ready Estuary is to

integrate specific action plans, formulated to address priority risks, into the ongoing effort to update the CCMP.

**Understanding the Unculturability of *Paracoccidioides brasiliensis* variant *ceti* through Novel Genomic Exploration**

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Similar to *Lacazia loboi*, which causes lobomycosis in humans, *Paracoccidioides brasiliensis* variant *ceti* is a fungal pathogen that infects common dolphins (*Tursiops truncatus*) and is endemic in the southern IRL. Both *L. loboi* and *P. brasiliensis* var. *ceti* are regarded as unculturable in contrast to other *P. brasiliensis* strains previously cultured. Cutaneous granuloma biopsies were collected post-mortem from a dolphin stranded in North Palm Beach, Florida. Genomic DNA (gDNA) was extracted from yeast-like fungal cells isolated from the skin biopsy specimens and then sent out for whole-genome sequencing. All subsequent analyses including de novo assembly were conducted in-house. In addition, PCR was used to target the internal transcriber spacer (ITS) region as well as the *Kex* gene. Overall, this is the first study to sequence and analyze the genome of *P. brasiliensis* var. *ceti* with the aim of identifying and characterizing genetic markers that may explain its pathogenicity and unculturability.

**Hydrodynamic Limitations and the Effects of Living Shoreline Stabilization on Mangrove Recruitment**

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Hydrodynamic forces, such as boat and wind waves, can dislodge mangrove seedlings, affecting the establishment of mangrove species and the long-term success of living shoreline stabilizations. Previous research has not provided quantitative thresholds to establishment in relation to these potentially limiting forces. We addressed this by quantifying the physical thresholds to recruitment in the early-life stages of the red mangrove, *Rhizophora mangle*, and the black mangrove, *Avicennia germinans*. In-field lateral pull-tests allowed us to simulate hydrodynamic forces exerted on these species, observing how force to removal changed through time and across different conditions. Significant increases (GLM: $p<0.01$) in force to removal occurred with increased below-ground biomass at early-life stages, as well as significant differences ($p<0.01$) between species. These measurements allow for the direct comparison of forces that seedlings experience in nature, improving our understanding of seedling susceptibility to uprooting and informing restoration methods.

**An Overview of the Loxahatchee River District's Volunteer Water Quality Monitoring Program**

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Since 1996 the Loxahatchee River District (LRD) has maintained a water quality monitoring program staffed entirely by citizen scientist volunteers from a wide range of ages and backgrounds. Over the 22 years, 75 people have collected water quality data one time or another at 42 different sites throughout the Loxahatchee River, its estuary and tributaries in the southern Indian River Lagoon. They have amassed nearly forty-four thousand data points on parameters including salinity, dissolved oxygen, pH, secchi depth, as well as water and air temperature. This data is compiled monthly and scored based on the available historical data from each individual site. The scores are compiled and presented as a water quality grade on LRD's website www.loxahatcheeriver.org (under Maps & Apps).

**Status of the Eastern Oyster (*Crassostrea virginica*) Population in the St. Lucie Estuary Following Hurricane Irma**

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The St. Lucie Estuary supports a robust oyster population when salinities fall within the optimal range. However, storm events and freshwater releases frequently decrease salinities to suboptimal levels causing widespread oyster mortalities. The most recent mortality event occurred following Hurricane Irma. Excessive rainfall and runoff associated with the storm resulted in large volumes of water being released into the SLE. The magnitude of these freshwater inputs were sufficient to cause a massive oyster die-off, but the timing and duration of the event exacerbated the effects and prolonged the recovery period by suppressing larval recruitment. Larval recruits that were in the water column when the storm hit were likely killed outright by low salinity and the absence of recruits in the following months suggests that the physical force of the water flowing out of the estuary prevented any downstream larvae from settling in the estuary before the spawning season ended.

**Genetic Diversity of *Halodule wrightii* Is Resistant to Large Scale Dieback – A Case Study from the Indian River Lagoon**

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Disturbance events can alter genetic diversity of a population (positively or negatively) which further impacts the population's response to additional disturbances. Seagrasses are experiencing increasing disturbance and large-scale losses; therefore, it is important to understand this diversity-disturbance relationship. In this study, we observe changes in diversity and population differentiation of *Halodule wrightii* during a large scale die-off in the Indian River Lagoon. While allelic richness and heterozygosity are relatively high and do not change over time, population differentiation ($F_{ST}$) increases, indicating genetic drift. The maintenance of diversity is important since seagrasses with high genetic diversity withstand environmental disturbances better than low diversity meadows. The observed increase in differentiation is only detectable because of replicate collections in one location, which are rare, but it indicates potential dispersal limitation which could hinder large-scale recovery. We recommend plant nurseries as management tools to preserve existing diversity and aid in restoration.

**Spatial and Temporal Variability of Algal Blooms in the Indian River Lagoon, Summer 2018**

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To better understand population dynamics of algal blooms in the Indian River Lagoon, phytoplankton concentrations were measured over Summer 2018. The spatial approach included thirty-four sites from the Mosquito, Indian River and Banana River Lagoons (all sites sampled in triplicate weekly). Whole water samples were collected from 0.5m depth and run through a flow cytometer. This sampling approach paints a picture of high temporal and spatial variability and highlights the occurrence of local hotspots in bloom initiation. Algal populations varied between and within lagoons. Mean cell concentrations varied from $5.0x10^4$ ($\pm 4.1x10^3$) cells $mL^{-1}$ (Melbourne Beach Pier, 5/21/2018) to $5.0x10^6$ ($\pm 7.2x10^4$) cells $mL^{-1}$ (Sykes Creek Parkway Bridge, 6/4/2018). *Aureoumbra lagunensis* ("brown tide") was usually present,

along with two to four overlapping phytoplankton communities dominated by mixed chlorophytes. These were likely of, or related to, the genera *Pseudoscourfieldia*, *Scherffelia*, *Nephroselmis* and others.

**Elasmobranch Community Dynamics in Florida's Southern Indian River Lagoon**

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Florida's Indian River Lagoon (IRL), an "estuary of national significance," has experienced myriad anthropogenic impacts in the past few decades. Unfortunately, there is a substantial data gap surrounding the status of elasmobranchs (sharks and rays) in the southern IRL. We implemented a long-term fishery-independent survey (longline/gillnet) to characterize elasmobranch communities and understand distribution in the southern IRL (Sebastian to St. Lucie Inlet). From July 2016-June 2018, 630 individuals of 16 species have been sampled and tagged, including two critically endangered smalltooth sawfish. Bull sharks, Atlantic stingrays, cownose rays, bluntnose stingrays, and bonnethead sharks were the five most common species encountered. Although dependent on survey gear type, we found evidence of seasonal and spatial patterns in elasmobranch abundance and species composition. This study provides the first baseline abundance indices for many elasmobranchs in the IRL and develops capacity to understand how elasmobranchs respond to further changes in this highly modified estuary.

**The 2013 Bottlenose Dolphin IRL UME Five Years Later: What Do We Know?**

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The 2013 IRL bottlenose dolphin unusual mortality event (UME) was the most severe of the three in recent history. Although the IRL has experienced more dolphin UMEs than any other U.S. estuary, causal factors remain uncertain. Initial assessments suggested the loss of seagrass during the 2011-2012 superbloom resulted in decreased prey availability and nutritional stress. The only consistent pathological finding to-date of emaciation would seem to support this conclusion. To provide greater insight into the ecology of these chronic UMEs we conducted a review of 2013 dolphin strandings and preformed stable isotope analyses as well as contaminant testing. While no clear source for the 2013 UME has yet emerged, our results indicate the loss of seagrass habitat did not result in nutritional stress but do suggest a long-term, food web-wide, alteration of the nitrogen cycle within the IRL which has been partially ameliorated through enhanced waste water treatment efforts.

**Preliminary Exploration of Algal Molecular Diversity in Florida's Waterways via Environmental DNA Sequencing**

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Algae are known to exhibit tremendous crypticism and modern approaches using DNA sequencing generally unveil much unsuspected diversity. Such approach is generally critical to accurately resolve species identifications, and in spite of the ongoing algal crisis in Florida, very little is actually known about the biodiversity of algae found in the State's waterways. This strongly impedes the capacity of environmental agencies to efficiently monitor, track and detect phytoplankton species, including harmful algal bloom species. In the present study, we assessed the feasibility of characterizing algal species in the Indian River Lagoon (IRL) with the gene *tuf*A. We present a preliminary molecular framework obtained from a few samples sequenced via cloning as a basis for oncoming high throughput sequencing via Next Generation Sequencing (i.e., Illumina metabarcoding).

**Integrated Observing Systems: An Approach to Studying Harmful Algal Blooms in South Florida**

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Ocean observing systems can play an integral role in evaluating the effects of both natural (e.g., climate change) and anthropogenic impacts (e.g., nutrient pollution) on such a complex system as the Indian River Lagoon. In this poster we present an integrated multidisciplinary approach to studying the recurrent large-scale harmful algal bloom (HAB) events that have threatened both the ecological and economic stability of the IRL and represent a significant public health hazard. Due to the complex biological, chemical and physical interactions associated with IRL HABs, the integration of classical observing methodology, such as phytoplankton surveys, with real-time water quality monitoring, innovative technology, and biological sentinels, is essential. The open sharing of data for research, education and public engagement is another key component of our approach. There are multiple stakeholders and end users that rely on these efforts to understand HAB dynamics in a unique marine system.

**Assessing the Effects of Oyster Reef Restoration on Macroinvertebrate Assemblages in Mosquito Lagoon, FL**

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Mosquito Lagoon (ML), the northernmost basin of the Indian River Lagoon (IRL), is home to hundreds of oyster reefs, which provide essential habitat for fishes and invertebrates. Oyster reef restoration is believed to benefit coastal ecosystems by increasing habitat availability. However, previous studies on the effects of restoration on benthic species assemblages in coastal estuaries have been equivocal. To address this issue experimentally, four dead oyster reefs in ML were restored in Summer 2017 and Summer 2018. To quantify species assemblage dynamics (i.e., changes in species diversity and composition) in response to restoration, restored reefs and control sites were sampled before and after restoration. Increases in species richness and Shannon diversity were observed on restored reefs post restoration. Nonmetric multidimensional scaling also revealed a shift in community composition on restored reefs over time. These and future results will be crucial to elucidating the cryptic mechanisms driving changes in marine communities.

**Intervention Strategies for Diseased Corals in Southeast Florida and Potential Impacts on Mucus Microbial Communities**

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Since 2014, southeast Florida's coral reefs have experienced an unprecedented disease event resulting in coral mortality of up to 83% on some reefs. The newly described disease, termed "scleractinian tissue loss," is now affecting coral reefs from Martin County to the Lower Florida Keys. As part of a joint research plan with the Florida Department of Environmental Protection, the Florida Fish and Wildlife Conservation Commission, and Nova Southeastern University, previously trialed antibiotic and chlorine intervention treatments will be implemented on *Montastraea cavernosa* and *Pseudodiploria clivosa* colonies at multiple sites in southeast Florida. Modeled 3D photogrammetry will be used to determine the efficacy of these methods. Additionally, coral mucus microbial communities of pre- and post-treatment individuals will be investigated to assess potential shifts in community structure that may indicate side

effects of treatment. These integrative datasets will contribute to knowledge of coral health and improved management strategies for coral disease outbreaks.

**ScienceIRL (In Real Life)**

Jennifer M. Sneed[1,2], Jasmine Fox[1,2], David Wood[2], Damian Spotts[2], Enrique Carmona[2], Philip Baldwin[2], Paul Reif[2], Kimberly Trosvik[2], and Gabby Barbarite[2]
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According to a 2016 study, only 40% of U.S. Adults have a "great deal" of confidence in the leaders of scientific communities. ScienceIRL is an initiative of the Indian River Lagoon Science Festival that aims to increase trust in science by making scientists more visible and accessible to the community. We implemented a pilot project in which we distributed t-shirts to local scientists with the text "This is what a scientist looks like" and asked scientists to wear the shirts simultaneously on Saturday, October 20 as they went about their daily business in the community. In this first year, 233 scientists participated from 30 local agencies/institutions. There was an overwhelmingly positive response from both the scientific community as well as the general public. In 2019, we plan to expand the project to include pop-up science events in the community, scientist happy hours, and more!

**Should We Look to the Sediments for Insights Regarding Future Seagrass Recovery in the IRL?**

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Seagrass provides numerous ecosystem services in the Indian River Lagoon, including habitat provisioning for juvenile fish as well as nutrient sequestration to mitigate coastal eutrophication. Changes in hydrology or water quality (e.g., light levels, nutrients, and harmful algal blooms), or in other unidentified factors in the IRL have caused drastic seagrass decline in some areas, with variable levels of subsequent basin-dependent recovery. Few restoration projects consider the role of sediment minerology in lieu of other primary factors. For example, the production of "toxic" sulfides fueled by organic carbon deposition has been demonstrated to cause mass seagrass mortality. We present results demonstrating that natural distributions of reactive iron in the IRL provide sediments with resilience by titrating sulfides from solution, effectively rescuing seagrass. By constraining the acceptable concentrations of reactive iron required for a healthy seagrass mineralogic substrate, these findings provide valuable insights into scalable strategies for future IRL restoration management.

**Have We Lost All Hope? Benthic Infaunal Monitoring across the St. Lucie River**

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Benthic infaunal communities are important indicators for the health of estuarine systems. They are relatively long-lived and immobile, and are sensitive to changes in water and sediment quality. Salinity and sediment type of the St. Lucie Estuary is influenced by freshwater inflow. To disentangle the effects of freshwater inflow and fine-grained sediments, benthic community and sediment samples were taken at five sites within the St. Lucie Estuary at three different water depths. The results suggests fine-grain sediments settle in the deeper sections of the estuary. Additionally, species richness was inversely related to the percentage of fine grain sediments. This indicates that sediment type plays a key role with salinity in determining community structure within the St Lucie Estuary. At shallow depths, less fine-grain sediments have more diverse communities indicating that there is hope for the St. Lucie River if both salinity and fine grain sediments are managed.

**Optical Discrimination of Harmful Algal Blooms in the Indian River Lagoon**

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In recent years, the Indian River Lagoon has experienced several algal bloom events, each dominated by a single phytoplankton type. These blooms can be harmful to the IRL ecosystem in a multitude of ways, including the production of toxins or other irritants, increased turbidity of the water column, and depletion of nutrients and oxygen by excessive biomass. The optical properties of these bloom events are examined for signatures that can be used to quantify the biomass present and to identify the dominant species, which is related to the type and amount of toxin that may be formed by a bloom. Optical measurements can also be used to determine the depth to which light can penetrate through an algal bloom, a value critical to maintaining healthy seagrass beds. This examination also informs what techniques are best suited to ongoing efforts to monitor harmful algal bloom events in the IRL.

**Health and Population Trends of North American River Otters from East Central Florida**

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North American river otters (*Lontra canadensis*) are widely distributed throughout Florida but the population and health status are not well studied in the state. As a top mammalian predator, we propose that river otters are an important sentinel species in the lagoon watershed as they epitomize the land/water interface. To understand the threats and status of otters, we initiated a two-pronged study: 1) a citizen science program to collect otter sightings 2) salvage of dead otters modelled after stranded marine mammal programs. Samples were collected for histopathology, virology, parasitology, protozoal serology, stable isotopes, stomach content analysis, and cytology. Gross necropsy results were consistent with vehicle strikes however signs of chronic and sub-lethal disease were apparent from histopathology. These preliminary results represent the first study of the health and status of river otters in east central Florida and the most comprehensive study of Florida otters in recent years.

**Can Biorock Be Used to Restore Oyster Reefs in the Indian River Lagoon?**

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Many marine invertebrates form a calcareous exoskeleton to protect them from predators or adverse environmental conditions. Biorock is a process, first proposed by Hilbertz (1977), where steel structures are driven cathodically to form cathodic chalks and create surfaces and local environments that are favorable to the settlement and growth of such organisms. Biorock has been successful in coral restoration efforts worldwide. This talk explores the application of cathodically protected steel mesh to replace the plastic which is commonly used in oyster restoration efforts. A pilot study, deployed at Port Canaveral, suggests that biorock will develop on steel mesh, enhance oyster recruitment, and help cement the organisms together.

**Genetic Diversity of a Seagrass Nursery – Managing Diversity**

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Seagrasses are being lost throughout the Indian River Lagoon, Florida, making restoration an important management tool for maintaining and increasing habitat. A lack of genetically diverse source material can hinder restoration efforts. Seagrass nurseries provide a strategic management tool that can be used to preserve and enhance natural meadow diversity. At the Florida Oceanographic Society, we have a land-based seagrass nursery, primarily composed of *Halodule wrightii* grown from naturally uprooted fragments. We genotyped the nursery and found that genetic diversity was within the range of naturally occurring populations. However, this diversity was not high and six distinct clones dominated. To preserve genetic diversity, we isolated and cultivated unique genotypes with distinct morphologies. Preliminary results show that *H. wrightii* morphology and growth differ between individual clones, and previous work suggests that diversity is related to increased population stability, highlighting the need for maintaining a genetically diverse nursery for restoration.

**Integrating Sense of Place into Future Indian River Lagoon Restoration: A Critical Move Forward**

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Environmental restoration is an activity rooted in human perceptions and priorities, since it requires making choices about which aspects of a place are valued, and whether they can or should be recovered. This project sheds light on the complex human-environment relationships in the Indian River Lagoon to better understand how people's values can inform oyster reef and living shoreline restoration. Since early 2018, concerned locals have mapped hundreds of points and polygons to show which places in the Indian River Lagoon have special meaning to them. People also mapped locations where they have seen signs of environmental degradation and places they would prioritize for restoration. Combined with qualitative data from focus groups and other spatial data about ecological conditions, these data tell a rich story about how future restoration can integrate local knowledge to facilitate communication, enhance restoration success, and strengthen productive collaborations between scientists and communities.

**Multi-decadal Shifts in Fish Community Diversity across a Dynamic Biogeographic Transition Zone**

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Species distributions are shifting in response to a warming climate, redefining regions of transition. Here we explore multi-decadal fish community diversity metrics across a coastal biogeographic transition zone to quantify changes in species assemblages, assess relationships between fish community diversity and the abiotic environment, and capture potential shifts of a putative biogeographic break using fisheries-independent data collected by the Fish and Wildlife Conservation Commission. These data indicate a small northern shift in the biogeographic transition zone which grows more significant when extrapolated into the future. Beta diversity was driven by species sorting associated with the environment. Excluding the summation of all potential environmental variables, temperature and its related variables (month, dissolved oxygen, etc.) best described patterns of diversity, while temperature and dissolved oxygen best described species assemblage. Quantifying and understanding these changes in community composition

will be critical to predicting, conserving, and managing future species assemblages in dynamic coastal systems.

### *Pyrodinium bahamense* Growth and Toxicity: Are Indian River Lagoon Cells More Toxic?

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*Pyrodinium bahamense* is a saxitoxin-producing harmful alga that blooms almost every year in the Indian River Lagoon (IRL) and Tampa Bay. Saxitoxins are potent neurotoxins that can accumulate in shellfish and cause paralytic shellfish poisoning in humans if consumed. Variability in *P. bahamense* growth and cellular toxicity (within and between populations) can have implications for resource management. To investigate this variability, we compared growth-irradiance curves and cellular toxin profiles and concentrations of two Florida *P. bahamense* isolates (from the IRL and Tampa Bay). Results suggest *P. bahamense* is a high-light adapted species, so toxin investigations were subsequently conducted under the observed optimal irradiances for growth. Growth and toxicity results for each isolate were compared to each other and to published values for Pacific isolates. Future work will focus on comparison of growth-temperature curves of the two isolates and toxin variability in response to changing environmental conditions like salinity and temperature.

### A Comparison of Oyster Settlement Monitoring Techniques

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Deployment of dead shell or rock substrate is an effective method of restoring oyster reefs if sufficient spat supply is available in the local water column. A common technique for assessing this supply and oyster reef restoration success is the use of a paired string array with hanging substrate for oyster spat settlement on PVC “Ts”. These arrays are typically deployed in association with natural and restored oyster reefs to determine success. However, settlement substrate, tidal elevation, and distance of substrate from the sediment can vary among studies. In this project, we tested how two different substrates (tile and oyster shell) at different elevations (suspended “Ts” and non-suspended cages) affected the eastern oyster (*Crassostrea virginica*) settlement in different tidal zones (high intertidal, mid intertidal, and subtidal). Preliminary results indicate limited recruitment in the high intertidal zone with recruitment in the intertidal and subtidal zones differing by settlement substrate.

### Determining the Genetic Relationship of Sympatric Croaker (*Micropogonias* spp.) Inhabiting the Indian River Lagoon

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The Atlantic Croaker (*Micropogonias undulatus*) is found in western Atlantic waters ranging from Massachusetts to Louisiana. The Whitemouth Croaker (*Micropogonias furnieri*) is commonly found in the coastal waters of the Caribbean and South America. Both species coexist in Indian River Lagoon (IRL), a biodiverse estuary on the east coast of Florida. In this region croaker may be hybridizing, as individuals cannot be identified using morphometric methods. To explore this possibility, we used genetic tools to identify species. We sampled from various regions and PCR amplified the mitochondrial COI gene. We

then constructed a haplotype network to determine the genetic divergence between populations. Samples from Jacksonville, the Gulf of Mexico, and offshore Atlantic formed one distinct group; the Southern IRL and St. Lucie Estuary formed a second distinct group; and individuals from the Northern IRL shared haplotypes with both groups, suggesting hybridization in the Northern IRL.

**Planting Seagrass: (1) What's the easiest way to plant seagrass? (2) How to involve the public?**
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(1) What's the easiest way to plant seagrass? Many seagrasses, including *Halodule wrightii*, naturally recruit by vegetative fragments. The natural process involves: rhizome fragments are uprooted (storms, manatees…), float, then sink, attach, and spread. Duplicating this process is easy, including the high failure rate. Rhizome fragments are held in place, either with staples or simply by pushing the fragments into the sediment. This staple process was successful at a site at the town of Sebastian – with volunteer help.
(2) How to involve the public? It will not be possible to plant the entire 130 $km^2$ of seagrass lost due to the 2011 phytoplankton superbloom. Instead, many patches need to be created, which will then supply recruitment material to surrounding areas. In order to plant many sites, many people are needed. With a short training video, most anyone could plant. But how and who to enlist volunteers? *Quo vadis?*

**Exploring the Presence of Seahorse Hybrids (*Hippocampus erectus* x *Hippocampus reidi*) in the IRL Using PCR-RFLP and DNA Barcoding**
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It has been documented that the lined (*Hippocampus erectus*) and longsnout seahorse (*Hippocampus reidi*) are able to make viable offspring in captivity, but no hybrids have been documented in the wild. The habitat range for these two species overlap in the Caribbean, and throughout Florida, yet the furthest north documented sighting for the longsnout seahorse is in the Caribbean. In this project, visually elusive longsnout seahorses and possible hybrids between the longsnout and lined seahorse were investigated from seahorses found by citizen scientists in the Indian River Lagoon. By extracting the DNA from each sample, we are able to explore polymerase chain reaction restriction fragment length polymorphism (PCR-RFLP) and mitochondrial cytochrome c oxidase 1 gene (CO1) for each sample. This project will help determine if the longsnout seahorse or hybrids are present in our local ecosystem.

**Endangered Birds, Imperiled Oyster Reefs, Citizen Science, and Engaging Children with Cancer**
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Oysters are a keystone species in the Indian River Lagoon based on their capacity to filter water, denitrification, and provide habitat as well as food for numerous species. In Mosquito Lagoon, oyster reef restoration (2007 – present) has successfully provided substrate for over 10 million oysters. Here we seek to understand the impact of oyster restoration on avian success, especially for threatened/endangered (e.g., wood storks, oystercatchers) and charismatic (e.g., pink roseate spoonbills) species that drive local eco-tourism. To complete this objective, we need lots of help! We will discuss our goals for citizen scientist participation in this project, as well as a new initiative with Nemours Children's Hospital PedsAcademy in Orlando, FL to have hospitalized children engage in extensive data processing.

**Construction of a Treatment Wetland to Reduce Nutrient Loading from Stormwater Runoff into Coastal Waters**

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A treatment wetland has been constructed using an existing diversion pond connected to an outfall canal that discharges stormwater from the urban Daytona Beach and South Daytona areas into the Halifax River. The goal of this restoration project is to improve existing stormwater discharge management systems within Reed canal, which receives untreated urban runoff totaling 1,252 acres from the drainage area. The treatment wetland uses native wetland plants for increased nutrient uptake, and an added dry pond diversion system to increase water retention time. Expected outcomes are a 20% reduction in total nutrients, and a 30% reduction in total sediment in the stormwater discharge evidenced by monthly water quality monitoring. Public education programs will be conducted to gauge knowledge and awareness of stormwater pollution, fertilizer ordinances, and how they impact estuarine systems. This project is funded by the Indian River Lagoon National Estuary Program (IRL-NEP).

**IRL Idiosyncrasies: Lessons Learned on Living Shorelines in Brevard County**

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Brevard Zoo has collaborated in multiple restoration projects throughout the Indian River Lagoon for the past decade. Since 2014, the now-named Restore Our Shores (ROS) program has focused on ventures in its own backyard, with Brevard County as a frequent partner. Preliminary data collected from the oyster gardening program and monitoring from the subsequent living shoreline projects built using gardened oysters gives a small glimpse into the complex variance within the IRL. The unique characteristics of Brevard County's portion of the lagoon have created challenges but also many opportunities to evaluate methodologies. Moving forward, multi-pronged approaches in restoration and enhancement projects will be explored to meet the distinct needs of Brevard.

**Full Mangrove Takeover: Exploring Ecosystem Shifts within the Indian River Lagoon**

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Ecosystem shifts are changes in the functions, structures and composition of a system. This research explored: 1) if an ecosystem shift has occurred in the Mosquito Lagoon between oyster reefs and mangrove islands, and 2) the sources of any shifts. GIS imagery from 1943-2017 was used to select 23 sites in various transitions. Data was collected on mangrove recruitment and success, live oyster density, and landscape effect. On each reef, three red and three black mangroves in each class (height: 0-50 cm, 51-100 cm, 101-150 cm) were tagged and the height and diameter were measured for each tree. Oyster data was collected through non-destructive live oyster counts with haphazardly tossed $0.5m^2$ quadrats, 30 per reef. Satellite imagery was digitized to analyze effect of geographic location on the transition. The data gathered from this research is essential to understanding the balance between two critical estuarine resources – oysters and mangroves.